PRELIMINARY MANUSCRIPT

CRIME PREVENTION THROUGH ENVIRONMENTAL DESIGN

CPTED PROGRAM MANUAL

Volume IIIB
CPTED Technical Guidelines
in Support of the
Analytic Methods Handbook

Prepared by

Imre R. Kohn, Westinghouse Electric Corporation
Richard M. Locasso, Westinghouse Electric Corporation
Avishay Dubnikov, Westinghouse Electric Corporation

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Westinghouse Electric Corporation
Arlington, Virginia 22202

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John Edwards, Loyola University, Chicago
Paul D. Jensen, Pennsylvania State University
Paul J. Lavrakas, Westinghouse Electric Corporation
Michael I. Liechenstein, St. Johns University
David L. Post, Pennsylvania State University

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ENVIRONMENTAL ASSESSMENT METHODS

1. Introduction

It is important to obtain information about the physical environment in the CPTED project area for three reasons. First, it provides a basic descriptive picture of the local environment. Basic environmental factors can immediately suggest specific CPTED strategies (e.g., painting and renovating rundown houses). Second, crime/environment relationships can be identified only if the necessary environmental information is adequately organized vis-a-vis crime data. Uncovering crime/environment relationships in the CPTED project area allows the development of strategies that are specifically tailored to meet these individual problems. Finally, certain types of environmental information are helpful in evaluating the effectiveness of the project.

The purpose of this guideline is to provide the CPTED analyst with the skills necessary to do valid environmental assessments in a project area. Different procedures for collecting information about the environment are discussed, and emphasis is placed on methods of analyzing and interpreting such information. This emphasis allows the CPTED analyst not only to collect the information but to more readily integrate and use it to help uncover crime problems in the community.

The guideline is written for individuals working in the general areas of planning, community development, or related municipal government agencies. A background in research methodology or data analysis is not necessary for the use of this material but would be helpful.

The term *environmental assessment* is used to apply to methods that have as their objective the collection of information concerning the characteristics of the physical environment. Excluded by this definition are data concerning the social environment (e.g., population data, social activity patterns, and social gathering spots), the institutional environment (e.g., the number and variety of community groups operating in the CPTED environment and business organizations), or the law enforcement environment (e.g., number of policemen available and deployment policies). Additionally, the working definition of environmental assessment for the present chapter excludes aspects of the physical environment that are unrelated to CPTED concerns (e.g., the color of houses, whether streets are paved with cement or asphalt). Finally, as noted above, the search for crime/environment relationships is a major point of emphasis throughout the discussions of the different environmental assessment methods presented. Thus, the many perspectives, insights, and analytic approaches presented will allow the reader to become more skilled and proficient when analyzing crime/environment problems in the local CPTED project area.

This guideline is organized in the following manner. Section 2 discusses the advantages of obtaining information from residents, police, and other key people in the local community. Section 3 describes how to construct and interpret crime/environment maps as a method of uncovering targets for further analysis. Section 4 discusses how to collect data about the environment through the use of questionnaire scales, together with the charting and interpretation of these data. Section 5 describes the OTREP (opportunity, target, risk, effort, and payoff) model and shows how the CPTED analyst can use this perspective to better understand and isolate those factors of an environment that encourage the potential criminal to commit a crime. Section 6 describes how to construct and use security surveys similar to those used by police departments throughout the United States.

2. Key-Person Interviews

Formal and informal interviewing procedures represent methods that are easy to use, flexible, and capable of providing data on a wide variety of issues. As part of overall CPTED methodology, valuable information concerning the physical and social environment can be obtained through interviewing techniques. Sessions with individuals who are familiar with the project setting should be conducted as part of the initial phase of crime/environment analysis. As will be discussed in Section 6, key-person interviews are also important during the final phase of the analysis.

2.1 Advantages of the Interview Method

The interview is a useful method for obtaining information about complex subjects and for probing opinions and sentiments concerning project-related problems and issues. In face-to-face interviews especially, the interviewer can observe not only what the person being interviewed (respondent) says but also how he or she says it. The most important feature, however, is the flexibility of the method. Various issues can be covered superficially or thoroughly depending upon the interviewer's requirements. Additionally, interviews can be conducted on an individual or group basis. The latter is useful for developing a sense of the range of opinions and perceptions.

The key to successful interviewing is in the rapport that is established by the interviewer. Although training can be helpful in preparing interviewers for meeting the public, it can only go so far. Some individuals are simply better able to interact with a variety of people than are others. Furthermore, rapport is affected by interviewer characteristics that cannot be influenced by training. In general, most people find it easier to interact with others who are similar to them in some respect. Differences in sex, race, ethnic background, or education level between interviewer and respondent constitute barriers to the open expression of feelings. Within certain limits, therefore, interviewers should be selected who are similar to the people with whom they will be talking. In all cases, they should also be people who inspire trust and respect.

With respect to structure, the order of questions is dictated by common sense as much as by any concrete guidelines. Thus, general questions (e.g., "Have you ever been to Madison Street?") should go before specific questions that follow from them (e.g., "Have you ever taken the Madison Street bus?" or "Have you ever visited the Madison Street Park?"). Also, more personal questions should come at the end, after answers to less sensitive questions have been obtained.

The degree of constraint on types of response can be quite varied. At one extreme is the open-ended question, in which the person provides a response in his or her own words. For example, on could ask, "How would you describe your feelings about walking around your neighborhood alone at night?" At the other extreme is the completely-closed-ended question in which the person must choose from a list of alternatives. For example, the previous question about walking around alone at night might be followed by such options as: "Very fearful, slightly fearful, not at all fearful, and don't know."

Both open- and closed-ended questions have their positive and negative features. Open-ended types are less susceptible to the effects of preconceived notions about what people's answers should be, and they can provide richer, more detailed information. On the other hand, the data are more difficult to code and analyze, and they are dependent upon the respondents' willingness and ability to express themselves verbally.

Closed-ended questions tend to have the opposite pattern of advantages and disadvantages -- what they lack in flexibility, they make up for in convenience. In fact, there is no reason why both types cannot be used. For example, an interviewer could begin with a general, open-ended inquiry, followed by more specific questions with fixed, alternative answers. In addition, the two types of questions are often used at different stages of an evaluation project. Open-ended questions could be used at the earlier stages of crime/environment analysis to determine what fixed alternatives would be relevant to use in a more refined, closed-ended questionnaire in the later stages, particularly when the OTREP Environmental Assessment Package is used.

2.2 Residents

Information about the environment can be obtained through discussions with residents of a community. This approach assumes that people living and working in an area daily would, through their intimate experience with the area, have a great deal to say about the positive and negative factors of that environment. While a CPTED planner can go into a community and observe the area to assess the environmental characteristics, he cannot gain the insights that the residents have developed from years of living in that community.

Decisions regarding sample size and other factors are made according to the purpose of the interviews. For example, when entering an area to determine if problems exist, the interviewer would ask informal, unstructured questions (i.e., open-ended questions) and would contact about 5 to 10 persons representing a fairly wide distribution of people. If, on the other hand, the existence of particular problems in a certain community has been determined, the interview could be more structured, involving a larger sample, to examine these problems.

It is important for the CPTED planner (or the staff who are going to conduct these interviews) to ensure that a representative selection of individuals are contacted. It is not a good procedure to walk down the street or to knock on a few doors and randomly speak with a few people. Together with other issues, the number of people to be contacted should be determined before interviews are initiated. (See Section 5 of Guideline 5 for a discussion of sampling methods.)

2.3 Law Enforcement Officers

Discussions with foot patrolmen and squad car personnel can identify those areas in the community that typically are characterized by certain types of crime. For example, policemen could say that more burglary of a certain type tends to occur on certain streets; harrassment of the elderly tends to occur in certain secluded areas; or, at a certain time of day or night, vandalism has been a problem near the school. These data may be available in detailed form in the police records; however, it takes a great deal of time to secure this information from records, and police officers often have information to offer that is not included in formal reports.

2.4 Members of Community Organizations

Community organizations can act as a source of crime/environment information for a given site. Many times, a civic association receives complaints from its members, who hope to initiate intervention by appropriate government agencies to solve their problems. The CPTED planner can take advantage of this by speaking with the leaders of community organizations and learning of the important crime-related issues that characterize a particular area.

The chamber of commerce can provide a list of community groups that are active in specific areas, together with names of the officers of these groups. These individuals, in turn, can direct the CPTED analyst to smaller groups that may be functioning in their area (e.g., block-watch groups). Members of the educational, business, and religious communities should also be contacted to determine if local organizations exist based on these areas of interest.

2.5 Use of Interview Data

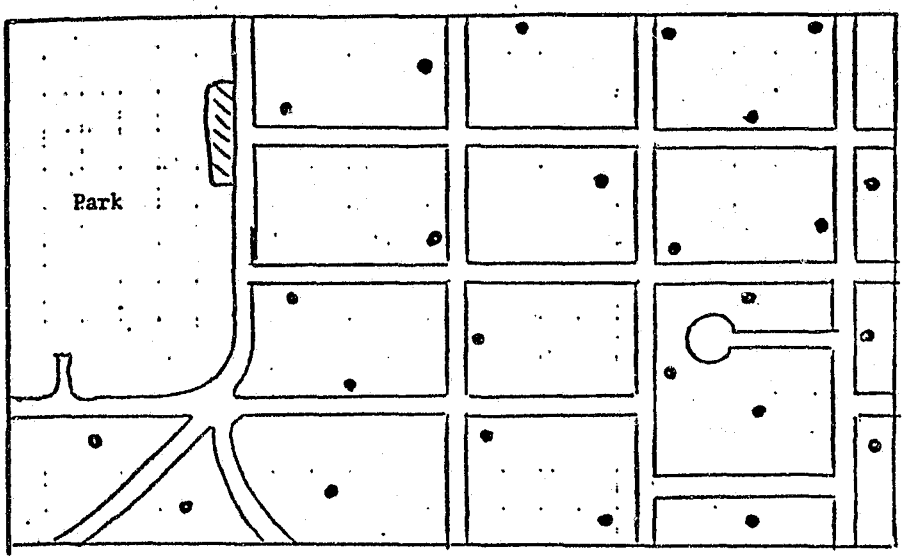
After interviews with residents in an area, policemen who work in a community, and leaders of the community organizations, it is desirable to verify the obtained information. For example, after receiving certain descriptions of environmental problems, the analyst should go to the environments in question and observe these problems. This extra step can lead to a more detailed analysis of existing problems or it can indicate to the analysts that the environmental problem may be more in the mind of the respondent than in the environment. Thus, it is important for the CPTED planner to be sure that the information with which he is working is accurate.

In addition to providing basic information for the CPTED planner, discussions with key persons in the community can generate formal hypotheses that can be tested by more rigorous data collection methods. Similar reports may come from residents of the community, the police, and the community organizations. For example, all of the reports could point to a particular three- or four-block area that is characterized by high burglary rates. Examination of the environment could indicate that the heavy foliage surrounding the rear of the homes shields the activities of criminals, or that the area is used by juvenile delinquents because they cannot be easily observed. These hypotheses could be tested through the design and conduct of small-scale field studies. Designing studies to formally examine these hypotheses is particularly important if the planner is considering expensive and costly activities to combat the problems in the community (see Chapter 3).

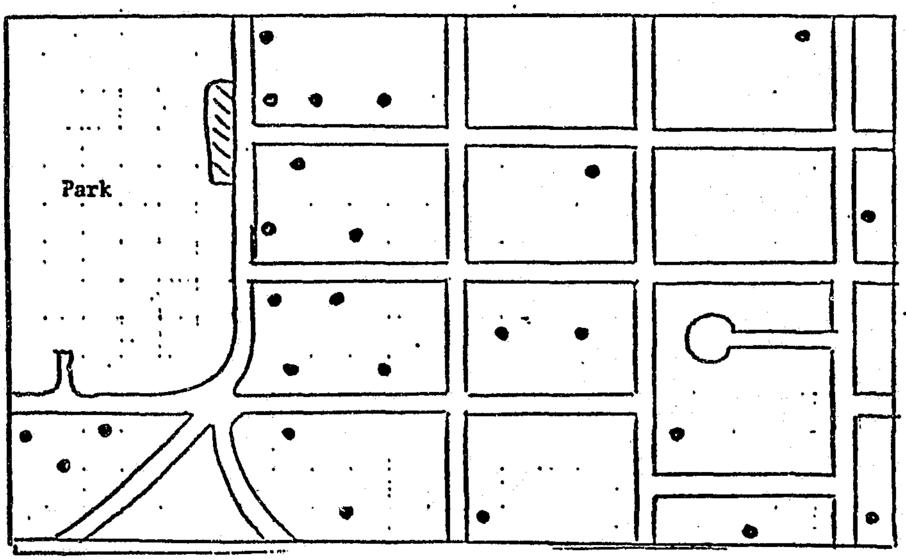
3. Mapping Crime/Environment Relationships

Consider the two crime/environment maps of a small, hypothetical residential area depicted in Figure 1. The points on each map represent the burglaries that occurred in the neighborhood over a period of one year. Although the total number of burglaries in each example is equal, the spatial distribution is very different. Map A shows a relatively random distribution of crime, with each area about as likely to be victimized as any other area. Map B indicates that the western portion of the neighborhood, particularly those blocks adjacent to the recreation park, experience much more burglary than other parts of the neighborhood. Onsite environmental evaluation of the high-crime-rate blocks made by the CPTED team, and discussions with area residents and the local police, could indicate that: (a) Burglars use the park as a quick and safe means of exit; (b) burglars can use the park to observe many different households without raising suspicion; and (c) burglaries of certain homes are facilitated by a lack of adequate fencing between the yards of the homes and certain parts of the park.

This brief example illustrates the value of crime/environment mapping for a CPTED project. Crime/environment mapping is useful for two reasons. First, it provides a descriptive picture of where crime is occurring in a given CPTED area. Second, it provides relational information concerning environmental factors that could account for the different patterns of crime. The relational information is valuable in that it allows the CPTED team to formulate crime prevention strategies that are designed specifically for the environment at



MAP A



MAP B

Figure 1. Two Hypothetical Distributions of Burglaries Occurring Over a One-Year Period in the Same Neighborhood

hand. Descriptive information can be very valuable, for example, when assessing the fear-of-crime problem in a given area. If local residents express fears concerning criminal victimization in certain areas in their neighborhood, the crime/environment map will indicate if high crime rates actually characterize the high-fear areas, or if the CPTED team should investigate possible environmental factors to account for the fear-of-crime problem.

Different statistical indices are typically used to provide descriptive and relational information about a body of data. Descriptive measures include means, standard deviation, pictograms, and so on, while relational information is provided by correlational statistics. Since statistical measures can be very precise and also can allow the quantification of relationships, one can justifiably ask why mapping procedures are being used in lieu of available statistical procedures. The answer is that while various aspects of crime (e.g., type of crime, age of offender, and time of day crime occurred) can be easily quantified, important characteristics of environmental information cannot. It is difficult and in certain instances meaningless to quantify environmental factors such as degree of cover provided by surrounding vegetation or the ease of escape through a back alley.

Since the relational information between crimes and characteristics of the environment comes from correlation coefficients, the CPTED analyst would have to quantify every conceivable environmental variable, compute the correlation coefficient between each environmental variable and characteristic of crime, and then examine the magnitude of each coefficient. In addition to being both prohibitively expensive and time-consuming, this approach is unrealistic because of the infinite number and variety of environmental configurations that can surround the criminal event.

The major emphasis of the present discussion on crime/environment mapping will concern the residential environmental mode. Most mapping work that has been completed to date has been done in residential areas. However, there is no reason that the techniques and procedures cannot be extended to different areas within the urban environment (e.g., commercial and recreational). A possible limitation is the difficulty of applying crime/environment maps to multilevel structures.

The remainder of this section is organized in the following manner. Section 3.1 discusses the types of maps used and where they may be obtained. Section 3.2 discusses the types of crime and environment data that are used, where they are obtained and how they are plotted. Section 3.3 shows how to prepare overlays to depict crime and environmental data, and Section 3.4 shows different ways of aggregating the data to facilitate visual analysis.

3.1 Environmental Maps

A large Sanborn map of the entire CPTED area is required for the crime/environment mapping procedure. The Sanborn map depicts streets, alleys, individual house lots, buildings, addresses, parks and recreation areas, and other land use functions, and is available from the municipal planning department. The map should be 3 by 5 feet or larger, so that a great amount of detail will be clearly visible. The paper should be mounted to a firm and durable backing, since the base map will experience a great deal of use over the months, perhaps years, of the CPTED project.

A Sanborn map can be available as a large single map, or it can be in the form of many small maps that will have to be pieced together. Occasionally, some of these smaller maps are drawn to different scales, necessitating the procurement of photographic enlargements or reductions before they can be combined into a single base map.

In some instances, the CPTED team can update an older map or add certain refinements to the base map. Systematic observations of the CPTED area could provide the following information for updating or improving the base map: Accuracy of zoning codes; location of vacant lots and abandoned houses; areas of many trees and heavy vegetation; exterior barriers (such as fences and concrete walls); informal pathways connecting one area to another; neighborhood landmarks, if any exist; and any other potentially valuable environmental data.

Although these data are typically drawn onto the base map, too much information of this sort can make the base map difficult to use and understand. To avoid this problem, the additional environmental information should be located on a series of transparent overlays. This practice not only keeps the base map free of too much clutter but also allows the systematic examination of each environmental factor, in turn, as the appropriate overlay is placed on the base map in conjunction with the crime pattern that is being analyzed.

Additional maps containing different or more detailed information could be available from other municipal departments. For example, the parks and recreation department could have excellent maps of the area's recreation facilities. Traffic engineering could offer maps that depict parking areas and regulations, and traffic flow patterns. The nature and effectiveness of illumination of streets and park areas could be found on maps from the public works department. If additional maps are available, they should be included in the crime/environment mapping process.

The design and construction of different maps available from municipal agencies can be varied and complex. It is important for the CPTED analyst to interpret the various symbols and mapped data correctly. The analyst should talk at length with officials in the different municipal agencies to be sure that the CPTED team is not misinterpreting any mapped information. Visits to local agencies to locate and interpret the available environmental maps should require from 2 to 5 days.

3.2 Crime Data

After the environmental base maps have been obtained, a sufficient variety and amount of crime data should be gathered so that the crime/environment mapping process can begin. A further description of the sources of crime data and methods of tabulation and interpretation is provided in Appendix C and Guideline 4. Only those data-related issues specific to crime/environment mapping are covered in the present discussion.

Most typically, the data concerning crimes in the CPTED area will come from records of the local police department. Sometimes this information is broken out in a manner that is immediately usable by the CPTED team but, more frequently, it will require searching and collation. Another possible source of information is the victimization studies that could have been completed recently in the CPTED area.

3.2.1 Property Crimes and Violent Crimes

Crimes can be sorted into two basic categories: Crimes against property and crimes of violence. The mapping process provides the most valuable insights when crimes against property are examined. This is true because crimes of violence (e.g., assaults, rapes, and murders) do not usually occur with sufficient frequency to permit detailed analysis. Additionally, crimes of violence in residential areas often take place between individuals who know one another (family members, neighbors, and friends) and, therefore, environmental factors play a much smaller role in these crimes than social or interpersonal factors.

The crime of robbery, however, represents a violent crime that can be effectively mapped. Robberies tend to occur between strangers and, in certain areas (especially commercial areas), a sufficient density exists to allow meaningful mapping analysis.

It is generally acknowledged that crimes of violence are much more fear-producing in the local population than property crimes. If the CPTED project area is identified as suffering from a fear-of-crime problem, a separate mapping analysis should be undertaken solely for data on violent crimes. This analysis should attempt to uncover any relationships between pockets of fear in the project area and the occurrence or patterns of fear-producing crimes. Unless otherwise stated, the following discussions on crime/environment mapping procedures concern only robbery and crimes against property.

3.2.2 Types of Property Crimes

Four basic types of crimes against property occur with sufficient frequency in the environment to permit meaningful mapping analysis. These crimes are burglary, larceny, auto theft, and vandalism. Unless circumstances in the specific CPTED area suggest otherwise, data for these four types of crimes should be collected. In addition to being identified by type of crime, the occurrence of each instance should be coded with respect to location (and this should be as detailed as possible), calendar date, day-of-week, time-of-day, offender age, victim age, and any other information that can have special meaning in the environments in question.

3.2.3 Data Collection Period

Data should be collected, organized, and mapped in 1-year time blocks. Data for no fewer than 3 successive years, beginning with the most recent complete year, are necessary before valid crime/environment relationships can be documented. It is impossible to know whether discernible crime/environment patterns present in data from 1, or even 2, years are due to chance factors.

3.2.4 Required Density of Crime Incidents

Crime/environment mapping can provide potentially valuable information only if crime incidents have occurred with sufficient density in the CPTED area. The fact that an area has already been singled out for CPTED attention implies that the existing crime density will be sufficient for meaningful mapping analysis. This is usually true for burglary and larceny and, depending upon specific environmental factors, may also be true for auto theft and vandalism.

An average frequency of about 2 crimes per residential block will provide a crime incident density that is adequate for meaningful mapping analysis. Thus, if a CPTED project covered an approximate 15- by 18-residential-block area, it would be desirable for purposes of analysis to have a minimum of 540 crimes.

As the density drops below the 2 -per-block guideline, it becomes increasingly difficult to visually spot crime/environment problems on the map. One does not know if the lack of discernible relationships on the map is an accurate reflection of the situation, or if the relationships are not apparent simply because too few crimes are plotted on the map. If, on the other hand, a crime/environment problem is present on a map characterized by low-density crime data (over 3 separate years), this would indicate that those problems exist in the CPTED project area.

Thus, crime/environment mapping, even with low-density crime data, can document problems in the CPTED project area. However, the absence of apparent crime/environment problems on the map cannot be interpreted to indicate a similar absence of problems in the CPTED area. This means that the CPTED team can benefit from mapping procedures with low-density crime data only if crime/environment problems are documented on the map;

if no such problems become apparent, then no conclusions concerning the presence or absence of crime/environment problems in the CPTED area can be validly drawn.

Another factor relevant to mapping with low-density crime data is the strength of the crime/environment relationship in the CPTED area. If a strong relationship exists (e.g., if the majority of auto thefts occur in secluded alley areas), this problem area should be easy to spot on the crime/environment map even with low-crime density data. Map B in Figure 2 shows what a map of this particular situation would look like. Map A depicts the same density of crime but with a weaker relationship between the auto thefts and the alleyways. In this situation (and illustrating the point made earlier), the low-density crime data becomes problematical. It is impossible to determine that a relationship exists because the weak relationship that is apparent could be due to chance factors when such a small number of crime incidents are plotted.

3.3 Construction of Crime/Environment Overlays

Construction of the environmental base map (the Sanborn map obtained from the local planning department) was described in Section 3.1. To construct a crime overlay, place a sheet of transparent material (such as acetate) over the environmental base map. Index the exact location of the acetate sheet on the base map. This will allow the crime overlay to be returned to its exact original position once it has been removed.

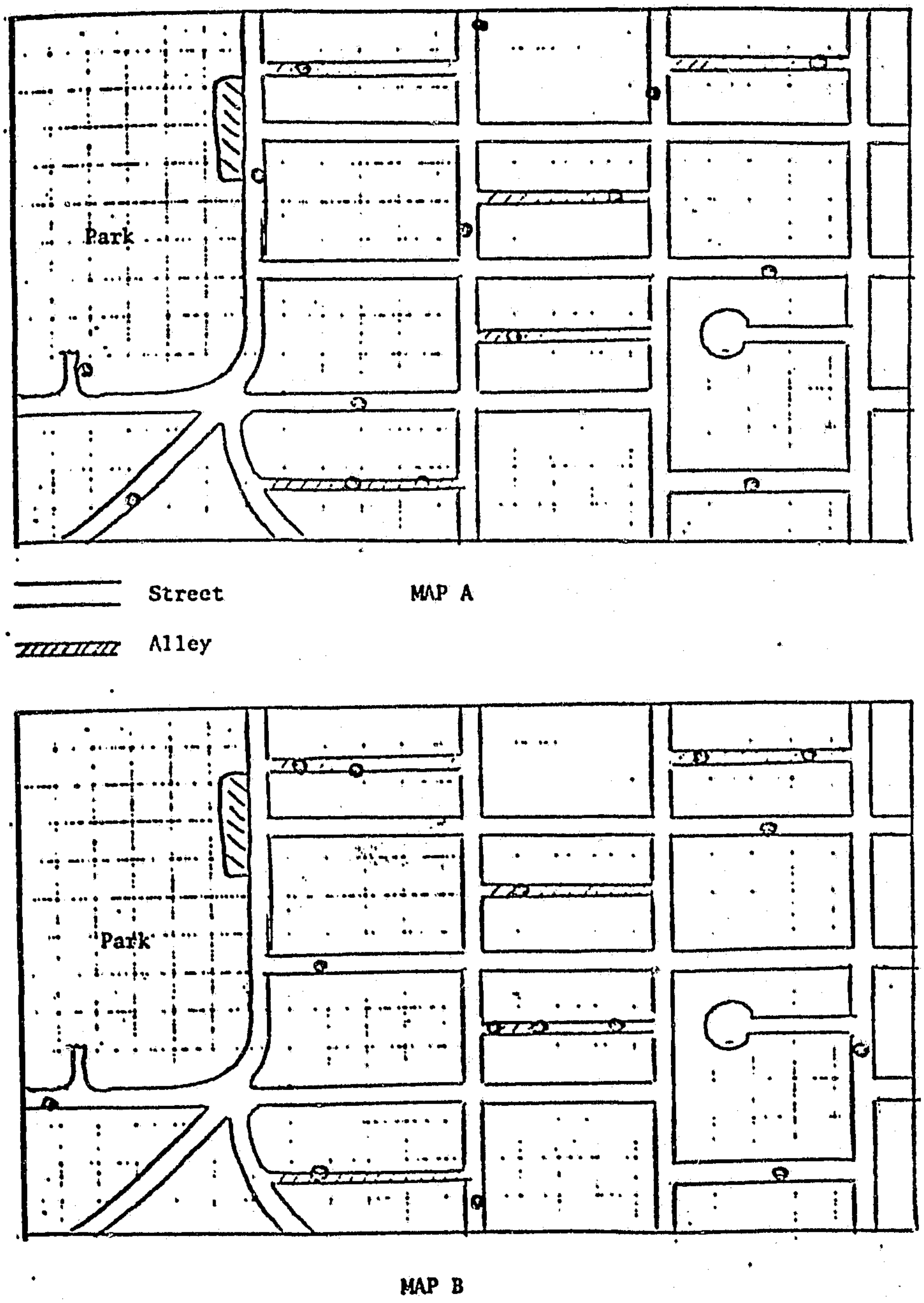


Figure 2. Low Density Crime-Environment Maps Depicting Weak (Map A) and Strong (Map B) Relationships Between Auto Theft and Alleyways

TABLE 1

Overlays for Crime and Environment Data

CRIME	ENVIRONMENT
1. Type of Crime	1. Lighting Pattern
a. Burglary	2. Informal Pathways
b. Larceny	3. Functional Areas
c. Auto Theft	4. Trees and Vegetation
d. Vandalism	5. Traffic/Parking
e. Crimes Against Persons	
2. Season	
a. Summer	
b. Winter	
3. Time of Day	
a. Daytime	
b. Nighttime	
4. Aggregated Data	

3.3.1 Construction of the Crime Overlay

Select a subset of crime data to be plotted for a specific overlay. Table 1 lists subsets of crime data that are typically used to define different crime overlays. The first series of overlays should show the distribution of different types of crime in the CPTED area. The crime of burglary will be used to illustrate the construction of a crime overlay.

After acquisition of data on the total number of burglaries in the CPTED are for a specific year, the first incident to be plotted should be selected. The exact location of the occurrence of that incident should be found on the base map and a small adhesive geometric symbol (e.g., circle, square, or triangle) applied onto the overlay to denote the location of that burglary. This is done for all of the burglaries. This process is repeated to construct additional overlays, using a new overlay and a different geometric symbol for each type of plotted crime. Each crime overlay should be labeled.

As indicated in Table 1, additional crime overlays can be constructed. If appropriate for the particular CPTED area at hand, an overlay showing the distribtuion of fear-producing crimes should be completed. Although the density of these crimes is low, it is still desirable to distinguish one type from another. This is accomplished by substituting the first letter of each crime for the geometric symbol that would have been plotted onto the overlay, with possibly an "S" assigned to robbery to distinguish it from rape.

To construct overlays by season or day versus night, the data for each crime type should be plotted separately. This means that the original overlay of all burglaries in the CPTED area will be augmented by additional overlays that show, for example, burglaries in the summer and winter, or overlays that depict daytime and nighttime occurrences. Thus, several overlays could be constructed for each type of crime that is analyzed in the crime/environment mapping procedure.

Additional overlays are also useful when there is a large number of crimes in a single category. Dividing high frequency crimes among two or more overlays prevents the possibility of plotting so many crimes on one overlay as to cover up parts of the base map.

Crime/environment mapping requires only a minimal commitment of time and money. A 400-crime analysis (including the phases of police data collection, obtaining environment base maps, field visits, and plotting crimes on different overlays) should require about 1 person-week. Once the necessary data and materials are on hand, and the analyst is familiar with the maps, plotting should be accomplished at the rate of about 30 seconds per crime.

3.3.2 Construction of Environmental Overlays

Table 1 also indicates different types of environmental overlays of potential value to the mapping procedure. As discussed above, this information is placed on different overlays to keep the base map clearer and easier to use. Also, if an environmental factor (e.g., neighborhood lighting patterns) has been found to show no relationship to the crime data, the environmental overlay showing lighting patterns can be conveniently removed from the base map, leaving it free of extraneous data.

All residential areas are characterized by what could be termed formal and informal pathways. Formal pathways are represented by streets, sidewalks, and alleys. Informal paths and networks typically function as convenient shortcuts between different points in the environment. The total of both formal and informal passageways in a neighborhood defines the escape routes available to criminals after they commit a crime. It is possible that the network of informal pathways, or the relationship between informal and formal pathways, could provide necessary information for the successful analysis of a particular crime/environment problem. If appropriate in a particular CPTED area, a systematic observational assessment of the network of informal pathways should be completed, with these data placed onto either an environmental overlay or the environmental base map.

It is possible for a residential environment to contain numerous land uses (such as educational, light industrial, retail commercial, and institutional). If this is the case, the analysis of relationships between crime and land use will be facilitated through the use of color-coded maps. It is easier to see these relationships on a crime/environment map if the different functions that the environment serves are outlined in different colors.

3.3.3 Construction of Aggregated Data Overlays

Under certain circumstances, the discovery of crime/environment relationships through visual examination of a crime/environment map will be facilitated by aggregating the crime data. For example, one simple method involves the summing of criminal incidents per residential block. Another overlay is then prepared by writing these sums over each block in the residential area. This procedure is particularly useful when dealing with an environmental area that is characterized by a great deal of crime. When crime density is high in a given area, the crime overlays of that area can be difficult to examine visually and interpret because of the number of geometric symbols involved.

Another method for aggregating high-density crime data involves the placement of an appropriately sized grid pattern over a specific crime overlay. The number of crimes occurring in each grid square is then summed, and this figure is written on the transparent grid pattern overlay.

It is important to select a grid pattern of appropriate size with respect to the density of crime data on the crime overlay. If the grid squares are too large, each square will contain many crimes, few squares will be crime free, and little useful additional information will be provided. If, on the other hand, the grid squares are too small, almost all of the squares will contain either no crime or very few crimes, and visual examinations will provide just about the same information as the original high-density crime overlay. It is important to choose a grid size for the specific crime density at hand that results in a number of squares containing no crimes, or perhaps one crime, and a large number of squares containing numerous crimes (e.g., six or more).

Aggregating the crimes that occur on the streets of the CPTED area could also prove useful. Here, crimes would be tallied for each block of a given street, and these sums would be written on another transparent overlay that had been placed over the original crime overlay. The total number of crimes occurring on each street could be calculated and these sums, when written on each street at one side of the overlay, would identify high-crime-rate corridors and low-crime-rate corridors.

This section has covered the construction of crime and environment overlays that are most typically used in crime/environment mapping analysis. If the data are available, additional overlays can be constructed to depict other sorts of information concerning crime or environmental factors. This option should be kept in mind by the CPTED team. Preparation of a few additional overlays to examine a hypothesis of a team member takes little effort and could prove worthwhile.

3.4 Analysis of Crime/Environment Maps

3.4.1 Basic Procedure

Once the various overlays and the base map have been prepared, the analytic phase of the mapping procedure can begin. During this phase, each crime overlay will be placed on the base map and individually examined. While each crime overlay is in place, any environmental overlays that have been prepared as part of the mapping project can be individually placed on the map to augment the base map. In effect, each crime overlay will be paired with each possible combination of environmental base map and environmental overlays.

The objective of the analytic phase of the mapping procedure is to try to identify subareas within the total CPTED project environment that are high in crime and subareas that have little or no crime. If no relationships existed between the location of various criminal incidents and the physical environment, one would expect a random or relatively constant distribution of crime throughout CPTED areas. To the degree that crimes tend to cluster in certain parts of the area and, similarly, to the degree that other subareas are consistently free of crime, certain crime/environment relationships can be hypothesized to exist.

The definition of a "cluster" of crimes is influenced by the density of that particular crime throughout the project area. With low-density areas, as few as 3 or 4 crimes occurring near each other can be defined as a cluster. It would certainly warrant a visit to the field to examine that area for problematical environmental elements. As crime density increases, the number of crimes required to define a cluster will also increase. Quantitative rules of thumb as to what is or is not a cluster would be misleading. The important notion is that if crimes seem to occur more frequently in certain small areas (irrespective of the absolute crime density), those areas in the environment should be visited in an attempt to uncover the environmental correlates that could account for the occurrence of crimes.

3.4.2 Complexity of the Physical Environment

The process of visual examination is simple in concept but demanding in practice. One looks for relationships between the location of criminal incidents as depicted by the distribution of geometric symbols on the crime overlay, and the design, structure, and/or use of the physical environment. Any factor, aspect, system, or usage pattern that can be used to define or describe the physical environment in a CPTED area can serve, potentially, as the basis of a crime/environment relationship. The very large number of these factors, together with the complex nature of some of them, accounts for the demanding aspect of crime/environment mapping analysis. Each physical factor must be identified, located on the map, and visually examined and related to the distribution of crime incidents.

An appreciation of the variety and scope of physical factors that can be related to crime is a prerequisite for successful crime/environment mapping analysis. The CPTED team will not succeed at this task unless they possess an accurate picture of the environment. During visual examination of a map, the following aspects of the physical environment should be kept in mind: Streets, alleys, presence or absence of sidewalks, residential blocks, central units versus end units on a block, barriers (such as fences, walls, gulleys, or thick vegetation), parking areas, parking lots, traffic flow patterns, informal pathways, functional areas of the environment, abandoned houses, and single versus multifamily dwellings.

3.4.3 Analysis of the Crime/Environment Map for Environmental Correlates

A given map can contain certain areas that are high in crime relative to other areas in that environment. Once certain locations in the physical environment are categorized as high-crime-rate areas, it is incumbent upon the CPTED analyst to attempt to uncover the environmental correlates responsible for these crime clusters. Similarly, environmental factors must be uncovered to account for the relatively crime-free nature of other areas in the environment.

The basic method for identifying environmental correlates of crime involves the use of the environmental base map and any environmental overlays that have been prepared as part of the mapping procedures. Through the systematic examination of this body of environmental information, many hypotheses concerning potential crime/environment relationships can be tested. For example, are crime patterns related to the type and location of lighting fixtures? Do crimes cluster in commercial areas or in areas characterized by multifamily dwellings? Do low-crime-rate areas contain many barriers of one sort or another in addition to few (if any) informal pathways? It is possible to uncover many crime/environment relationships during this stage of analysis.

3.4.4 Analysis of the Neighborhood for Environmental Correlates

Before going to the field, the CPTED analyst should return to the police data and obtain more precise information about the crimes of each cluster. Additional data could include a more precise location of each crime, the exact time of day, the criminal modus operandi, and other potentially valuable information. Additional information is usually available because there was simply no reason to go into this depth of detail for each crime during the initial review of police data. Also, other police reports (e.g., narrative, supplementary) that were not initially reviewed can now be examined. These additional data will allow a more thorough and accurate onsite assessment of the environment for crime-related environmental correlates.

After the information on the environment base map and various environmental overlays is exhausted, mapping analysis procedures should move into the onsite observation phase, and the CPTED team should visit those subareas in the CPTED project that have both high and low crime rates. No systematic procedure can be offered for the next steps. Team members must look around, move throughout the area, and try to determine why crimes of a certain type tend to occur there. Informal conversations with local residents or businessmen can provide useful information.

As discussed in Section 2.2, the OTREP model provides a valuable analytic tool for onsite observations. As the environment is being assessed, the observer should ask, Where does the opportunity for crime lie? What are the available targets? Is the risk of getting caught high or low, and why? Does anything indicate that the crimes can be very easily committed (i.e., with minimal effort on the part of the criminal)? Are the payoffs particularly large in this area? The OTREP model could provide the perspective to observe some environmental factors that might otherwise go unnoticed.

The area immediately adjacent to the CPTED project area should also be examined as a possible cause of crime. Restricting a CPTED project to a specific, bounded area does not necessarily mean that all of the crime occurring within that area must be accounted for by characteristics of that area.

Another approach involves the comparison of the similarities and differences between the high-crime-rate areas and the low-crime-rate areas in the CPTED environment. Environmental factors that can be seen to distinguish high- and low-crime-rate areas can account for the difference in the crime rates. A number of color photographs of the high- and low-crime-rate areas will facilitate the comparison of these different parts of the environment. Color photographs can serve as the basis for discussion between CPTED team members and can also be used to elicit suggestions from other audiences (such as police department personnel or area residents).

3.4.5 Determination that a Crime/Environment Problem Exists

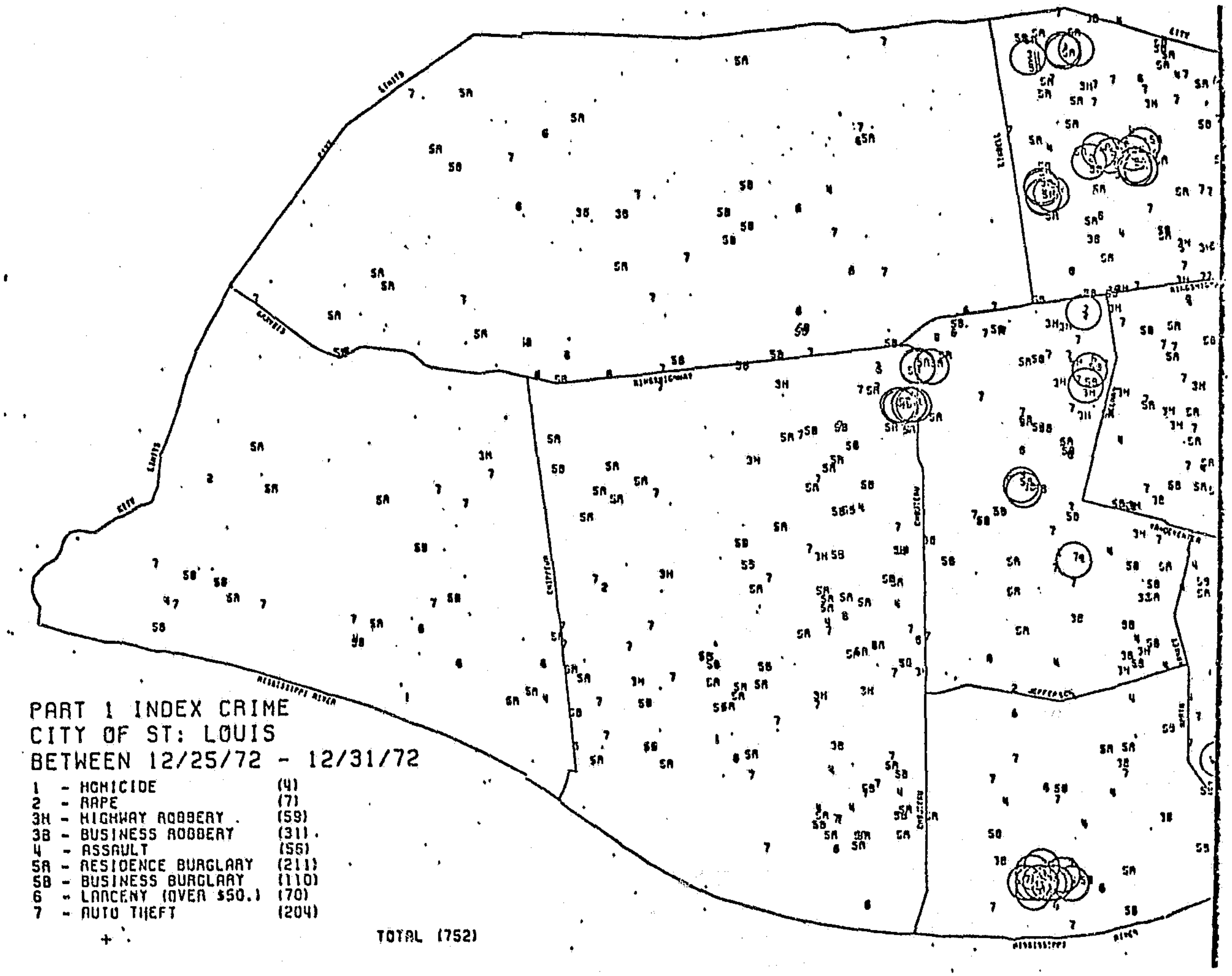
The presence of a crime/environment problem in the CPTED project area is firmly supported if this problem is found on the maps of 3 separate years of crime data. If a crime/environment problem is present in 1 or 2 of the 3 years, interpretation is somewhat problematical. One can reasonably ask why the problem was not present throughout the three year period. Although by no means conclusive, the observation of a crime/environment problem in 1 or 2 out of the 3 years represents evidence that cannot be ignored. The CPTED analyst should regard the existence of the particular problem as a viable hypothesis, and other methods (such as onsite observations and resident interviews) should be employed to document or further substantiate the existence of the crime/environment problem in question.

3.4.6 Computer Mapping

The process of transferring data from Offense Reports to maps can be substantially facilitated by the use of computers. A number of police departments use computers to plot crime/environment maps. The raw data are stored in the computer for purposes of compilation, analysis, and retrieval, a special computer program can be written to convert the numeric data into graphs (see Figure 3).

The main advantage of such a program is that it can be used for a variety of purposes. Not only can the location of a crime be plotted but the computer can provide printouts of various combinations of crimes and crime-specific data elements. Moreover, computerized mapping enables the analyst to examine many hypotheses regarding spatial relationships among crimes or particular features of crimes.

With relatively little effort one can program a computer to yield almost an endless number of combinations and patterns. Thus, the CPTED



Source: U.S. Department of Justice. Law Enforcement Assistance Administration. National Institute of Law Enforcement and Criminal Justice. Police Crime Analysis Unit Handbook, November 1973.

Figure 3. Example of Computer Printout

analyst is urged to take advantage of computerized mapping where it is available.

4. Environment Description Questionnaire

In an interview situation, people are asked a series of questions concerning their feelings and perceptions about the community environment, criminal activity, and so on. As they respond, the interviewer records the nature of their comments on the interview form. The types of questions can vary from open-ended to highly structured (see Guidelines 3 and 4), but the basic approach is to ask the person to provide his own description of various factors in the environment.

This approach is basic to the use of environment description scales for obtaining information about the environment. The environment description scales is a questionnaire consisting only of rating scales. A respondent completes the questionnaire by checking one of seven perceptions between two opposites (e.g., near -- far). The perceptions are "very," "quite," "slight," "neutral," "slight," "quite," and "very." The major difference between use of environment description scales and interviews, as discussed in Section 2.1, concerns the manner in which the individual makes his response. While the interview situation calls for verbal responses, when using the scales individuals simply place an "X" in the appropriate category on a response scale to indicate their assessment of a particular environmental characteristic. For example, if a person felt that the environment in question (e.g., a small residential park) was very crowded, he would place his "X" as follows:

Crowded	X							Uncrowded
	Very	Quite	Slightly	Neutral	Slightly	Quite	Very	

Environment description scales offer the CPTED analyst many advantages over the interview situation. First, because responses can be made to the scale items very quickly, little time is needed to collect data. Second, responses can be numerically scaled, and statistical analyses can then be performed directly since the responses are precoded. A wide variety of statistical questions can be addressed in this manner, and numerous methods of analysis can be employed to uncover additional information (these methods are discussed more fully below). Finally, data from scale items can be clearly organized and presented to various user groups (e.g., CPTED team, community organizations, and government agencies).

Many questionnaire scales exist in the literature for the description of both interior and exterior environments. These scales typically look like the example given in Figure 4. A typical set of instructions appears in Figure 5, and a comprehensive listing of environment description factors useful for CPTED analyses is given in Table 2.

4.1 Procedures

4.1.1 Collection and Charting of Data

Environment description scales typically are used in the following manner. From the scales presented in Table 2, a subset will be selected that is appropriate for the particular area under analysis. These scales are then included in a questionnaire, together with brief instructions on how the respondent should use the questionnaire. The analyst will

	V	Q	S	N	S	Q	V	
Well Lighted	___	___	___	___	___	___	___	Poorly Lighted
Attractive	___	___	___	___	___	___	___	Unattractive
Simple	___	___	___	___	___	___	___	Complex
Colorful	___	___	___	___	___	___	___	Drab
Noisy	___	___	___	___	___	___	___	Quiet

Figure 4. Typical Environment Description Scales

ENVIRONMENT DESCRIPTION SCALES

Instructions

This questionnaire contains (1)* environment description scales. Respond to the scales in the following manner. If you feel that the (2) is VERY unusual or VERY usual, QUITE unusual or QUITE usual, or only SLIGHTLY unusual or SLIGHTLY usual, then check the appropriate scale category. For example, if you thought that the (3) was only slightly unusual, you would check as follows:

Unusual			X					Usual
	Very	Quite	Slight	Neutral	Slight	Quite	Very	

If you feel that the (4) is neutral on a pair of words, then place your check-mark in the center NEUTRAL space.

Although some words may appear similar, they all evaluate different aspects of environments. Respond to each scale individually and please do not be careless for we want your true impressions of the (5).

IMPORTANT: (1) Place your check-marks in the middle of spaces, not on the boundries.

THIS					NOT THIS
__ X __	__	__	__	__	__ X__

(2) Be sure you check every scale. Do not omit any.

(3) Never put more than one check-mark on a single scale.

PLEASE PROVIDE THE FOLLOWING INFORMATION ABOUT YOURSELF (6).

*See footnotes next page

Figure 5. Environment Description Scale Instructions (Page 1 of 2)

Footnotes for Previous Page

1. Insert number of scales used in questionnaire.
2. Name of environment, e.g., room, building, park, plaza, etc.
3. Same as 2 above.
4. Same as 2 above.
5. Same as 2 above.
6. Possible biographical questions:

Sex: Male ______ Age ______

Female ______

Resident of Neighborhood: Yes ______

No ______

Race: ______________

Transportation to Site ________________________

Address of your job ________________________

Income:			
	0 - 5,000	Year	______
	5,000 - 15,000	Year	______
	15,000 - 25,000	Year	______
	25,000 +	Year	______

Figure 5. Environment Description Scale Instructions (Page 2 of 2)

TABLE 2

Environment Description Factors
(Page 1 of 2)

UNLITTERED - LITTERED
CLEAN - DIRTY
NEAT - MESSY
TIDY - UNTIDY
UNCLUTTERED - CLUTTERED

POPULAR - UNPOPULAR
UNCROWDED - CROWDED
FREE SPACE - RESTRICTED SPACE
EMPTY - FULL
ROOMY - CRAMPED

MODERN - OLD FASHIONED
STYLISH - UNSTYLISH
CONTEMPORARY - TRADITIONAL
FASHIONABLE - UNFASHIONABLE
GOOD LINES - BAD LINES

COMFORTABLE - UNCOMFORTABLE
PLEASANT - UNPLEASANT
INVITING - REPELLING
INTERESTING - UNINTERESTING
NICE - AWFUL

LARGE AREA - SMALL AREA
WIDE - NARROW
ADEQUATE SIZE - INADEQUATE - SIZE
HUGE - TINY
LARGE - SMALL

ORGANIZED - DISORGANIZED
EFFICIENT - INEFFICIENT
USEFUL - USELESS
WELL PLANNED - POORLY PLANNED
WELL ORGANIZED - POORLY ORGANIZED

HARD - SOFT
FRAGILE - STURDY
STRONG - WEAK

IMPERSONAL - PERSONAL
SOCIABLE - UNSOCIABLE
FRIENDLY - UNFRIENDLY
HOSPITABLE - INHOSPITABLE

RELAXED - TENSE
SAFE - UNSAFE
SECURE - INSECURE
THREATENING - UNTHREATENING

GOOD VENTILATION - POOR VENTILATION
FRESH ODOR - STALE ODOR
DRAFTY - STUFFY
DRY - HUMID

COMFORTABLE TEMPERATURE - UNCOMFORTABLE TEMPERATURE
GOOD TEMPERATURE - BAD TEMPERATURE
HOT - COLD

GOOD LIGHTING - POOR LIGHTING
DIFFUSE LIGHTING - DIRECT LIGHTING
LIGHT - DARK

CONVENIENT - INCONVENIENT
NEAR - FAR
ACCESSIBLE - UNACCESSIBLE

FINISHED - UNFINISHED
COMPLETE - INCOMPLETE
TEMPORARY - PERMANENT

BUSY - CALM
LIVELY - DULL
PEACEFUL - CHAOTIC

REFRESHING - WEARYING
EXCITING - UNEXCITING
FATIGUING - INVIGORATING

ATTRACTIVE - UNATTRACTIVE
APPEALING - UNAPPEALING
BEAUTIFUL - UGLY

BRIGHT COLORS - MUTED COLORS
GOOD COLORS - BAD COLORS
COLORFUL - DRAB

TABLE 2

Environment Description Factors
(Page 2 of 2)

REAL - PHONY
NATURAL - ARTIFICIAL

CHEERFUL - GLOOMY
GAY - DREARY

VERSATILE - NONVERSATILE
MULTIPLE PURPOSE - SINGLE PURPOSE

ELEGANT - UNADORNED
DECORATED - STARK

WELL KEPT - RUN DOWN
WELL MAINTAINED - POORLY MAINTAINED

QUIET - NOISY
GOOD ACCOUSTICS - POOR ACOUSTICS

URBAN - RUSTIC
SCENIC - UNSCENIC

CONFUSED - CLEAR
EASY TO USE - HARD TO USE

DISTINCTIVE - ORDINARY
UNUSUAL - USUAL

HEALTHY - UNHEALTHY

NEW - OLD

ENOUGH EQUIPMENT - NOT ENOUGH EQUIPMENT

FORMAL - INFORMAL

GOOD - BAD

VISIT FREQUENTLY - VISIT INFREQUENTLY

FAMILIAR - UNFAMILIAR

PRIVATE - PUBLIC

REPUTABLE - DISREPUTABLE

PART OF NEIGHBORHOOD - ISOLATED FROM NEIGHBORHOOD

IMPRESSIVE - UNIMPRESSIVE

LIVABLE - UNLIVABLE

HUMAN SCALE - INHUMAN SCALE

then go to the environment in question and select a sample of individuals to respond to the questionnaires. These individuals can be selected randomly, or procedures can be adopted to ensure that the sample is balanced with respect to certain variables (e.g., sex of respondent, spatial distribution throughout the neighborhood, or other factors to be discussed below). The selected indivuduals will then fill out the questionnaire and return it to the CPTED analyst. The environment in question could be an interior space, a playground, a small park, a street, or a neighborhood.

One option is to mail the questionnaires with self-addressed envelopes, but the chief drawback with mailed questionnaires is that the return rate is usually low, rarely as high as 50 percent. If the proportion of people who return completed questionnaires is small, there may not be enough information to draw any conclusions. Moreover, if the people who take the trouble to return the questionnaire are different in many ways (e.g., more civil-minded, more concerned about crime) from those who throw it away, the analyst risks drawing conclusions about the entire community when in fact the data apply only to a segment of that community. Some of the factors that affect return rate include: (a) The characteristics of the recipients (e.g., people with strong feelings are more likely to respond); (b) the sponsorship of the questionnaire; (c) the attractiveness, clarity and ease of answering the questionnaire; and (d) the incentives offered for replying (e.g., monetary compensation, information about the results). Return rates can also be improved by sending follow-up reminders.

After the questionnaires are filled out, the data will be statistically analyzed and average scores will be computed for each scale. These means will be plotted on a chart that has the different scales located on the horizontal axis and the range of scale values (in the present case, from 1 to 7) indicated on the vertical axis. The resulting chart is called an environmental profile. A hypothetical profile for a small park is shown in Figure 6.

4.1.2 Interpretation of an Environmental Profile

Examination of the environmental profile can indicate some very interesting aspects of a given environment. For example, the park described in Figure 6 can be characterized as crowded, noisy, and somewhat littered. However, it also is one in which the users feel very safe and secure, and one that is visited frequently. It is important to note that, while the park is regarded as relatively adequate, there seems to be a need for additional playground facilities. This is due not only to a lack of basic facilities (not enough equipment) but to broken items that are not repaired as quickly as they should be (poorly maintained).

Suppose, however, that the park were not extensively used by the residents of the area. The analyst could visit the park to have the questionnaires filled out and find the park deserted. In this case, the analyst would have to go to homes in the immediate area and solicit individuals to respond to the questionnaire for the park in question. Data obtained in this manner could be similarly statistically analyzed, and a resulting environmental profile could appear as shown in Figure 7.

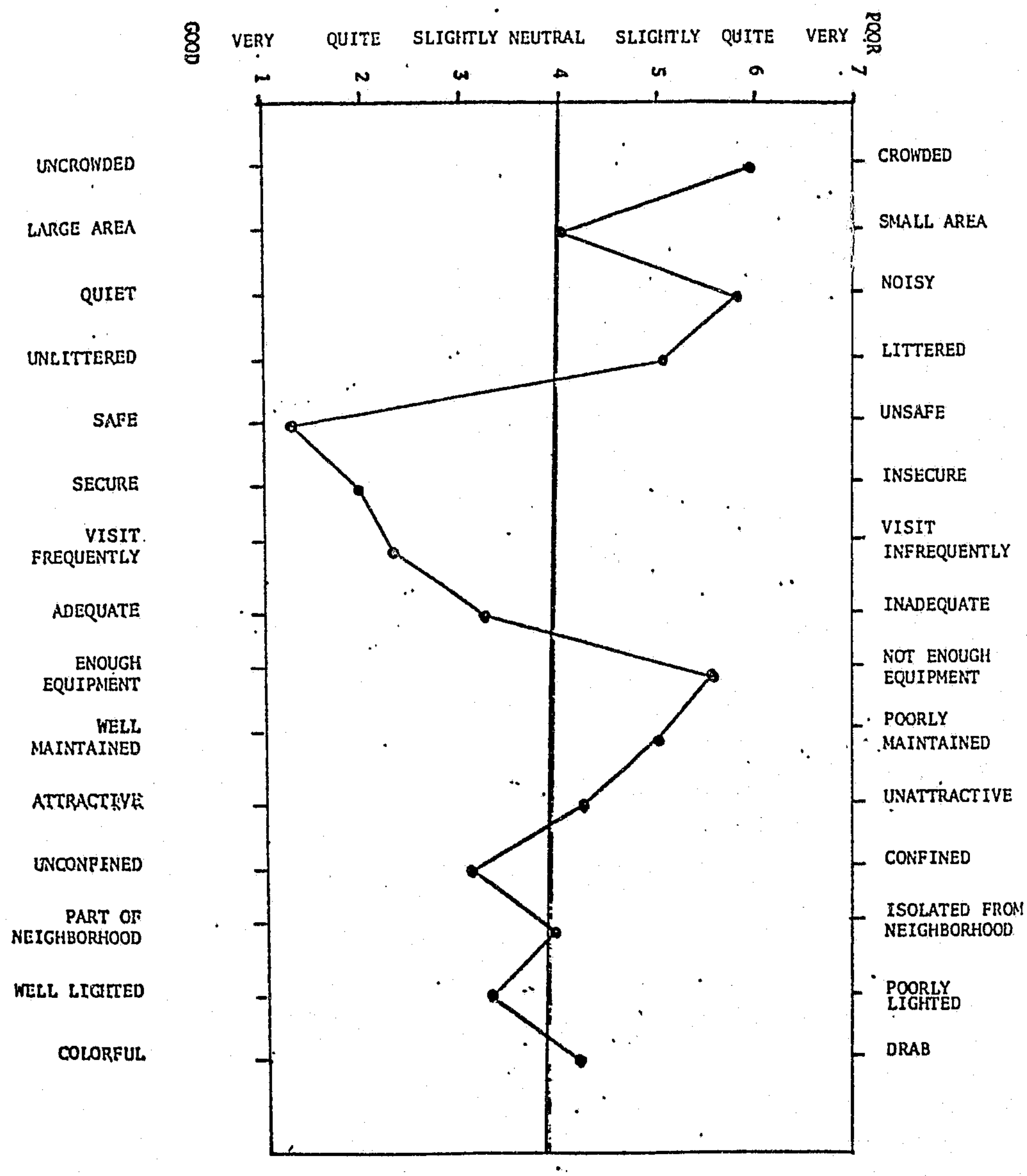


Figure 6. Environmental Profile of Hypothetical Small Park

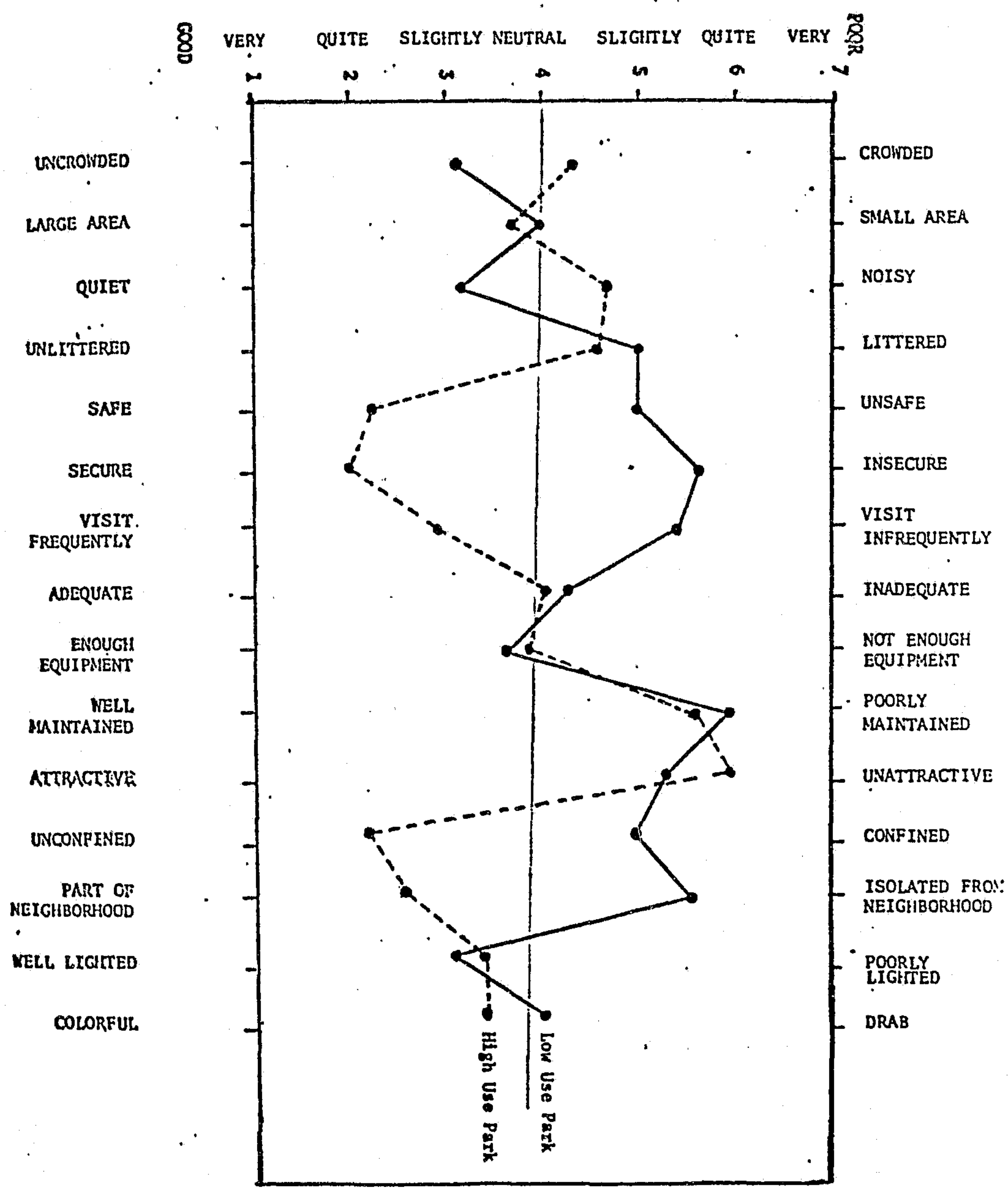


Figure 7. Environmental Profiles of Hypothetical High Use and Low Use Small Residential Parks

4.1.3 Comparison of Two Environments

Two environmental profiles have been generated for two small parks (see Figures 6 and 7), one of which is used extensively by the local residents while the other is almost always deserted. What could be the reasons for this markedly different usage pattern? Examination of the respective environmental profiles provides some possible explanations. The low-use park is characterized by problems in maintenance, aesthetics, and litter, but some of these problems are found in the high-use park also. However, the difference on the scale concerning feelings of isolation and confinement should be noted. Individuals describing the low-use park indicate that they feel isolated and cut off from the basic flow of social activity in the community. On the other hand, individuals in the high-use park feel that they are quite involved and a part of the community when they are in the park. It is quite possible that the difference between the usage patterns of the two parks could be related to this isolated and autonomous feeling on the part of users of this park.

With this information, the CPTED planner could formulate some informal hypotheses. It is possible that some characteristics of the park or the surrounding area contribute to the feeling of social isolation that is detrimental to park usage. Visits to the park and further discussions with the respondents could indeed indicate this to be the case. Thus, one could find that the park, while originally landscaped for aesthetic purposes, is now characterized by an overabundance of vegetation. This vegetation acts as a barrier between people using the park and the homes in the surrounding residences, eliminating informal surveillance by the residents of the area. Users of the park feel somewhat isolated and, according to the profile, insecure as a result.

To carry the example a little further, the CPTED planner could develop some very simple CPTED strategies. The entire park area could be relandscaped, perhaps with the intensive involvement of the local community residents, both to improve the aesthetic impact of the area and to reduce the isolation problem. This CPTED strategy might not have evolved without the initial environmental profiles that were developed for the small parks.

4.1.4 Comparison of Responses from Men and Women

There are additional ways to use environment description scales that can provide the CPTED analyst with very valuable information. One method commonly used is to generate an environmental profile of a given area for the male users of the area, and a similar profile for the female users. In the example given above, one profile would show how the park is viewed by men in the community. A second profile would show (over the same scales) how the park was regarded by the women in the community.

Using this approach, the CPTED analyst can make a somewhat detailed analysis of the environment in question. He or she could find, for example, that the isolation and lack of security problem was not manifested by the men who used the park. Additionally, the profile could reveal that the men stayed away because the equipment that was located there was not to their liking. Thus, breaking out environment data by the sex of the respondent can be a very valuable technique for analyzing different aspects of crime/environment problems.

Preparing multiple profiles based on some variable can also provide information that otherwise could have gone uncovered. For example, if the original environment profile of the low-use park had contained information from both men and women, the average response on the isolation or insecure/unsafe scales could have been rather neutral. This would indicate no problem with regard to this scale. However, separation of the data by male and female responses could result in the situation described earlier. The female respondents would be the ones threatened by the lack of surveillance and isolation of the small park. On the other hand, the male respondents could feel relatively secure even though no informal surveillance existed.

4.1.5 Analysis of an Environment at Different Times of the Day

Another method of analysis using the environment description scales involves the description of a given environment at different times of the day. Comparison of the average scores on each scale would indicate certain problem areas that could be related to changes that occur during the course of a normal day, particularly from daylight to nighttime hours. Problems in the lighting of an outdoor area could become particularly apparent through this analysis. One could also find that mothers and their children stayed away from the park during a specific time period, for example, between 4:00 p.m. and 7:00 p.m. Environmental observations by the CPTED analyst could show that, during this time period, the park was taken over by teenagers who were passing through and lingering there on their way home from school. Many other insights are available through the analysis of environmental profile data at different time points.

4.1.6 Comparison of Responses of High- Versus Low-Frequency Users

Another technique for using environment description scales involves generating separate profiles for the same environment based on the extent to which that environment is used by the respondent. One environmental profile would be generated from responses of individuals who constantly frequent an environment. The other profile would come from people who are basically similar to the first group of individuals (e.g., mothers with young children), except that they tend to stay away from the environment. Comparison of the two profiles could indicate why the environment is not used by a certain group of people. One could find that infrequent users are people who have not been there in a long time and that their image of that particular place is incorrect. It could also be determined that a particular group of mothers stays away because certain safety features are not included in the park that they feel are necessary, or certain types of equipment that they feel should be there are absent. With this method of analysis, the CPTED team can obtain further insights into why people use or do not use certain community environments.

Thus, there are many different ways available to the CPTED analyst for analyzing and interpreting environmental profile data. The present discussion concerns analyses by different environmental area, by time-of-day, and by the sex or frequency of usage of the questionnaire respondent. Other methods of analysis are possible and, often, these approaches emerge as a function of the particular situation with which the CPTED planner is dealing. The analytic flexibility characteristic of environmental profile data and the insights and interpretations that this flexibility can offer should be kept in mind when doing crime/environment analyses.

4.2 Additional Uses of Environment Description Scales

The resulting environmental profiles are very useful when making presentations to community groups and organizations. Transparencies can be made of different profiles and projected onto a large screen so that these data can be easily seen and discussed. Additionally, transparencies can be overlaid to highlight the differences in profiles between two environments, two different groups of respondents, or other important variables.

When making a presentation, it is also useful to include color transparencies of the environments in question. The audience can then understand and relate the environmental profile information to the real environment. Transparencies also help to stimulate discussion and suggestions from the audience, and serve to dispel misconceptions about what an area actually looks like. Transparencies can be made of a number of alternative proposals for changing a specific environment.

In this manner, the CPTED planning team can assess community attitudes toward possible changes in their environment. The use of transparencies of environmental profile data, together with transparencies of real and proposed environments, offers the CPTED planner a valuable tool for communication and interaction with the local community.

4.3 Methodological Considerations

Although environment description scales can provide valuable information, it is easy to use these scales incorrectly. This can happen when certain methodological requirements for the administration of the questionnaires are not met. If unaware of the proper requirements, the analyst would assume that the data that he or she is collecting are valid. This could lead to an incorrect assessment of the crime/environment problem and, as a result, to the design and implementation of inappropriate CPTED strategies. Methodological requirements discussed below must be met before data from environment description scales can be useful to the CPTED effort.

4.3.1 Number of Scale Items

When designing a questionnaire for a specific environment, a large number and a sufficient variety of environment description scales should be included. The only information that will be received for analysis will be that which comes from the individual's responses to the scales included in the questionnaire. It is important for the particular environment to be closely examined and for the appropriate scales to be selected for inclusion in the questionnaire.

Just as one can have too few scales in a questionnaire, having too many scales in a questionnaire will also cause problems. These problems involve fatigue on the part of the respondent, certain response biases that will occur when too many scales are being used, and a similarity of meaning between different scale items that subjects tend to perceive in a suspicious manner. It is suggested that no more than 30 scale items be included in a given environment description questionnaire.

The format of scale items should follow the examples given in Figures 4 and 5. A final page can request biographical data for the individual respondent (e.g., sex, frequency of usage, length of residence in the area, and other issues that can be important for a particular problem at hand).

4.3.2 Number of People in the Sample

It is important to sample a sufficient number of people for each environmental profile. As a general rule, an environmental profile should be based on data from at least one and one-half times the number of scale items. Thus, a questionnaire with 30 scales should be administered to at least 45 people. If one wants to analyze the data by sex (i.e., generate two profiles), 45 men and 45 women should be sampled. When fewer persons are used, the resulting environmental profile may be less accurate. A profile of 30 scales based on data from 15 people will be less reliable as to whether differences between scale means are a true reflection of the environment in question, or if the sample happened to be comprised of people who tended to regard the environment in a certain way. (See Section 5 of Guideline 5 for a discussion of sampling techniques.)

4.3.3 <u>Recent Arrivals in the Environment</u>

Another source of error concerns the amount of time that a resident has lived in a given area. Research has indicated that people judge a certain environment relative to the area from which they have recently moved. An individual moving into a middle-sized town from New York City would judge that town to be relative peaceful, quiet, and not too hectic. Another person moving to the same middle-sized town from a small rural area would see that town as very hectic and crowded. This same phenomenon can characterize moves from one region to another, or from one neighborhood to another.

When data are collected with an environment description questionnaire, length of residence should be controlled for, either by requesting the respondent to indicate on the questionnaire how long he or she has been a resident of that area or by soliciting cooperation only from individuals who have lived in the particular area for a given amount of time or longer. Two environmental profiles based on this factor could be generated. These profiles would indicate differences in the way the area was perceived by new residents, as compared to people who have lived there for some time.

4.3.4 Other Respondent Characteristics

It is important that the analyst be aware of other characteristics of the individuals who comprise the sample, including such variables as sex, marital status, income, length of time in the area, and frequency of visits to the particular environment. The sample should accurately reflect the residents or users of an area. A larger sample increases the chance that the results will be representative of the community at large.

4.3.5 Location of the Respondent

It is desirable to administer a questionnaire in the environment that is being evaluated. Thus, if the respondent is unsure about some of the scales, he can look around the environment and more accurately make his response. However, research has indicated that, if an individual is *very* familiar with a given space, the person can fill out an environment description questionnaire for that space when he is in fact some place else. For purposes of definition, the person can be said to be familiar with an environment if he has visited it on the average of once a week for at least one month.

5. Use of the OTREP Model for Environmental Assessment

This section describes two major applications of the OTREP model, as described in Appendix A, for environmental assessment: (a) As an unstructured perspective that can be used in either large or small environmental areas; and (b) as a structured package that can be used for detailed crime/environment analyses in small environmental areas.

5.1 Use of OTREP for Environmental Assessment

All environments can be evaluated with respect to the four OTREP factors of target, risk, effort, and payoff. In a sense, every environment could be said to have an OTREP profile. That is, each environment is characterized by certain opportunities for crime, specific crime targets, a certain amount of inherent risk to the criminal when a crime is committed, a given amount of effort, and a payoff of some magnitude. The "ideal" environment is one in which no opportunity for any crime would exist. This environment would contain few targets, apprehension would be certain, the amount of effort that a criminal would have to expend would be inordinately high, and the resulting payoff to the criminal for a successful crime would be negligible. The following discussion expands upon the four OTREP factors and the fifth "cognitive" factor to illustrate how the OTREP model can be used profitably as an informal and unstructured perspective for crime/environment analysis.

Consider a large residential environment as a CPTED project area. The presence of crime in the area means that criminals are attracted to that particular environment for one or more reasons. If one systematically analyzes the four OTREP factors in that environment, insights should be obtained concerning the amount of criminal activity occurring there. These insights will lead to the definition of the crime/environment problems, which determine the design and implementation of effective CPTED strategies.

5.1.1 The Target Factor

Applying the OTREP perspective for environment assessment to a residential area with a burglary problem, the analyst takes each OTREP factor individually and makes subjective judgments concerning the salience of each factor in that setting. For example, the first question which would be asked is, Where are the targets for these crimes in this environment? Being a dichotomous variable, certain targets will either be present or absent. Since burglaries are being examined in the present example would be to remove every home from the area. Thus, one cannot capitalize on changing the opportunity for crime in this residential environment by removing the target.

Analysis of the target factor can be very valuable in other crime/ environment situations. For example, some urban areas experience a serious problem involving the theft of welfare checks from mailboxes. Removing the target in this case (the welfare check) is a viable prevention strategy. Recipients can either pick up thier checks at a local welfare office, or the checks can be deposited directly into bank accounts.

5.1.2 The Risk Factor

The second question to be asked when using the OTREP perspective for environmental assessment is, Where is the risk to the criminal when he works in this setting? In a high-crime-rate area, it is likely that risk to a criminal is low. The CPTED analyst has to ask, Why is there low risk of apprehension for this particular crime when it is committed in this particular environment?

A large number of factors can account for the low risk of apprehension of a criminal in a given setting. These factors include very limited or inadequate patrols by security personnel, quick and easy escape from the immediate area through multiple escape routes, low surveillability of the criminal by others who could be in the immediate area, and low numbers of other people in the area. These different environmental characteristics should be closely analyzed for the particular environment that is being examined.

Through this approach, the analyst might find, for example, that alleys running between the rows of houses on a block are being used both by residents and by strangers passing through the area. Thus, potential criminals have very easy access to an area and, without attracting any attention, they can easily "case" the many houses in a residential environment for potential burglary targets. Appropriate CPTED strategies could be evolved to combat this particular crime/environment problem.

5.1.3 The Effort Factor

The third question that the CPTED analyst should ask is How much effort does the criminal have to expend to commit these crimes? Are these crimes so easy to commit that the potential criminals are attracted to this particular area? The ease with which a crime is committed is directly related to the amount of time that is required to commit the crime. Thus, the effort factor is related to the amount of physical effort required -- and whether the criminal is capable of expending, or desires to expend, that amount of effort -- and the increase in risk that is associated with crimes that take a long time to commit.

The low amount of effort required to commit a burglary could be related to the lack of adequate fencing around the home, or the knowledge of the location of valuables within a particular household. If it is found, for example, that the majority of entries were not forced but were through open doors or windows, community education activities and selected target-hardening approaches are immediately suggested.

5.1.4 <u>The Payoff Factor</u>

The final question to be asked concerns the payoff to the criminal. What is the degree of the reward, the nature of the gain that the criminal expects to obtain? In contrast to the target factor, payoff can be reduced to decrease the attractiveness of the target in a given environment for a particular criminal.

To reduce the payoff available to burglars in a residential environment, a number of approaches could be adopted. Stolen goods are less valuable if they are engraved with the owner's name, address, and social security number. Such Operation Identification activities have been successful in past applications. Another approach would involve the systematic inventory by each family of its valuables, and the placement of these items in safety deposit boxes or other secure storage areas. If organized and done on a neighborhood basis, and if adequate publicity is given to the activity, burglars should be less attracted to this particular residential neighborhood. Other strategies exist for reducing payoff in commercial and schools environments. For purposes of environmental assessment, the important notion is that a payoff of some sort always characterizes environments in which crime occurs. Analysis of the situation from this perspective can be valuable and may provide a better definition of the crime/environment problem.

5.1.5 The Cognitive Factor

Although not a part of the formal OTREP model, this fifth OTREP factor offers potential utility for environmental assessment. Here, the important questions concern the perceptions and beliefs of potential offenders about the specific CPTED environment. Not only must the environment hold a great deal of risk for the criminal but the criminal must *perceive* the risk before it will function as an effective deterrent to crime. Similarly, consonance must exist between other OTREP factors in the environment and the criminal's perception of these factors. Thus, the CPTED analyst should ask, Does the environment present a valid and visible picture of the OTREP factors to the potential offender?

Manipulation of the fifth factor can be accomplished in a number of ways. Promotional campaigns and publicity over various news media can make the potential offender aware of anticrime programs. Information concerning arrest rates, sentencing, and related topics can also be disseminated. Depending on the extent of this type of effort, a large amount of information can be made available to the public. Signs in storefronts and private residences can provide information about participation in, or the use of, different anticrime programs and strategies (e.g., Operation Identification, blockwatch, security patrols, burglar alarms, low-cash-on-hand policies, surveillance systems).

Thus, a basic part of the OTREP environmental assessment is to examine the visibility of the OTREP factors in the CPTED environment. An issue to be examined is whether the members of the community made effective use of the various cues mentioned above to enhance the anticrime image of their environment. The CPTED analyst should consider whether this image can be improved by: (a) Assessing the visibility of the different OTREP factors; (b) pinpointing deficiencies or potential sources of misperception; and (c) suggesting strategies (promotional campaigns, signs, etc.) to overcome these deficiences. Successful environmental assessment will occur only if four OTREP factors are examined both in the environment and in terms of the *appearance* of the environment to the potential offender.

6. Use of the OTREP Package for Environmental Assessment

The OTREP Package for Environmental Assessment (OEAP) is distinguished from the OTREP perspective discussed in Section 5 in the following ways. First, its use is restricted to smaller environmental areas, such as parks or residential blocks or parts of blocks. Second, OEAP is a highly structured and systematic procedure. It is organized into a physical questionnaire-type instrument to be used by CPTED analysts in the field. Finally, OEAP along with the security surveys is used in the final stages of the crime/environment analysis process, whereas the OTREP perspective is recommended as a preliminary analytic activity (see Chapter 3). The OTREP Environmental Assessment Package itself is presented in Section 8 of this guideline.

6.1 Method

To be effective, complete OTREP environmental assessment should involve three different methods of data collection. Most of the data can be obtained from on-site observation by members of the CPTED team. Other information (such as the activities of community organizations and police patrol procedures) can only be obtained through additional key-person interviews (see Section 1). These interviews would be conducted *after* crime/environment targets have been identified to elicit information about why a particular subarea is vulnerable to crime. A final method, security surveys of selected residences and commercial establishments, is discussed in Section 7.

6.1.1 Size of the Environment

OEAP should be used in small, discrete areas that have been identified as crime/environment target areas (e.g., one or two residential blocks, parks, large buildings, shopping centers). Most of the scales used in OEAP require the analyst to examine detailed physical characteristics in the environment (e.g., quantity of places to sit and talk, amount of trees and shrubs, visibility of alleys and pathways, fencing around backyards). The observer has the ability to make these detailed examinations when the total environment area is small and relatively homogeneous. Large areas may be too diverse and complex to allow observers to make accurate judgments using the OTREP scales.

OEAP is used to assess subareas within the CPTED project area where clusters of crimes occur. The location of crime clusters can be accomplished through the use of crime/environment mapping procedures, although information obtained through onsite observations or key-person interviews can also be useful. OEAP can also be used to assess pockets of fear that have been uncovered through the assessment of the fear of crime in the CPTED project area.

After the preliminary stages of the crime/environment analysis phase are completed, the CPTED team could have identified, for example, one cluster of auto larcenies, three clusters of burglaries, and three clusters of vandalism. Each location defined by each cluster could then serve as an environmental pocket (crime/environment target) that can be analyzed in detail using OEAP.

6.1.2 The Control Environment

Before an OEAP assessment can be made of a CPTED target subarea, the analyst should locate a highly similar but low-crime-rate control environment. The control area is required because the format of the rating scales used in OEAP requires each judgment of a physical characteristic in a CPTED project subarea to be made relative to a control subarea. For example, ratings of a high-crime residential block on the scale "trees and shrubs" can be "more than," "about the same as," or "less than" the quantity of trees and shrubs in a low-crime residential block. The low-crime subarea can be inside or outside of the project area so long as it is similar to the target subarea.

The use of both the CPTED target subarea and the control subarea is based on the following logic and assumptions:

- Offenders can commit crimes in either of the two subareas, but they more frequently decide to commit crimes in the high-crime subarea.
- The decisionmaking process resulting in the selection of a site in which to commit a crime can be modeled according to OTREP principles.
- Differences in the OTREP factors of the two environments account for differences in crime rates.
- By comparing the OTREP profiles of the two subareas, the environmental characteristics responsible for crime in the high-crime-rate area can be uncovered.

An important aspect of this procedure is that it parallels the relative nature of the evaluation process used by the criminal. The offender can be expected to make a determination of the target, risk, effort, and payoff factors *relative* to surrounding environments. It is not as if a decision to commit a criminal act will automatically occur when the level of a given OTREP factor passes a certain absolute point. Rather, the working assumption is that the criminal selects that environment and time from those available which, in his judgment, provide a sufficient opportunity and chance of success.

After the crime/environment mapping process has identified crime clusters, the CPTED analyst should select a control subarea for each of these pockets.

Each low-crime subarea should be selected to meet the following criteria (the source of the information is in parentheses):

- Located within 1 mile of the CPTED target subarea (onsite observation).
- Similar in size to the target subarea (onsite observation or planning department maps).
- Similar average age of adult residents, plus-or-minus 15 years (census data, block statistics; onsite survey).
- The racial or ethnic composition should be the same as in the target subarea; majority groups should be similar percentage of total neighborhood population, plus-or-minus 15 percent (census data, block statistics).
- Similar family size, plus-or-minus one-half family member (onsite survey).
- Similar home value or rent structure, plus-or-minus 25 percent (census data, block statistics).
- Similar composition of dwelling unit types, plus-or-minus 15 percent of each category (planning department maps; onsite observation).
- Similar building density, plus-or-minus 10 percent (planning department maps; onsite observation).

It probably will be difficult to find a control subarea for each target subarea that meets all of the above criteria. Potential control subareas may not have sufficiently low crime rates* or, if crime rates are low, property values could be $20,000 higher or lower in average, housing could be made up primarily of single-family dwellings (as opposed to multifamily garden apartments), and so on. When these trade-offs are made, the following factors should be regarded as the most important: (a) Location; (b) racial and ethnic composition; and (c) home value or rent structure. To the degree that the control subarea differs from the CPTED target subarea, the value of OEAP procedures will decrease. However, even a dissimilar control subarea will provide more utility than no control subarea at all.

6.1.3 OEAP Procedures

After each control subarea is selected, the CPTED analyst should become highly familiar with both the control and target subareas. A review of the OEAP observation questionnaire will indicate the important factors to look for in the environment, and observers should take a copy of OEAP along with them on visits to the field. The two subareas should be toured both during the day and at night. Stores should be visited, open spaces should be explored, and there should be informal conversations with residents. This will provide an indication of the prevailing social climates. After becoming familiar with both environments, the CPTED

*If the subarea is within the project area, it would be in fact a crime/environment target for which another control subarea would have to be located.

analyst should complete the observation portion of the OEAP. The environmental assessment (completion of rating scales) is made of the CPTED target area only, and should be completed in the field.

If more than one person is using the OEAP questionnaire, then it should be completed by each person for each target subarea to increase the reliability of the scale ratings. However, because of the complexity of some target subareas and the nature of the judgments being made, different scale ratings can occur. Whenever different ratings emerge, the scale items should be discussed at lengt additional visits to the control and target subareas should be made, and the discrepancies should be resolved. Although each analyst will complete an OEAP questionnaire, the procedure does not require each analyst to conduct key-person interviews and security surveys.

Some scales may be difficult to interpret because of the complexity of the scale item in both environments. For example, it could be hard to judge whether backyard access is easier or more difficult in the target subarea because of the number and diversity of backyards facing an alleyway. Ratings of scale items that are particularly difficult can be deferred until the other questionnaire items are completed. Then, the control and target subarea could be visited again, and detailed observations of environmental characteristics relative to the difficult scale items could be made.

Both daytime and nighttime assessments should be made during peak crime hours. These times will vary somewhat by type of crime and neighborhood. Three or more field visits could be required to complete the various phases (e.g., interviews, security survey) of any one OEAP assessment. However, one field trip will suffice in most cases.

7. Use of Security Surveys

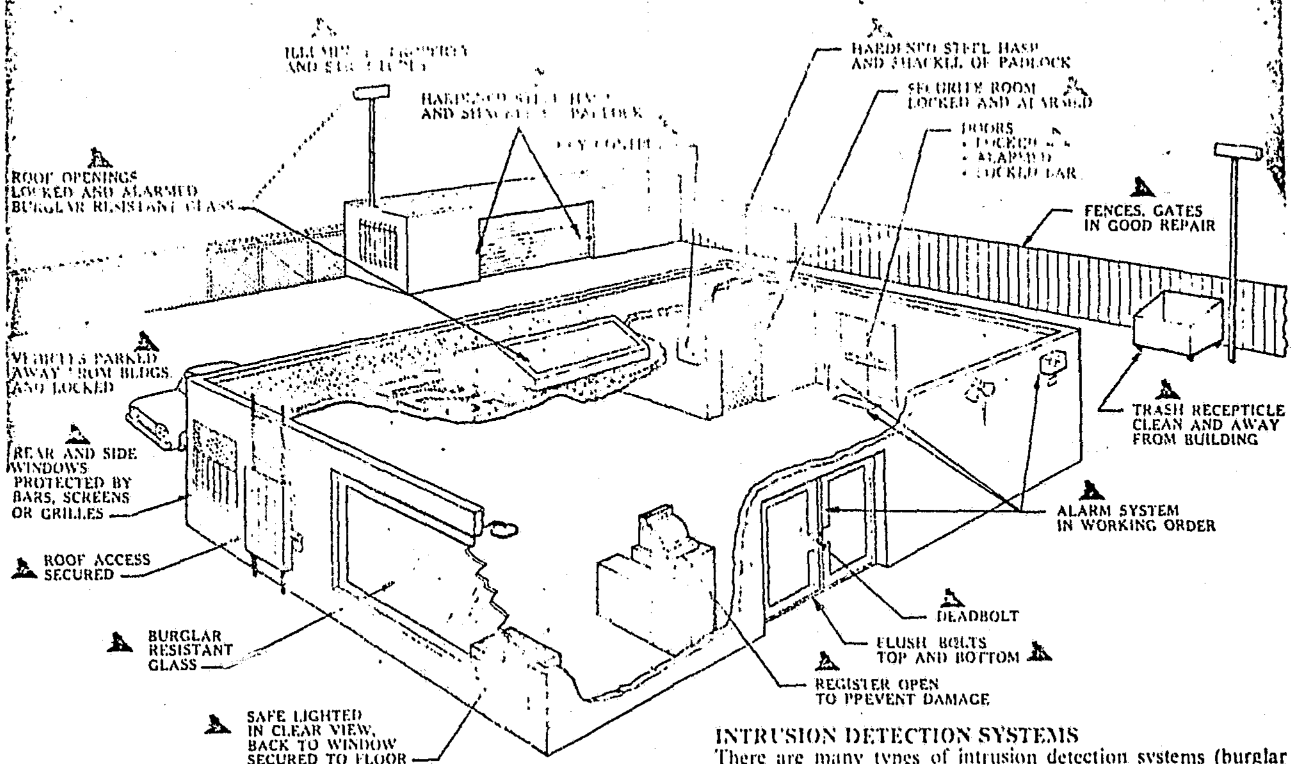
A security survey is an indepth, onsite examination of a physical facility and its surrounding property (i.e., industrial plant, business, public building, residence, etc.). The survey is conducted to determine a facility's security status, identify deficiencies or security risks, assess the protection needed, and make recommendations to minimize criminal opportunity. Many law enforcement agencies offer this service at no cost to interested citizens, and the results of the surveys are kept in the agency files. While it is unlikely that police agencies will give permission to a CPTED analyst to study these files for proprietary reasons, there may be an analytic process developed by the agency that can be adopted by the CPTED analyst.

The CPTED analyst should first contact the local law enforcement agency division that conducts these surveys. This police function may be the responsibility of the community relations division, or there may be a separate unit to conduct these surveys (such as a crime prevention section or a crime resistance section). Officers in these units are usually well trained in security procedures and can be of value in the development of the CPTED security survey. Often, these officers have received intensive training in nationally recognized crime prevention institutes and seminars. Thus, they usually are experts not only in the unique characteristics of local security problems but may also have a general expertise in crime prevention.

One type of CPTED security survey will be concerned with perimeter security, focusing on the outside of a building and grounds to identify environmental design elements that indicate how secure the place is. A second type of security survey will focus on internal security design (e.g., whether deadbolt locks are used, burglar alarms are used). Figure 8 provides guidelines on what to look for in a commercial setting, and Figures 9 and 10 are examples of burglary prevention survey forms.

The local police can help in developing the focus of the CPTED security surveys. For example, the police could suggest that a perimeter security survey should note the difference between the number of casement windows that are easy to secure and the number of louver windows that are difficult to make burglar-proof. For an internal security survey, the police could recommend that the type as well as the number of locks on doors be noted. Their recommendations will be based on a general expertise in crime prevention as well as on their knowledge of the characteristics of the community.

Conducting the perimeter security survey is a relatively straightforward process -- the instrument is available and permission by property owners is likely. Conducting an internal security survey, however, can be more problematic in terms of getting permission. If the CPTED project is in a residential area, local community organizations should be approached for their assistance in this matter. The mayor, police chief, or city planning office can also assist by informing the residents of the purposes of the CPTED project and their



SECURITY SURVEY

The Arlington County Police Department offers you the opportunity to participate in a comprehensive evaluation of your business. The purpose of the security survey is to evaluate the physical and procedural weaknesses of your establishment and make recommendations that will increase your level of protection against crime.

All survey information and evaluations are strictly confidential for your protection. Arrangements for security surveys can be made through the Arlington County Police Department.

INTRUSION DETECTION SYSTEMS

There are many types of intrusion detection systems (burglar alarms) on the market today. Beware of the advertised "best" system. Each system should be designed and installed by a professional alarm company. Careful consideration must be made in selecting the proper system. Areas to consider are your location, value of items to be protected, coverage desired, incorporation with a fire alarm system, and cost. A properly designed and implemented system may qualify your business for a substantial insurance discount.

Your Crime Prevention Officer or a reputable alarm company representative can assist you in selecting an intrusion detection system.

Source: Arlington County, Virginia, Police Department

Figure 8. Typical Commercial Security Checkpoints

NAME: ____________________ ADDRESS: ____________________

BURGLARY PREVENTION CHECK LIST

PREVENTION TIPS	OK	NEEDED	RECOMMEND REPLACEMENT
Doors;			
Strong Pintumbler Locks:			
Front Door.			
Back Doo			
Side Doo.			
Basement Door			
Chain Latch:			
Front Door			
Back Door			
Side Door			
Basement Door			
Heavy Duty Door Hinges:			
Front Door			
Back Door			
Side Door			
Basement Door			
Peep-Hole			
Front Door			
Back Door			
Doors with Windows			
Need key to open inside & out			
Mail Box			
Mail Slot in Door			
Garage Door			
Pintumbler Lock			
Windows;			
All Windows with pintumblers			
Bar or Strip of Wood(Patio Door)			
Bars or Grill Work;			
"Out of the Way Windows"			
Garage Windows			
Basement Windows			
Keys:			
Change Tumblers			
When you moved in			
If Keys are Lost			
Don't Give Out Duplicate Keys			
Home and Automobile Key Separate			
Don't put Name & Address on Keys			
House Key hidden outside			

Source: Metropolitan Police Department, Washington, D. C.

Figure 9. Police Security Survey for Burglary Prevention (Page 1 of 2)

PREVENTION TIPS	OK	NEEDED	RECOMMEND REPLACEMENT
Valuables;			
Serial Numbers, TV, Radios etc.			
List	____	____	____
Bank Deposit Box			
Cash (Large Amounts)	____	____	____
Jewelry	____	____	____
Bonds (Negotiable)	____	____	____
Under Lock and Key			
Check Books	____	____	____
Credit Cards	____	____	____
Bicycles List all Serial Numbers	____	____	____
Lights;			
Outside;			
Front	____	____	____
Rear	____	____	____
Side	____	____	____
Inside;			
Autoatic Device Lights & Radio	____	____	____
Small Door Light			
Front	____	____	____
Rear	____	____	____

The following are important Reminders to help you from being the next victim of a Burglar.

A. Keep all doors and windows locked at all times.
B. When home alone leave lights on in other rooms.
C. Always close the curtains and draw the shades after dark.
D. Always use your chain latch every time you answer the door.
E. Require identification from repairmen and utility company representatives.
F. Don't let anyone in unless you are sure they are who they say.
G. Be alert for strangers who loiter in hallways, elevators, and laundry rooms.
H. Make note of license tag numbers of suspicious autos you notice in your neighborhood.
I. Stop delivery of Mail, Milk, and Newspapers when you are going away.
J. Arrange to have your grass cut or the snow shoveled when you are away.
K. If you are a woman and live alone use initials on mail box, door, and in phone book.
L. Let the police know when you will be going out of town.
M. Most important always call the Police whenever you see or hear anything suspicious in your neighborhood.

OPERATION IDENTIFICATION

Operation Identification is available at your local police station in the District of Columbia, at no cost to you.

1. Borrow an ENGRAVER from the police station.
2. Engrave your SOCIAL SECURITY NUMBER on your property (TV, Radio, etc.).
3. Return the engraver to the police station, and pick up stickers.
4. Place the WARNING STICKERS on doors/or/windows.

Inspecting Officer______________ District__________ Date__________

Source: Metropolitan Police Department, Washington, D. C.

Figure 9. Police Security Survey for Burglary Prevention (Page 2 of 2)

Don't let a burglar hit you where you live. In five minutes you can take this simple test to determine how well protected your home is against burglary. Your home protection depends on good locks, adequate lighting and safe practices.

YES NO

1. Are the locks on your most used outside doors of the cylinder type? ☐ ☐
2. Are they of either the deadlocking or jimmy-proof type? ☐ ☐
3. Can any of your door locks be opened by breaking out glass or a panel of light wood? ☐ ☐
4. Do your use chain locks or other auxiliary locks on most used doors? ☐ ☐
5. Do the doors without cylinder locks have a heavy bolt or some similar secure device that can be operated only from the inside? ☐ ☐
6. Can all of your doors (basement, porch, french, balcony) be securely locked? ☐ ☐
7. Do your basement doors have locks that allow you to isolate that part of your house? ☐ ☐
8. Are your locks all in good repair? ☐ ☐
9. Do you know everyone who has a key to your house? (Or are there some still in possession of previous owners and their servants and friends?) ☐ ☐
10. Are your window locks properly and securely mounted? ☐ ☐
11. Do you keep your windows locked when they are shut? ☐ ☐
12. Do you use locks that allow you to lock a window that is partly open? ☐ ☐
13. In high hazard locations, do you use bars or ornamental grille? ☐ ☐
14. Are you as careful of basement and second floor windows as you are of those on the first floor? ☐ ☐
15. Have you made it more difficult for the burglar by locking up your ladder, avoiding trellises that can be used as a ladder or similar aids to climbing? ☐ ☐
16. Do you lock your garage door at night? ☐ ☐
17. Do you lock your garage when you are away from home? ☐ ☐
18. Do you have good, secure locks on the garage doors and windows? ☐ ☐
19. Do you lock your car and take the keys out even when it is parked in your garage? ☐ ☐

YES NO

20. Do you stop all deliveries or arrange for neighbors to pick up papers, milk, mail, packages? ☐ ☐
21. Do you notify a neighbor? ☐ ☐
22. Do you notify your sheriff. They provide extra protection for vacant homes. ☐ ☐
23. Do you leave some shades up so the house doesn't look deserted? ☐ ☐
24. Do you arrange to keep your lawn and garden in shape? ☐ ☐
25. Do you plan so that you do not need to "hide" a key under the door mat? ☐ ☐
26. Do you keep as much cash as possible and other valuables in a bank? ☐ ☐
27. Do you keep a list of all valuable property? ☐ ☐
28. Do you have a list of the serial numbers of your watches, cameras, typewriters and similar items? ☐ ☐
29. Do you have a description of other valuable property that does not have a number? ☐ ☐
30. Do you avoid unnecessary display [illegible] of your valuables? ☐ ☐
31. Have you told your family what [illegible] cover a burglar breaking in or [illegible]? ☐ ☐
32. Have you told your family to leave the [illegible] undisturbed and call the sheriff or [illegible] they discover a burglary has been committed? ☐ ☐

Every "no" check mark shows a weak point that may help a burglar. As you eliminate the "no" checks, you improve your protection.

Your local sheriff or chief of police can arrange a thorough home security inspection of your house or apartment at no cost to you. Give them a call today. REMEMBER—Crime Prevention Begins At Home.

PREPARED AND DISTRIBUTED BY
THE NATIONAL SHERIFFS' ASSOCIATION
IN COOPERATION WITH
YOUR LOCAL LAW ENFORCEMENT AGENCY
FUNDED BY A GRANT FROM
THE LAW ENFORCEMENT ASSISTANCE ADMINISTRATION
U.S. DEPARTMENT OF JUSTICE

Figure 10. Burglary Prevention Survey

providing the CPTED team with some identification (e.g., a letter) that they must present prior to conducting a survey of each residence. If the CPTED project is in a commercial area, the assistance might be provided by local business organizations.

8. OEAP (OTREP Environmental Assessment Package)

Instructions

The user of this package should be very familiar with the environmental subareas in question. The onsite observation portion of OEAP should be completed in the field after the user has explored and become familiar with both the control and target subareas.

OEAP contains a separate section for each OTREP factor (e.g., Target). Each section, in turn, contains a list of items (e.g., money, autos, jewelry) to help define or operationalize the OTREP factor so that the user knows what to look for in the environment. Part 1 of OEAP is used for the daytime assessment, and Part 2 is used for the nighttime assessment.

Under each scale in each section is a blank space so that the observer can write down any ideas, comments, or questions that come to mind during the process. This space should be used to note that a specific scale is not applicable to the environment at hand, or that a scale checked "about the same" reflects none of the characteristics in either the project or control environment (e.g., no policemen were seen in either environment).

OTREP Environment Assessment Package

PART I: DAYTIME ASSESSMENT

Contextual Information

- Time of Day __________

- Name of environment (and bounding streets):

- Brief description of physical environment (types of buildings, types of behavior settings):

- User characteristics (typical age, sex, race, etc. of potential victims):

- Potential offender population. List groups, organizations in area or nearby which act as source of potential offenders (e.g., schools. pool halls, bars, low SES neighborhoods, dense racial/ethnic groups, unemployed, etc.):

OEAP-DAYTIME

A. Targets

If there are no targets in an environment, crime cannot occur. Check any targets present in this environment which have been or can act as the objective of crimes. Note places in environment where amounts of cash and property can accumulate. Note vulnerability to theft or vandalism of selected targets.

		Comments/Ideas
	• Money	
______	Checks (pay, social security, medicare)	______
______	Cash registers	______
______	Cash on persons	______
______	Cash in homes	______
______	Safes	______
______	Stocks, bonds	______
______	Change machines	______
	• Private Property	
______	Autos, cycles, bikes	______
______	Jewels, silver, jewelry	______
______	Art ojbects (paintings, sculpture)	______
______	Clothing	______
______	Collections (coins, stamps)	______
______	Tools	______
______	Appliances (T.V., stereos)	______
______	Trees, flowers, shrubs	______
	• Public Property	
______	Street furniture	______
______	Parking meters	______
______	Statues	______
______	Transportation systems	______
______	Street lights, signs, fire alarms	______
______	Phone booths	______
	• Wholesale/Retail Property	
______	Retail stores: soft goods/ hard goods	______
______	Service stores (laundries, restaurants)	______

A. Targets (Continued)

- Offices

_______ Office equipment _______________
_______ Document and records _______________

- People (Assault, Robbery)

_______ Children _______________
_______ Adults _______________
_______ Elderly _______________
_______ Drunks _______________

B. RISK-DAY

Criminals prefer environments in which the risk of committing a crime is low. Listed below are factors which influence risk to the criminal. Compare the CPTED target subarea to the control subarea on each scale. Check to indicate if the CPTED target subarea is better than, the same as, or poorer than the control subarea. Use the space between scale items to jot down any notes or observations that you have concerning the environment.

- Factors Relating to Surveillance

*People in the CPTED target subarea.

"CONTROL"
ENVIRONMENT

MORE PEOPLE VISABLE	ABOUT THE SAME	FEWER PEOPLE VISABLE
MORE PEOPLE IN TRANSIT	ABOUT THE SAME	FEWER PEOPLE IN TRANSIT
MORE PEOPLE SITTING, STANDING	ABOUT THE SAME	FEWER PEOPLE SITTING SITTING, STANDING
MORE TALKING, SOCIAL-IZING, INTERACTING	ABOUT THE SAME	LESS TALKING, SOCIAL-IZING, INTERACTING
STRANGER FEELS MORE CONSPICUOUS	ABOUT THE SAME	STRANGER FEELS LESS CONSPICUOUS
MORE CHILDREN VISABLE	ABOUT THE SAME	FEWER CHILDREN VISABLE
MORE ADULTS VISABLE	ABOUT THE SAME	FEWER ADULTS VISABLE

B. RISK-DAY (continued)

- Factors Relating to Surveillance

*Peop?e in the CPTED target subarea.

"CONTROL" ENVIRONMENT

MORE PEOPLE ON SIDE-WALK, FRONT YARDS	ABOUT THE SAME	FEWER PEOPLE ON SIDE-WALK, FRONT YARD
EASIER TO CASE ENVIRONMENT	ABOUT THE SAME	MORE DIFFICULT TO ENVIRONMENT
MORE PEOPLE LOITERING	ABOUT THE SAME	FEWER PEOPLE LOITERING
MORE UNDESIRABLE "CHARACTERS"	ABOUT THE SAME	FEWER UNDESIRABLE "CHARACTERS"

RISK-DAY

- Surveillance

*Auto Traffic in CPTED Area.

"CONTROL"
ENVIRONMENT

GENERALLY MORE TRAFFIC	ABOUT THE SAME	GENERALLY LESS TRAFFIC
MORE COMMERCIAL TRAFFIC	ABOUT THE SAME	MORE COMMERCIAL TRAFFIC
MORE STREET PARKING AVAILABLE	ABOUT THE SAME	LESS STREET PARKING AVAILABLE
MORE VEHICLES PARKED IN STREET	ABOUT THE SAME	LESS VEHICLES PARKED IN STREET
MORE JUNK, BROKEN OR STRIPPED VEHICLES	ABOUT THE SAME	FEWER JUNK, BROKEN OR STRIPPED VEHICLES
MORE VEHICLES WITH OUT OF STATE LISCENSE PLATES	ABOUT THE SAME	FEWER VEHICLES WITH OUT OF STATE LISCENSE PLATES
	ABOUT THE SAME	

RISK-DAY

- Surveillance

*Physical Environment in CPTED Area.

"CONTROL"
ENVIRONMENT

MORE PLACES TO SIT, REST, TALK	ABOUT THE SAME	FEWER PLACES TO SIT, REST, TALK
GENERALLY MORE WINDOWS FACING STREET	ABOUT THE SAME	GENERALLY FEWER WINDOWS FACING STREET
GENERALLY MORE CURTAINS, BLINDS OPEN	ABOUT THE SAME	GENERALLY MORE CURTAINS, BLINDS CLOSED
BACKYARDS MORE VISIBLE TO NEIGHBORS	ABOUT THE SAME	BACKYARDS LESS VISIBLE TO NEIGHBORS
BRIGHTER LIGHTING, FEWER DARK SPOTS	ABOUT THE SAME	DIMMER LIGHTING, MORE DARK SPOTS
GENERALLY MORE TREES, SHRUBS	ABOUT THE SAME	GENERALLY FEWER TREES, SHRUBS
MORE ELEVATED VIEWS, SECOND STORY WINDOWS	ABOUT THE SAME	FEWER ELEVATED VIEWS, SECOND STORY WINDOWS
ALLEYS, PATHWAYS LESS VISIBLE TO RESIDENTS	ABOUT THE SAME	ALLEYS, PATHWAYS MORE VISIBLE TO RESIDENTS

RISK-DAY

- Surveillance.

Law Enforcement Personnel.

"CONTROL" ENVIRONMENT

POLICEMEN/PATROL CARS MORE FREQUENTLY SEEN	ABOUT THE SAME	POLICEMEN/PATROL CARS LESS FREQUENTLY SEEN
MORE FOOT PATROLMEN IN AREA	ABOUT THE SAME	FEWER FOOT PATROLMEN IN AREA
MORE CAR PATROLS	ABOUT THE SAME	FEWER CAR PATROLS
MORE PRIVATE SECURITY PATROLS	ABOUT THE SAME	FEWER PRIVATE SECURITY PATROLS

*This information can be obtained from police officers who patrol the subareas in question.

RISK-DAY

- Access Control

Buildings, Stores in CPTED Area.

"CONTROL"
ENVIRONMENT

MORE BURGLAR ALARMS	ABOUT THE SAME	FEWER BURGLAR ALARMS
MORE STRONG/DEADBOLT LOCKS	ABOUT THE SAME	FEWER STRONG/DEADBOLT LOCKS
MORE PRIVATE BUILDING GUARDS	ABOUT THE SAME	FEWER PRIVATE BUILDING GUARDS
MORE BARS ON WINDOWS	ABOUT THE SAME	FEWER WINDOWS BARRED
MORE WINDOWS, SECOND ENTRANCES ON GROUND FLOOR	ABOUT THE SAME	FEWER WINDOWS, SECOND ENTRANCES ON GROUND FLOOR
MORE FENCES AROUND BUILDING	ABOUT THE SAME	FEWER FENCES AROUND BUILDING
MORE FIRE ESCAPES	ABOUT THE SAME	FEWER FIRE ESCAPES
MORE ALLEYWAYS, PATHWAYS	ABOUT THE SAME	FEWER ALLEYWAYS, PATHWAYS

*This section can be expanded using the guidelines suggested in E.7.

RISK-DAY

- Access Control

*Residences in CPTED Area.

"CONTROL" ENVIRONMENT

MORE HOMES FENCED	ABOUT THE SAME	FEWER HOMES FENCED
FENCES GENERALLY TALLER	ABOUT THE SAME	FENCES GENERALLY SHORTER
MORE SOLID WOOD FENCES	ABOUT THE SAME	FEWER SOLID WOOD FENCES
MORE LOCKS ON GATES	ABOUT THE SAME	FEWER LOCKS ON GATES
MORE WATCH DOGS IN YARDS	ABOUT THE SAME	FEWER WATCH DOGS IN YARDS
BIGGER TEETH IN WATCH DOGS	ABOUT THE SAME	SMALLER TEETH IN WATCH DOGS
MORE PATHWAYS BETWEEN HOUSES	ABOUT THE SAME	FEWER PATHWAYS BETWEEN HOUSES

RISK-DAY

- Access Control

*Residences in CPTED Area (con't).

"CONTROL"
ENVIRONMENT

FRONT YARDS BETTER DEFINED WITH BUSHES, CURBS, ETC.	ABOUT THE SAME	FRONT YARDS MORE POORLY DEFINED WITH BUSHES, CURBS, ETC.
BACK YARDS BETTER DEFINED WITH BUSHES, CURBS, ETC.	ABOUT THE SAME	BACK YARDS MORE POORLY DEFINED WITH BUSHES, CURBS, ETC.
MORE DOORS, WINDOWS AJAR, OPEN	ABOUT THE SAME	FEWER DOORS, WINDOWS AJAR, OPEN
MORE DEAD END STREETS	ABOUT THE SAME	FEWER DEAD END STREETS
HOMES MORE CROWDED, CLOSER TOGETHER	ABOUT THE SAME	HOMES LESS CROWDED, FURTHER APART
MORE ALLEYS	ABOUT THE SAME	FEWER ALLEYS
BACKYARDS MORE ACCESSIBLE	ABOUT THE SAME	BACKYARDS LESS ACCESSIBLE

RISK-DAY

- Activity Support.*

"CONTROL"
ENVIRONMENT

MORE COMMUNITY ORGANIZATIONS	ABOUT THE SAME	FEWER COMMUNITY ORGANIZATIONS
LARGER COMMUNITY ORGANIZATIONS	ABOUT THE SAME	SMALLER COMMUNITY ORGANIZATIONS
MORE ANTI-CRIME PROGRAMS	ABOUT THE SAME	FEWER ANTI-CRIME PROGRAMS
MORE COMMUNITY ACTIVITIES	ABOUT THE SAME	FEWER COMMUNITY ACTIVITIES
BETTER POLICE RELATIONS	ABOUT THE SAME	POORER POLICE RELATIONS
MORE YOUTH PROGRAMS	ABOUT THE SAME	FEWER YOUTH PROGRAMS

*This information can be obtained from community leaders who are familiar with social programs in the subareas.

III. EFFORT-DAYTIME

Criminals prefer environments in which the amount of physical effort required to commit a crime is low.

- Target Hardening*

"CONTROL"
ENVIRONMENT

MORE STRONG/DEADBOLT LOCKS	ABOUT THE SAME	FEWER STRONG/DEADBOLT LOCKS
MORE BARS ON WINDOWS	ABOUT THE SAME	FEWER BARS ON WINDOWS
MORE WINDOWS OF MODERN, STRONG DESIGN	ABOUT THE SAME	FEWER WINDOWS OF MODERN, STRONG DEISGN
PHYSICAL COMPONENTS NEWER, BETTER MAINTAINED	ABOUT THE SAME	PHYSICAL COMPONENTS OLDER MORE POORLY MAINTAINED
STRONGER, MORE MODERN SAFES	ABOUT THE SAME	WEAKER, OLDER SAFES
TARGETS, VALUABLES BETTER CAMOUFLAGED	ABOUT THE SAME	TARGETS, VALUABLES MORE POORLY CAMOUFLAGED

*These ratings would be based on the security surveys (see Section 7).

III. EFFORT-DAYTIME

- Target Hardening (continued)

	"CONTROL" ENVIRONMENT	
VALUABLES, TARGETS LESS EXCESSIVELY EXPOSED LOCATION	ABOUT THE SAME	VALUABLES, TARGETS MORE EXCESSIVELY EXPOSED LOCATION
VALUABLES EXPOSED LESS FREQUENTLY, LESS TIME	ABOUT THE SAME	VALUABLES EXPOSED MORE FREQUENTLY, MORE TIME

IV. PAYOFF-DAYTIME

Criminals prefer environments in which the payoff value of the potential targets is high.

- Targets

"CONTROL" ENVIRONMENT

GENERALLY LOWER PAYOFF VALUE	ABOUT THE SAME	GENERALLY HIGHER PAYOFF VALUE
MORE TARGETS CAN BE RELOCATED TO ANOTHER ENVIRONMENT	ABOUT THE SAME	FEWER TARGETS CAN BE RELOCATED TO A SAFER ENVIRONMENT
MORE TARGETS CAN BE REDUCED IN PAYOFF VALUE	ABOUT THE SAME	FEWER TARGETS CAN BE REDUCED IN PAYOFF VALUE
SUITABLE FOR OPERATION IDENTIFICATION	ABOUT THE SAME	NOT SUITABLE FOR OPERATION IDENTIFICATION
PAYOFF VALUE MORE EASILY OBSERVED	ABOUT THE SAME	PAYOFF VALUE LESS EASILY OBSERVED

V. COGNITIVE FACTOR-DAYTIME

OTREP factors will function better to deter crime if the criminal accurately perceives the nature of each factor in the environment.

- News Media*

"CONTROL"
ENVIRONMENT

MORE NEWSPAPER ARTICLES	ABOUT THE SAME	FEWER NEWSPAPER ARTICLES
MORE T.V. & RADIO SPOTS	ABOUT THE SAME	FEWER T.V. & RADIO SPOTS
MORE COMMUNITY PROJECTS	ABOUT THE SAME	FEWER COMMUNITY PROJECTS
LARGER, MORE COMPLEX COMMUNITY PROJECTS	ABOUT THE SAME	SMALLER, SIMPLER COMMUNITY PROJECTS
MORE NEWSLETTERS FROM LOCAL GROUPS	ABOUT THE SAME	FEWER NEWSLETTERS FROM LOCAL GROUPS

*Requires interviews with community members.

COGNITIVE-DAY

- Environmental Signs

"CONTROL"
ENVIRONMENT

MORE OPERATION IDENTIFICATION SIGNS VISABLE	ABOUT THE SAME	FEWER OPERATION IDENTIFICATICN SIGNS VISABLE
MORE BLOCK WATCH SIGNS VISABLE	ABOUT THE SAME	FEWER BLOCK WATCH SIGNS VISABLE
MORE SECURITY PATROL SIGNS VISABLE	ABOUT THE SAME	FEWER SECURITY PATROL SIGNS VISABLE
MORE BURGLAR ALARM SIGNS VISABLE	ABOUT THE SAME	FEWER BURGLAR ALARM SIGNS VISABLE
MORE "LOW-CASH-ON-HAND" COMMERCIAL SIGNS VISABLE	ABOUT THE SAME	FEWER "LOW-CASH-ON-HAND" COMMERCIAL SIGNS VISABLE
MORE SURVEILLANCE SYSTEM SIGNS VISABLE	ABOUT THE SAME	FEWER SURVEILLANCE SYSTEM SIGNS VISABLE

CONTINUED

1 OF 5

COGNITIVE-DAY

- Environmental Cues

"CONTROL"
ENVIRONMENT

CLEANER	ABOUT THE SAME	DIRTIER
BETTER MAINTAINED	ABOUT THE SAME	MORE POORLY MAINTAINED
MORE LITTER, TRASH	ABOUT THE SAME	LESS LITTER, TRASH
MORE ATTRACTIVE	ABOUT THE SAME	LESS ATTRACTIVE
EASIER TO USE, GET AROUND IN	ABOUT THE SAME	MORE CONFUSING TO USE, GET AROUND IN
MORE ATTRACTIVE, BETTER MAINTAINED LANDSCAPING	ABOUT THE SAME	LESS ATTRACTIVE, MORE POORLY MAINTAINED LANDSCAPING

PART II: NIGHTTIME ASSESSMENT

Contextual Information

- Time of Night ________

- User characteristics (typical age, sex, race, etc. of potential victims):

- Potential offender population. List groups, organizations in area or nearby which act as source of potential offenders (e.g., schools. pool halls, bars, low SES neighborhoods, dense racial/ethnic groups, unemployed, etc.):

OEAP-NIGHTTIME

A. Targets

If there are no targets in an environment, crime cannot occur. Check any targets present in this environment which have been or can act as the objective of crimes. Note places in environment where amounts of cash and property can accumulate. Note vulnerability to theft or vandalism of selected targets.

	• Money	Comments/Ideas
______	Checks (pay, social security, medicare)	______
______	Cash registers	______
______	Cash on persons	______
______	Cash in homes	______
______	Safes	______
______	Stocks, bonds	______
______	Change machines	______
	• Private Property	
______	Autos, cycles, bikes	______
______	Jewels, silver, jewelry	______
______	Art ojbects (paintings, sculpture)	______
______	Clothing	______
______	Collections (coins, stamps)	______
______	Tools	______
______	Appliances (T.V., stereos)	______
______	Trees, flowers, shrubs	______
	• Public Property	
______	Street furniture	______
______	Parking meters	______
______	Statues	______
______	Transportation systems	______
______	Street lights, signs, fire alarms	______
______	Phone booths	______
	• Wholesale/Retail Property	
______	Retail stores: soft goods/ hard goods	______
______	Service stores (laundries, restaurants)	______

A. Targets (Continued)

- Offices

______	Office equipment	______
______	Document and records	______

- People (Assault, Robbery)

______	Children	______
______	Adults	______
______	Elderly	______
______	Drunks	______

B. RISK-NIGHT

Criminals prefer environments in which the risk of committing a crime is low. Listed below are factors which influence risk to the criminal. Compare the CPTED target subarea to the control subarea on each scale. Check to indicate if the CPTED target subarea is better than, the same as, or poorer than the control subarea. Use the space between scale items to jot down any notes or observations that you have concerning the environment.

- Factors Relating to Surveillance

*People in the CPTED target subarea.

	"CONTROL" ENVIRONMENT	
MORE PEOPLE VISABLE	ABOUT THE SAME	FEWER PEOPLE VISABLE
MORE PEOPLE IN TRANSIT	ABOUT THE SAME	FEWER PEOPLE IN TRANSIT
MORE PEOPLE SITTING,STANDING	ABOUT THE SAME	FEWER PEOPLE SITTING SITTING,STANDING
MORE TALKING, SOCIAL-IZING, INTERACTING	ABOUT THE SAME	LESS TALKING, SOCIAL-IZING, INTERACTING
STRANGER FEELS MORE CONSPICUOUS	ABOUT THE SAME	STRANGER FEELS LESS CONSPICUOUS
MORE CHILDREN VISABLE	ABOUT THE SAME	FEWER CHILDREN VISABLE
MORE ADULTS VISABLE	ABOUT THE SAME	FEWER ADULTS VISABLE

B. RISK-NIGHT (continued)

- Factors Relating to Surveillance

*People in the CPTED target subarea.

"CONTROL"
ENVIRONMENT

MORE PEOPLE ON SIDE-WALK, FRONT YARDS	ABOUT THE SAME	FEWER PEOPLE ON SIDE-WALK, FRONT YARD
EASIER TO CASE ENVIRONMENT	ABOUT THE SAME	MORE DIFFICULT TO ENVIRONMENT
MORE PEOPLE LOITERING	ABOUT THE SAME	FEWER PEOPLE LOITERING
MORE UNDESIRABLE "CHARACTERS"	ABOUT THE SAME	FEWER UNDESIRABLE "CHARACTERS"

RISK- NIGHT

- Surveillance

*Auto Traffic in CPTED Area.

"CONTROL"
ENVIRONMENT

GENERALLY MORE TRAFFIC	ABOUT THE SAME	GENERALLY LESS TRAFFIC
MORE COMMERCIAL TRAFFIC	ABOUT THE SAME	MORE COMMERCIAL TRAFFIC
MORE STREET PARKING AVAILABLE	ABOUT THE SAME	LESS STREET PARKING AVAILABLE
MORE VEHICLES PARKED IN STREET	ABOUT THE SAME	LESS VEHICLES PARKED IN STREET

RISK-NIGHT

- Surveillance

*Physical Environment in CPTED Area.

"CONTROL"
ENVIRONMENT

GENERALLY MORE CURTAINS, BLINDS OPEN	ABOUT THE SAME	GENERALLY MORE CURTAINS, BLINDS CLOSED
BACKYARDS MORE VISABLE TO NEIGHBORS	ABOUT THE SAME	BACKYARDS LESS VISABLE TO NEIGHBORS
BRIGHTER LIGHTING, FEWER DARK SPOTS	ABOUT THE SAME	DIMMER LIGHTING, MORE DARK SPOTS
ALLEYS, PATHWAYS LESS VISIBLE TO RESIDENTS	ABOUT THE SAME	ALLEYS, PATHWAYS MORE VISIBLE TO RESIDENTS

RISK-NIGHT

- Surveillance.

Law Enforcement Personnel.

"CONTROL"
ENVIRONMENT

POLICEMEN/PATROL CARS MORE FREQUENTLY SEEN	ABOUT THE SAME	POLICEMEN/PATROL CARS LESS FREQUENTLY SEEN
MORE FOOT PATROLMEN IN AREA	ABOUT THE SAME	FEWER FOOT PATROLMEN IN AREA
MORE CAR PATROLS	ABOUT THE SAME	FEWER CAR PATROLS
MORE PRIVATE SECURITY PATROLS	ABOUT THE SAME	FEWER PRIVATE SECURITY PATROLS

*This information can be obtained from police officers who patrol the subareas in question.

RISK-NIGHT

- Access Control

Buildings, Stores in CPTED Area.

"CONTROL"
ENVIRONMENT

MORE PRIVATE BUILDING GUARDS	ABOUT THE SAME	FEWER PRIVATE BUILDING GUARDS
MORE BARS ON WINDOWS	ABOUT THE SAME	FEWER WINDOWS BARRED

*This section can be expanded using the guidelines suggested in Section 7.

RISK-NIGHT

- Access Control

*Residences in CPTED Area.

"CONTROL"
ENVIRONMENT

MORE LOCKS ON GATES	ABOUT THE SAME	FEWER LOCKS ON GATES
MORE WATCH DOGS IN YARDS	ABOUT THE SAME	FEWER WATCH DOGS IN YARDS
BIGGER TEETH IN WATCH DOGS	ABOUT THE SAME	SMALLER TEETH IN WATCH DOGS
MORE DOORS, WINDOWS AJAR, OPEN	ABOUT THE SAME	FEWER DOORS, WINDOWS AJAR, OPEN

III. EFFORT-NIGHTTIME

Criminals prefer environments in which the amount of physical effort required to commit a crime is low.

- Target Hardening*

"CONTROL"
ENVIRONMENT

TARGETS, VALUABLES BETTER CAMOUFLAGED	ABOUT THE SAME	TARGETS, VALUABLES MORE POORLY CAMOUFLAGED
VALUABLES, TARGETS LESS EXCESSIVELY EXPOSED LOCATION	ABOUT THE SAME	VALUABLES, TARGETS MORE EXCESSIVELY EXPOSED LOCATION
VALUABLES EXPOSED LESS FREQUENTLY, LESS TIME	ABOUT THE SAME	VALUABLES EXPOSED MORE FREQUENTLY, MORE TIME

*These ratings would be based on the security surveys (see Section 7).

IV. PAYOFF-NIGHTTIME

Criminals prefer environments in which the payoff value of the potential targets is high.

- Targets

"CONTROL" ENVIRONMENT

GENERALLY LOWER PAYOFF VALUE	ABOUT THE SAME	GENERALLY HIGHER PAYOFF VALUE
PAYOFF VALUE MORE EASILY OBSERVED	ABOUT THE SAME	PAYOFF VALUE LESS EASILY OBSERVED

V. COGNITIVE FACTOR--NIGHTTIME

OTREP factors will function better to deter crime if the criminal accurately perceives the nature of each factor in the environment.

- Environmental Signs

"CONTROL"
ENVIRONMENT

MORE OPERATION IDENTIFICATION SIGNS VISABLE	ABOUT THE SAME	FEWER OPERATION IDENTIFICATION SIGNS VISABLE
MORE BLOCK WATCH SIGNS VISABLE	ABOUT THE SAME	FEWER BLOCK WATCH SIGNS VISABLE
MORE SECURITY PATROL SIGNS VISABLE	ABOUT THE SAME	FEWER SECURITY PATROL SIGNS VISABLE
MORE BURGLAR ALARM SIGNS VISABLE	ABOUT THE SAME	FEWER BURGLAR ALARM SIGNS VISABLE
MORE "LOW-CASH-ON-HAND" COMMERCIAL SIGNS VISABLE	ABOUT THE SAME	FEWER "LOW-CASH-ON-HAND" COMMERCIAL SIGNS VISABLE
MORE SURVEILLANCE SYSTEM SIGNS VISABLE	ABOUT THE SAME	FEWER SURVEILLANCE SYSTEM SIGNS VISABLE

CPTED TECHNICAL GUIDELINE 2

Behavioral Observation Methods

Behavioral Observation Methods

1. Introduction

Behavioral observation is basic to understanding natural phenomena. Scientists of nearly all types attempt to expand their understanding of various phenomena, either by observing how they behave or by inspecting recorded evidence of their past behavior. For the CPTED analyst, behavioral observation is useful as a means of obtaining information about the behavioral patterns that occur within a particular project setting. This information can be put to use in two general ways. First, it can assist in the exposure and clarification of problems that might otherwise go unnoticed or be misunderstood. Thus, it helps the analyst form crime/environment hypotheses and identify appropriate CPTED strategies. Second, it can provide a means of evaluating the changes in behavior that occur after the project is initiated, so that something can be learned about its effects.

The purpose of this guideline is to prepare the user to conduct effective behavioral observation studies as part of a CPTED project. This is accomplished by a systematic discussion of relevant techniques, issues, and problems. The discussion is not, however, all-encompassing. Only matters having particular utility for the CPTED analyst are covered.

As with all data gathering, it is desirable that a behavioral observation study be both valid and reliable (See Guideline 5 for a discussion of these and related topics). The analyst must not only convince himself or herself of the data's accuracy but also must be convincing to others, such as government officials, funding agencies, and the general public. The overriding difficulty with achieving validity and reliability is that the techniques that are most useful to a CPTED analyst involve studying behavior in its natural setting. People and their activities should be observed in public locations, preferably without their knowledge.

The naturalistic character of behavioral observation is both a strength and a weakness. The strength is that since behavioral observation techniques focus on the setting of interest, the validity of the data can be very high. The weakness, however, is that the analyst exercises no direct control over the setting. Human behavior is varied and complex, making it difficult to identify the important attributes that should be observed.

The analyst's main strategy for performing good naturalistic observation is to maximize control over the observation methods rather than the environment. This is accomplished partially by performing the study in as consistent and systematic a fashion as possible. Additionally, the analyst tries to select measures that are objective and descriptive, avoiding the use of conjecture and inferences, which may be unjustified or premature. An effort must also be made to focus solely and inclusively upon those factors which are both relevant to the question at hand and readily measurable. As will be seen, it is not always easy to reconcile these two requirements.

1.1 Advantages of Observation Methods

Some form of informal observation is generally the starting point for more rigorous observation. For example, if someone casually notices that more people are out at night on well-lighted than poorly lighted streets, this can form the basis of further study of the phenomenon using more controlled observation. The usefulness of initial, informal observation cannot be overemphasized. It is fruitless to set up a costly observation schedule if the phenomenon of interest does not occur naturally or occurs rarely. It would be difficult to observe that there is less crime on well-lighted streets because of the comparative infrequency of crime on a daily or weekly basis.

Another point to consider is that an environment is not only physical, it is also social. The nature of an urban neighborhood is largely determined by the type of people found there. One way of describing the inhabitants of an area is to observe how they behave and note their similarity along such dimensions as age, race, and ethnic group. The reason for looking at what people are, as well as what they do, is that community anticrime organizations are more likely to thrive in a neighborhood where people share many characteristics as well as values than where people have little in common.

In addition to description, observation in natural settings (even of an informal, preliminary type) can aid in the selection of problems on which to focus and the formulation of testable CPTED hypotheses. For example, an observer could learn that pedestrian traffic varies from one area to another. Some areas can be frequented by retirees taking leisurely strolls while others could be populated by workers hurrying about their business. This could lead to a study of the effects of type of pedestrian on type of crime.

Perhaps the most important potential advantage of observational methods is that they can be carried out in natural settings without the targets of observation necessarily being aware that their actions are being recorded. Although there are some ethical concerns that should be weighed before noting citizens' behaviors without their consent (see Section 2), such concerns are minimized when only public behavior, which is open to the scrutiny of any bystander, is being recorded.

Another advantage is that citizens' use of space patterns can be compared to their reports as revealed in interviews on how they use space. There is a considerable body of evidence showing discrepancies between citizens' actual behavior and what citizens say they have done or (especially) what they would do in hypothetical situations. For example, a citizen can report a high degree of willingness to keep watch on his neighbor's property because he thinks it is the right thing to say. In actual practice, however, the citizen may not have the time or energy to perform such surveillance.

1.2 Disadvantages of Observation Methods

A major methodological problem is that many behaviors judged relevant to a given study occur too infrequently to discern changes in location or over time. For example, in one study (1) concerned with the use of outdoor areas in a residential complex with 463 duplex row-houses, 27 observation hours were spread out over 2 summer months, generating a record of 2,116 activities. Children's play, pedestrian traffic, and sitting and talking outdoors were observed more than 100 times. Day-of-week and, in some cases, morning-versus-afternoon comparisons were possible because these activities occurred often during any given day. Additionally, useful locational data could be culled (e.g., use of front rooms, back yards, traffic density on walks). Other activities, such as domestic behavior (eating or cooking outdoors) accounted for 62 recorded activities and gardening and building or repairing objects for 27 activities each. For those behavior categories, events occur with such infrequency that it is very difficult to establish reliable temporal or locational patterns.

A second major problem is that observation, when used by itself, provides little insight into the reasons underlying a person's actions. An observer noting that most patrons drive rather than walk to a neighborhood bank might infer that they are afraid of being robbed. However, interviews with these patrons may reveal some different reasons (e.g., banking is one of several errands being completed at that time). The point of this example is that a combination of methods not only corrects for the weaknesses of each but affords a better analysis of the issue in question.

There are several considerations to keep in mind in weighing the relative advantages and disadvantages of observation, as opposed to other approaches. One such consideration is the nature of the subject matter itself. Some phenomena of interest may not occur in places that are subject to visual surveillance. For example, some of the precautions that people take to deter crime (such as buying extra locks) may not be directly observable. On the other hand, there can be characteristics of citizen behavior that are most easily measured by direct observations.

If it is important to determine how people use their environment, the most valid and direct method to employ would be observation. However, observational research is costly in terms of manpower. Observational techniques require the training and supervision of observers. Depending on the scope of a project, such costs can be prohibitive.

2. <u>Ethics of Observation</u>

Social scientists have reached some general agreement regarding the ingredients of ethical conduct. The basic principles are: (1) The individuals observed should not be harmed in any way as a result of their participation; (2) they should be informed and not forced to participate; and (3) deception should be avoided and, when used, should always be followed by a debriefing session in which the subjects are completely informed of the true situation.

As already mentioned, most often people are studied without their knowledge. This is because people tend to behave differently when their actions are being recorded. Thus, informed consent often is not obtained in advance. To do so would slow the rate of data collection and render it useless or else would attract too much attention to the study. It is also worth considering that, even if informed consent is obtained and debriefing performed, the observed person has been subjected to a deception (i.e., he was allowed to believe that his behavior was a relatively private matter when, in fact, it was being systematically recorded).

Studies conducted in public settings can generally be fairly lax about these considerations. This is because the information gathered is usually impersonal and the subjects' identities remain unknown.

However, behavioral observation is not always carried out in public. Sometimes, the behavior of interest takes place only in private settings, making it necessary to employ a technique called participant observation. This method places an observer in direct contact with the persons to be studied and, recognizing that concealment is impractical, seeks to make him as inconspicuous as possible. Once again, the objective is to observe and record without disturbing that which is being observed. To accomplish this, it often is necessary that the observer change his physical appearance or otherwise conceal his identity. This procedure can require considerable amounts of deception and produce highly personal information. Even in studies that inform the people ahead of time of the observer's identity and purpose and use no deception, care must be taken. Information about a person or group can be misused and so, as the information gathered becomes more personal and the subjects' anonymity decreases, the observer's responsibility to prevent that information from causing them harm increases. The dangers of invading privacy must be weighed against the value of the gained information and a careful balance struck.

Resolving the ethical issues, however, is sometimes not enough. Concern over invasion of privacy has increased during recent years and one cannot always be certain that a proposed study which appears to be ethical is also legal. Additionally, one must consider the fact that the relationship between observer and subject is not privileged, as it is between doctors and lawyers and their clients. Thus, if a participant observer witnesses his group committing a crime, he can be required to testify even though to do so violates his commitment to prevent them from being harmed by the observation. Aside from this, the observer can be charged with failure to report a crime, withholding evidence, and aiding and abetting. For these reasons, it is generally desirable to seek legal counsel if it is economically feasible when planning a study involving participant observation. Legal advice can alert the analyst to potentially dangerous approaches before resources are wasted on them.

3. <u>Degree of Structure Imposed on Observations</u>

Structure can be regarded as a continuim ranging from a very open (i.e., with few or no definite categories for coding behavior) to a highly closed system (i.e., checklists that supposedly contain an exhaustive set of behaviors that occur in the situation of interest). Unstructured methods are thought to provide much richer, or more detailed, data by allowing for a full range of behaviors to be recorded. Unstructured methods can consist of little more than a pen and blank paper in the hands of an experienced, open-minded observer. The observer does not impose any preconceived notions about the situation and can alter his definition of the problem as events dictate. Such openness is desirable in the early stages of a study, and the information gained can be used as the basis for formulating a structured coding system. When all the behaviors of interest can be accounted for in a coding system, unstructured methods can be abandoned.

Despite their simplicity, flexibility, and potential for richness, unstructured methods have several drawbacks. Since it is not possible or desirable to record a complete account of a behavioral episode, observation must be selective. An observer can be influenced by numerous biases in the selection of events to record and this bias can change over time and situations. Specifically, it has been found that conclusions based on "early returns" alter the interpretation of later events. One way of correcting for observer bias is to employ several observers with different biases. Unfortunately, this is a rare practice when unstructured methods are used, partly because of the difficulty of making exact comparisons across observers. Another common fault of informal observations is that they are often based upon samples of persons and behaviors that may not be representative of the general citizenry. Again, this need not be the case, but it is not unusual when making some preliminary observations to focus on that which is most convenient to observe.

A final potential problem of unstructured methods involves the accuracy of recording. Notes can either be made on the spot or written down later, based upon one's recollections. The former can be distracting and could interfere with the observation process, while the latter can be affected by memory distortions. Tape recordings can substitute for written notes, but their convenience can be offset by their cost. Thus, such problems as observer bias and such advantages as flexibility suggest that unstructured observation is appropriate for the generation of ideas but not for their testing.

On the basis of information and insights gained from initial unstructured observations, coupled with input from other sources (such as key-person interviews and police reports), the analyst should be prepared to devise a more structured system for coding behavior. Some of the advantages of structured methods are: They facilitate quantification for statistical analysis; they permit comparisons across different times, places and observers; and they can be used by less experienced observers. In constructing a set of observational categories, decisions must be made about what elements should be observed. These elements are summarized below and discussed more fully in later sections:

- People in a situation should be described in terms of their observable characteristics (such as race, age, sex), as well as other factors (such as whether they are in an organized group versus being a collection of strangers).
- The setting in which the behavior occurs should be described in terms of various physical properties (such as time of day, weather conditions, population density), as well as in terms of certain subjective characteristics (such as pleasantness and whether it seems to encourage or discourage particular behaviors).
- The behaviors that occur in the situation should be noted according to their frequency and possible other characteristics to be discussed below.

4. <u>Procedural Steps</u>

The previous sections introduced important basic issues. This section presents the actual steps involved in planning a behavioral observation study. These steps are necessarily discussed in a particular order, but one should not infer that this order is always appropriate. The unique requirements of differing CPTED analysts will vary considerably and one must be flexible enough to alter the approach accordingly.

4.1 Operationalizing -- Deciding What to Measure

The analyst's first task is to choose an objective. One can decide to perform an exploratory study, designed to provide some general, initial information about an area. Alternatively, the study can be for evaluative purposes, yielding either baseline data before the initiation of some change or data on the results of that change.

Next, it is a good idea to establish a clear understanding of what one desires to measure (measurement points), an activity which is known as operationalizing (measurement criteria). State the problem formally, in a clear and concise sentence or two. Performing this exercise should suggest measurement points. For example, the objective "To discover the usual traffic patterns of visitors to Briarwood Park" clearly suggests that the study should concentrate on pedestrian movement. However, two other things also have been established. First, the location of the study is to be Briarwood Park. If the problem statement is to study the movements of visitors to parks in general, this sort of specificity would not be appropriate. Secondly, the word "usual" is applied to the traffic patterns of interest, so the study should not attempt to catalog the full range of human activity in the park, but only those activities that relate to traffic (walking, running, etc.).

The preceding example lends itself to the development of useful data gathering by defining the object of measurement and classifying some important factors related to the scope of the study. However, if the problem statement was "To discover the cause of vandalism", it would lack specificity. First of all, it assumes that vandalism has a single cause, which may or may not be correct. Secondly, even if this cause can be established, it is not apt to come about as the result of a single behavioral observation study. What is suggested is a massive piece of research, consisting of many individual studies.

The next step is to consider the different types of behavior that are potentially relevant. Behavior can be defined in terms of visual fixations, posture, locomotion, manipulation, gestures, and vocalizations. Begin by generating a rough list, noting as many different types as possible.

Suppose that, instead of studying traffic patterns in Briarwood Park, the purpose is to catalog the different types of behavior observed there. The initial list could be very long, containing such diverse items as: Teenagers playing baseball, family picnics, old men reading, and children feeding ducks. After this list is generated, look for similarities and differences among the behaviors and form categories into which they will fit. Sometimes this categorization must take place at more than one level. For example, writing a letter, taking notes on a book, and composing music might all be placed under a category called "writing." Writing, reading, eating, or walking alone might be categorized as "isolated-active" behavior.

Regardless of whether multiple category levels are generated, it is necessary to select a categorization system that is manageable and meaningful. For instance, in the example given earlier, it might be satisfactory to choose a set of four reasonably broad categories: Isolated-passive, Isolated-active, non-isolated-passive, and non-isolated-active. Because purposes and resources can vary so widely from one situation to the next, there is no simple rule for choosing the right set.

Having chosen a set of categories, it is wise to check them once again to make certain that nothing important has been overlooked. Are there relevant behaviors that would not fit any of the categories or would fit more than one? It is essential that there be no confusion about the differences in meaning between categories.

Then, identify the observable characteristics of each category. If there is no way to recognize and differentiate them observationally, they are useless. For example, suppose that the analyst has included a category called "sleeping." This might seem to be a fairly straightforward thing to observe, but one can legitimately ask, "How do you know that a person is asleep?" Short of using an EEG machine, the answer is that one does <u>not</u> know and can only draw an inference from the subject's behavior. Therefore, one must consider what attributes that behavior should have to be labelled "sleeping." One might invent a rule which states that a person who sits or lies relatively motionless with closed eyes is asleep. Alternatively, one might decide that, for the purposes of the study, the truly important factor is not whether the person is actually asleep, but whether he is moving and in visual contact with the surroundings. In this case, the "sleeping" category should be replaced and, perhaps, the rest of the categories rethought.

During this last phase of the operationalization process, it is not at all unusual to discover that the categorization scheme is deficient in some way. Rather than becoming discouraged, the analyst should try again, using the information gained from the mistake to generate a better classification system.

4.2 Temporal Aspects of Behavior

It is common to investigate certain relationships between behavior and time in an attempt to quantify the amount of behavior occurring. One aspect that can be examined is how often a behavior occurs within a given time span, which is simply a measure of its frequency. This is accomplished by counting the number of times it is displayed during the observation period or some other defined interval. For example, one might wish to compare the frequency with which conversations occur between pedestrians during the morning rush hour with that during the evening rush hour.

Another aspect which may be significant is the behavior's duration. Perhaps conversations occur less frequently in the morning, but tend to last longer than those in the evening. This could be important information, but may not be easy to obtain. What is desired is a measurement of the interval between the onset and cessation of a behavior, but the data may lie beyond the technique's range. That is, the conversations may begin or end somewhere out of sight, so that all an observer can report is the observed duration and this is probably not a good estimate of their true duration.

Another problem can be determining exactly when a relevant activity ends and another begins. Behavior is a continuous phenomenon, i.e., activities tend to flow smoothly from one to the other without containing obvious transitory phases. It can be difficult to break behavior into meaningful discrete, sequential entities. For example, does a conversation end if a third party joins along the way? If so, does the ending of the first conversation always precede the starting of the second, or is there an overlap? The cure for this problem lies in the success of the operationalization phase. Good definitions of the relevant behaviors usually make it fairly easy to establish sensible, albeit arbitrary, transition points between activities so that the estimates of their duration can at least be reliable and accurate.

The rush-hour-conversation example makes a comparison between different hours of the day. This brings up another aspect, the time-of-occurrence. It is important to realize that behavior is very apt to change markedly as a function of what time it is. One would not expect to find the same types or levels of behavior in a playground at 2:00 a.m. as at noon. Similarly, playground activities during July are probably not the same as those during January, and those observed in 1970 may be different from today.

Still another aspect which is sometimes valuable to consider is the *brilliance* of ongoing behavior (2). This is defined as the number of times the behavior changes or number of elements it displays per unit time. While observing the pedestrians during rush-hour, it might be noted that a person mailed a letter, lit a cigarette, tied a loose shoelace, and caught a taxi -- all in the course of a 2-minute period. One could then say that the average brilliance of that behavior was 2 activities per minute. It may be useful to know that average brilliance during the morning is triple that found in the evening.

The problem is deciding how far to go in dividing behavior into separate components. Tying one's shoelace, for example, can be regarded as a single act or can be broken into several more, such as noticing the untied shoe, kneeling, grasping the laces, and so on. And, of course, each of these acts can be similarly divided, ad infinitum. In that case, did the person really display two activities per minute, or were there many more? Brilliance, therefore, is not a constant value which can necessarily be compared across different studies. It is relative to the categorization scheme one is using. If the person's four activities fall into different categories and there is no further subdivision to accomodate items such as noticing untied laces then it is perfectly correct to say that, for the purposes of the study, 2 activities per minute were observed. However, if the 4-category scheme was used for the Briarwood Park example, all activities would belong to the "isolated-active" label. In this case, it would be equally correct to say that only one activity was observed, which yields an average brilliance of .5 activities per minute. If the level of detail provided by one's classification scheme is insufficient, it must be expanded.

The last aspect relating to time is the behavior's intensity. In the case of the conversations, this might be taken as a function of both frequency and duration. One could multiply the number per unit of time (e.g., hour) the average duration (e.g., two, three, or four minutes), yielding a composite measure that might be called "average time spent in conversation per hour." Considered along with the number of persons who were observed, this could provide another way of looking at "how much" behavior is occurring.

If one wishes to measure the intensity of childrens' play, however, the solution is not so obvious. A good measure would be their metabolic rates, but obtaining this information is impractical. Should one try to estimate their velocity or acceleration, or perhaps count the number of times they scream? Unfortunately, the only feasible way to measure intensity often turns out to be reliance on the judgment of the observers. This is generally undesirable because of the potential lack of consistency of these judgments, a problem which will be discussed later.

4.3 Subdivision of Project Area

Subdividing the site may be necessary if it includes too much territory to be studied all at once by a single person. For example, the buildings, trees, people, and expanse of a shopping mall could make it difficult to observe the whole area. Also, if the mall has a pinball arcade or a spot equipped with benches for tired shoppers, the persons and activities in these places are apt to differ from those in others as a function of the locations' physical characteristics. Whether it makes sense to differentiate or eliminate various sublocations depends upon the study. These decisions follow essentially the same logic as that used for considering the importance of physical differences between people: Greater detail yields more information but requires greater effort and may generate unneeded data. Conversely, reducing detail and eliminating superfluous elements is less costly but can produce useless data if needed detail is lacking.

4.4 Scouting the CPTED Project Area

Prior to initiating behavioral observations, the study area should be scouted. This involves going to the area or areas and taking note of what is going on there. A notepad, tape recorder, or camera are useful for recording interesting occurrences and one's general and specific impressions. A scouting trip can be immensely valuable during the early stages of a CPTED project. It can provide a new perspective on crime/environment relations and help generate ideas and insights and allow informal testing of ideas and procedures.

Scouting is also essential for creating a map of the project area. A map is necessary for any study that concerns itself with the physical location of behavior. Depending upon the study, the accuracy and detail shown may or may not be critical. If not, a rough map produced during an informal scouting trip is adequate. Otherwise, the rough map may be helpful, but a map with the required characteristics should be produced or obtained from existing sources as soon as possible.

Regardless of precisely how scouting is conducted, it is a highly recommended procedure. No matter how familiar one is with the area, producing a map is apt to produce new insights as well. A single scouting trip may not be sufficient. The analyst is encouraged to make as many as are believed to be necessary during the formative stages of study.

4.5 Observation Techniques

Next, the analyst should decide what sort of observation technique is to be used. Usually, this is one of the last decisions that is made and to a large extent the choice is limited by decisions about who, what, when, and where. However, it is worthwhile to review some of the strategies.

4.5.1 Sampling Time and Events

The first aspect to be considered is the type of sampling scheme to be used. Two basic types of sampling are time and event. In time sampling, some interval is selected during which the behaviors that are occurring are recorded. The size of the interval (e.g., every 10 minutes, make observations for 30 seconds and do this 2 hours a day for a week) is determined by such factors as the supposed frequency of events and how much time is available to the observer. In contrast, event sampling requires continuous observation and enhances the possibility of observing rare but possibly important events. (Technical Guideline 5 includes a discussion of sampling techniques.)

4.5.2 Stationary Versus Moving Observers

If a simple naturalistic observation is desired, there are basically two ways of deploying the observers. One is to place them in fixed locations for the required period of time and the other is to have them move through the area on foot or in a car. These two approaches are usually combined in some way.

Moving observers are required whenever the area is too large to be seen in the necessary detail from a fixed vantage point. Generally, it is not a good idea to make observations or notes while moving, although a tape recorder can make it feasible. This is because the movement distracts the observer's attention. The common approach is to establish either a series of physical locations or fixed time intervals that signal stopping points. If physical locations are used, they can be spots that are judged to be particularly good for making an observation (i.e., provide concealment, better visibility) or they can be selected so as to be equidistant from one another. If a timing interval is used (i.e., the observer walks along the route for a fixed amount of time between each observation) the results will be similar to those obtained from using equidistant physical locations.

Regardless of whether the observer moves or remains stationary, the period of time to be spent observing must be specified. Generally, as the number of locations decreases, the time that can be spent at them increases, but the precise interval that is appropriate depends entirely upon what is being studied and the amount of detail that is required. This is another example of how a scouting trip can be useful. The analyst can obtain a rough estimate of what the interval should be by timing how long it takes to record the information the study is seeking.

4.5.3 Number of Observers

Another important decision concerns the number of required observers. It is conceivable that a study involving 8 one-hour periods of observation in different areas every day could get by with only one observer. However, if 10 samples are needed at each of the one-hour intervals at all 8 locations, this would call for 80 person-days of work.

The probable effects on the observer's reliability must also be considered. It would be better to hire 8 observers and move each of them to a different location every hour over a 10-day period. This example does not illustrate all the complexities of deciding how many observers to use, but is intended to introduce the topic. It will be further developed in parallel with portions of the remainder of this guideline.

A related concern is the size of the area. It is possible to hire enough observers to cover a large site without moving, but it is not usually wise to do so. In fact, even for small areas which require only one observer, it is generally best to include at least one movement to a new position. Each viewpoint, no matter how good, has a unique perspective and by looking at the area from a different location, the observer can discover information that otherwise would be missed.

4.5.4 Walking Versus Riding

One question concerns the desiribility of a moving observer walking or riding through an area. The main advantages of walking are increased visibility and the ability to gain access to more places. A car provides some degree of concealment and usually allows a single observer to move more quickly from one site to another, thereby covering a larger territory. Observation is not usually performed from inside an automobile because of the lack of mobility and visibility. Most often, the car is used only to transport the observer to the site and to serve as a temporary base of operations. However, if a pedestrian count is desired, for example, it might be advantageous to have one observer drive while a partner performed the counting. Note that this would be a different measure than would be obtained by stationing an observer on the street to count the number of pedestrians that pass by. In the first case, we would know how many people were on the street during a relatively brief interval. In the second, however, we would know only how many people passed the observer.

4.5.5 Participant Observation

Participant observation is used particularly for studying groups of people in private or semipublic locations. The information produced tends to be highly detailed, specific, and personal, and can therefore be used to complement the more general results from simple observation.

If it is expected that knowledge of the study would significantly change the behavior of interest, it is usually conducted secretly. This requires one or more observers to actually become members of the group for a temporary period. The requirements for membership can vary considerably. For example, to study the patrons in a bar would require much less preparation and effort than to study a block association. The difference lies in how large, formal, and closely knit the group is. It is difficult to be unobtrusive if they are all aware of the newcomer in their midst. Normally, there is no need to conceal the study from the group. In this case, it is customary to inform them fully of one's intentions and secure their permission.

Thus, just as with other observers, it is important that participant observers' physical characteristics and actions are unobtrusive. Toward this end, they do not usually take notes while observing, since this would attract attention. Instead, notes are produced afterward. Sometimes a tape recorder is used, either to replace or supplement notes.

4.5.6 Photography

The last measurement technique to be discussed is photography, which can involve anything from inexpensive pocket cameras to high-quality movie cameras or videotape equipment. The main virtue of photographic methods is that they are extremely reliable. Nothing within the range of the lens is missed due to human inattention and no distortion of the data takes place. Instead, one obtains a permanent visual copy of what was observed, which can be examined repeatedly. This permits much more accurate and detailed information to be drawn from complex and/or brief events that a human observer would have difficulty absorbing as these events occur.

When the scale of a photograph is known, grids can be superimposed on it so that reasonably precise estimates of distances between people and/or objects can be made. This can be valuable when trying to create a map of an area, as well as during the study. If moving pictures, time-lapse photography, or videotape are used, additional information can be gained by running through the record forward and backward and at varying speeds. It is also possible to estimate the direction and speed of moving objects.

Another advantage of photographic methods is that the equipment can sometimes be set to operate automatically on some fixed schedule. Several pieces of equipment can be synchronized to produce film from different locations within the same area or from totally separate sites. It can be very useful to know what was happening simultaneously in physically disparate areas and it is difficult to achieve this degree of synchronization with human observers.

Other advantages include the fact that the equipment can sometimes be used in places that are unsafe, too small, or otherwise unsuitable for a human. Also, it may be possible to hide the equipment or make it unobtrusive in ways that would be impossible for humans. Often, the strategy used is to conceal the equipment and leave the observer in the open. The observer then takes the usual notes and triggers the camera, when appropriate.

Lastly, the permanent record that photography produces can be used to help communicate the results of the research to others. This may be valuable during the study when discussing points with colleagues, and afterwards when making a formal presentation.

Photography is a powerful tool which can yield immense benefits when used to supplement naturalistic observation. However, it must be utilized properly. If the camera is facing the wrong direction, it cannot turn itself around, and if large amounts of footage are taken indiscriminately, it is not much better than if no record exists at all.

Whether photography should be used in a particular study depends upon the degree of detail and accuracy required, the location, and the skills and resources available to the analyst. If only a few snapshots are desired, this should not be an obstacle. If an elaborate photography scheme involving a great deal of expensive gear is required, the analyst should consider very carefully whether it will be worthwhile. In the unlikely event that the equipment is readily available, film and developing can nevertheless be costly, as is the possible expense of hiring photographers.

Videotape equipment seems to have especially good potential for use in naturalistic observation, even by relative amateurs. It is not difficult to learn to operate it properly, and the use of a television monitor provides the user with constant and immediate feedback so that maladjustments can be rapidly corrected. The initial investment can involve several thousand dollars, but the equipment is reasonably long-lived, versatile, and portable. Also, it has many of the advantages of a movie camera without the cost of film processing. The magnetic tape also can be reused. The only major advantage of film over videotape is that film usually produces a sharper picture and can be enlarged, which may be important when fine detail is required. However, when these needs are recognized in advance, video cameras can usually be positioned or equipped with special lenses so that satisfactory results will be produced.

4.6 The Measurement Instrument

Having chosen an observation technique, the analyst must create a means of recording the data. This calls for some permanent record, such as a coding form.

When dealing with measuring instruments, it is worthwhile to consider the issue of *sensitivity* versus *reliability*. The record's sensitivity is affected by the level of detail, accuracy, and sheer mass of information it is to contain. Studies have shown that, generally, as these increase, the observer's reliability decreases and, hence, so does the instrument's (3). To a certain extent, some compensation may be achieved by increasing the time spent observing, but no amount of time can permit the recording of events that exceed the capacity of human senses.

4.6.1 Illustrations

One sort of record that can be used is the prose form, which consists of a series of phrases, written down or spoken into a tape recorder by the observer to describe what is occurring. This can be entirely free-form or subject to varying degrees of systemization. Free-form records are flexible because the observer can decide to include anything that seems interesting, but they suffer from a lack of selectivity. The observer cannot note everything and will, therefore, create a record having unique content. Also, free-form data are difficult to quantify. This, in turn, makes the results difficult to interpret. Because of its flexibility, the free-form approach is recommended for informal investigations (such as scouting trips), but the inherent difficulties of selectivity, observer bias, and interpretation preclude its use in more structured observation procedures. Increasing the systemization in a prosaic record will reduce the problems encountered with free-form data, but also reduces the flexibility.

Another form is a precoded observation sheet, as shown in Figure 1. This is a portion of a form that was developed to study child pedestrian behavior. A hidden cameraman spent several weeks filming kindergarten children as they crossed a particular street on their way home. Afterwards, the films were studied by observers who filled out a form for each observed child.

Curb Behavior

______ child stops ______ child does not stop

(duration 1 2 3) (change in approach rate 1 2 3)

social situation at curb (1 2)

group composition (1 2 3)

interaction (1 2)

enters street (1 2)

______ street-directed observing behavior (+, -)

______ one-way ______ two ways ______ behind

______ other child in group appears to look

Source: N.W. Heimstra et al, "An Experimental Methodology for Analysis of Child Pedestrian Behavior," Pediatrics, 1969:832-838.

Figure 1. Sample Coding Form

The example has some features worth mentioning. First notice that a checkmark is used to record whether the child stopped at the curb. This sort of simple yes/no judgment is the easiest to make with consistent accuracy. Second, although numbers appear on the form, they are used as codes and scales rather than as counts. It is essential that the observers agree on the exact meaning of the codes and the scaling factors. In the case of "interaction" only two choices are available, so it is likely that good agreement is achievable. However, "duration" may be more open to interpretation. If the observers use stopwatches and the range covered by the three categories is precisely defined, this problem can be avoided. A subjective judgment would probably be much less reliable.

Figure 2 is a slightly different coding form. It was designed specifically for studying patients in a hospital ward, but could be adapted to other purposes as well. Observers were stationed throughout the ward and coded forms simultaneously every 15 minutes. This example is considerably more detailed than the preceding one and condenses much more information onto a single page. The letters M, F, S, and V are used to differentiate the numbers below as to whether they are counts of male patients, female patients, staff, or visitors.

Note also that the patients are not identified individually. Instead, the population has been divided into groups having agreed upon characteristics and the record shows how many from each group were observed. The row marked "Ind" is available for staff and visitors or for individual patients, if data is desired on a particular one. The form also records information about certain environmental variables (such as date, time,

Ward Observation Form

Date 7/15 | Ward 10 | Observer 3 | Time M ____ A ____ E 8:15 | Census M 4 F 24 T 28

Day Room	Talk				Games				Watching an Activity				Writing				Read				Stand				Pace			
	M	F	S	V	M	F	S	V	M	F	S	V	M	F	S	V	M	F	S	V	M	F	S	V	M	F	S	V
Ind																							1					
Group 1		1	1																									
Group 2		1		1																								
Group 3																												
Group 4																												
Group 5																												

	Personal Hygiene				Lie Awake				Sleep				Sitting Alone				Arts & Crafts				TV				House-keeping			
	M	F	S	V	M	F	S	V	M	F	S	V	M	F	S	V	M	F	S	V	M	F	S	V	M	F	S	V
Ind													1	1														
Group 1																						2						
Group 2																												
Group 3																												
Group 4																												
Group 5																												

	Phono-Radio				Eating				Hospital Routine				Traffic															
	M	F	S	V	M	F	S	V	M	F	S	V	M	F	S	V	M	F	S	V	M	F	S	V	M	F	S	V
Ind																												
Group 1																												
Group 2																												
Group 3																												
Group 4																												
Group 5																												

Source: H.M. Proshansky et al, Environmental Psychology: Man and His Physical Setting, New York, NY: Holt, Rinehart and Winston, Inc., 1970.

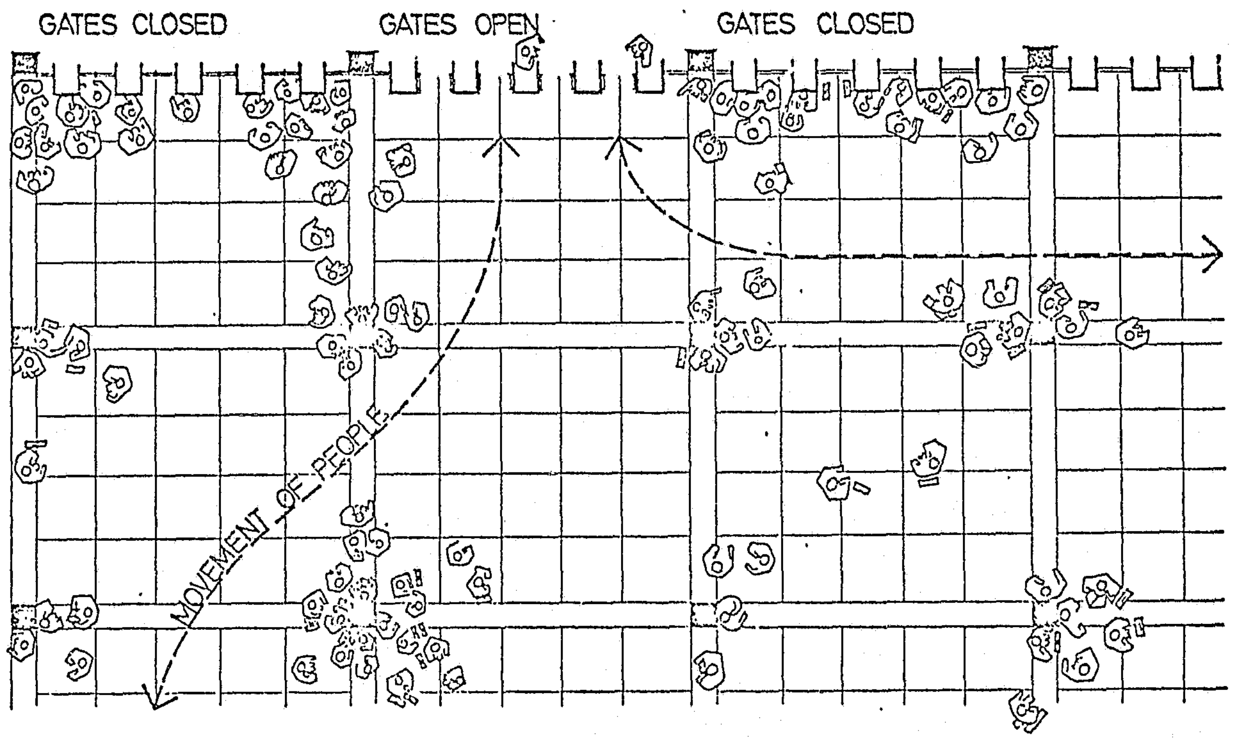
Figure 2. Ward Observation Form

and location). If photography had been used, it might also include data concerning such things as lighting or film speed.

The next type of record is a map of the setting. Maps can provide a very simple means of recording information about movement or location. Figure 3 is an example of a map that was used to study movement in a railway station. A grid has been superimposed on the area and the locations of individuals noted. The arrows, which summarize the results, were used by the observers during the study to indicate the movement of the persons. Note that an environmental variable (gates open or closed) was also recorded.

The last example concerns a community play area, as shown in Figure 4. A preestablished route (dashed line) begins at South Lane at the corner of a building numbered 16 on the observer's map. The observer walks along the front of building 16, recording any activities observed on the stoops, in the yards, or on the front path. If any part of the play area is being used, the observer stations himself at one of three points indicated (stations) and records activities. The observer then proceeds around to the other side of the play area and along the front of building 15.

Figure 5 indicates what the resulting tabulation might look like. As the observer walks along the front of building 16, he sees two adult women talking in one yard, and two little boys and one little girl sitting in another yard playing together with toys. Therefore, he records the first two rows on the behavioral observation sheet in the following manner. In the "Place" column of the first row, he writes "FR 16"



Source: David Canter, Psychology for Architects, London: Applied Science Publishers Ltd., 1974.

Figure 3. Location of People in a Railway Station

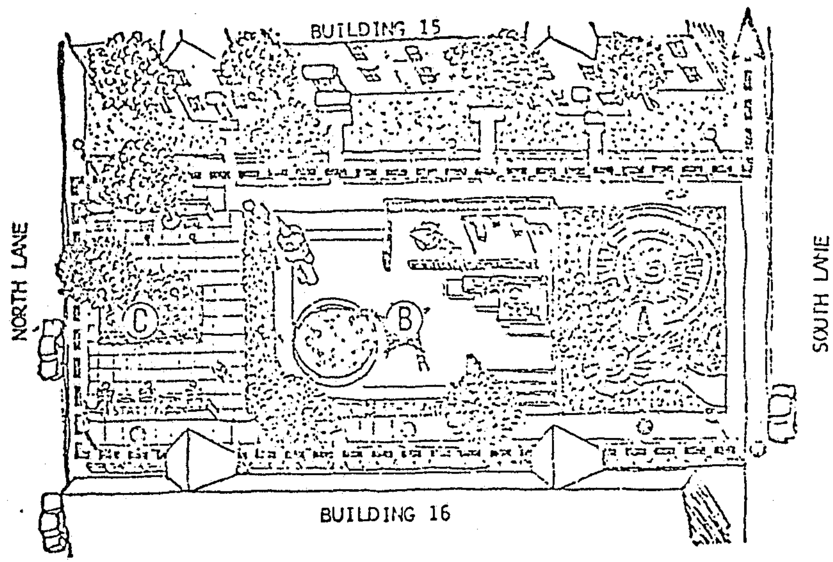


Figure 4. Example of Behavioral Observation Route.

WEATHER ______________________ TIME IN ____________

OBSERVER ______________________ DATE ______________ TIME OUT ____________

Place	Space	Act.	Child		Adol.		Adult		Eld.		Gates	Comments
			M	F	M	F	M	F	M	F		
FR16	Yard	70						2				
FR16	Yard	51	2	1								
A		75	1		1							

Figure 5. Example of Results Tabulation.

Source: I.R. Kohn et al, Defensible Space Modifications in Row-House Communities, National Science Foundation, 1975.

(the number representing a given type of activity); in the "Space" column, "yard"; in the "Activity" column (the code for play, sitting); in the "Child M" column, "2"; and in the "Child F" column, "1." Thus each row constitutes one observed activity. Table 1 suggests how the activities categories might be grouped.

The observer also may have noted that there are several activities going on in the northern part of the play area (precoded as "A" on the map). One activity is a game of catch between a male teenager and a young boy; he therefore writes "A" in the "Place" column; leaves the "Space" column blank; writes "75" in the "Act." column; "1" in the "Adol. M" column; and "1" in the "Child M" column. He then continues on his tour.

The "Place" column of the observation sheet refers to the general location of an activity: Parking lots, play areas, the fronts or backs of buildings, and precoded building numbers. The "Space" category focuses on design elements: Doorways, stoops, yards, paths, benches, sidewalks, streets, small play areas, fences, curbs, and the like. In addition to the relevant activity and the number of persons in each age and sex category, the code number and the condition (open, closed, locked) of each yard gate could be recorded. If the observer feels that a given code is inadequate, he uses the "Comment" section to explain why. The categories of activities; the designation of areas, places, and spaces; and the plotting of observation routes would be determined during preliminary observations and would be invariant after that.

Table 1

Suggested Categories of Activities

High-Energy Physical Release:
- Bicycle
- Climbing
- Jump off
- Rough house
- Running
- Fighting
- Restrain person

High-Energy Organized:
- Football
- Baseball
- Scalesies
- Jump rope
- Play ball

Low-Energy Organized:
- Arts and Crafts
- Game - sit
- Play - sit
- Read
- Write

High-Energy Unorganized:
- Play - active
- Play - equipment
- Animal
- Rollerskate
- Hydrant - related play
- Motorcycle/minibike
- Dance

Domestic:
- Cook
- Eat and Drink
- Feed child
- Food preparation
- Garbage
- Clean

Verbal-Other than Talking:
- Argue
- Calling
- Crying
- Discipline
- Laugh and smile
- Giving directions
- Giving instructions

All Sitting:
- Sitting
- Sunning
- Reclining

All Building and Fixing:
- Maintenance
- Fix and repair
- Build and construct

Music:
- Music
- Singing

Traffic:
- Walking
- Moving object
- Arriving
- Leaving
- Lock/unlock

Intimate Contact:
- Cuddle, touch
- Grooming
- Hold child

The following activities remained discrete:
- Gardening
- Laundry
- Talking
- Car
- Look - object
- Look in door, window
- Stand
- Watch

These examples of measuring instruments are only intended to be useful illustrations. There is no way to provide a set of coding forms or maps to cover every possible situation. The analyst is urged to combine the understanding gained from these examples with some imagination and careful thought when creating his particular instrument. Note that, especially when developing coding forms, successful operationlization will make the task much easier. The format is strongly influenced by the categorization scheme. If the analyst experiences unusual difficulty, a look at similar research might help generate some ideas.

4.7 Training Observers

The analyst must deal next with the problem of obtaining and preparing the observers. Experience is an important factor in the value of an observer. The observer's task can appear to be a simple one that can be adequately performed by virtually anyone, but this is not usually true. Good observation requires patience, discipline, and judgment. It is essential that the observers appreciate their importance in the effort and understand the impact their performance will have on the findings.

It is important to be certain that the observers have a full understanding of the purpose of their observations. This gives them a clearer appreciation of what is expected of them and may lead them to think of valid questions regarding procedure.

Regardless of the observers' expertise, it is essential that the analyst plan some kind of training for them. Every study is unique in its precise focus and even if they have participated in similar studies, it is unlikely that the requirements will be the same. Furthermore, the observers should be made familiar with the area of the study.

Training can take place either in a classroom-type situation or in the field. Field training is usually best, since the analyst can demonstrate more realistically what the observers are to do, but classroom training can also be effective. In the latter case, a particularly good approach is to present films taken in the study area. The film should be edited to present a condensed demonstration of the behaviors of interest. Later, unedited film can be used to allow the trainees to practice observations. This has some advantage over field training, since the analyst can present more examples in a given time period, stop the action, and show protions of the film over again to clarify points.

It is desirable that the observers be trained together by the same person or persons. If the training takes place on an individual basis or in subgroups, experiences will not be the same. Questions raised in one session may not come up in another. Using the same trainer(s) for each session is also recommended.

4.7.1 Interjudge Reliability

The main goal of the training procedure is to ensure that the observers will respond in essentially the same way to the same situation (i.e., there will be interjudge reliability). The usual approach is to have them practice observing and recording the behavior of interest and then inspect the results. This provides some feedback so that misunderstandings and errors can be spotted and corrected. Also, the data can be checked to determine the amount of reliability that is being attained. Another good reason for training the observers as a group is that they can be exposed to the same situations. It would be invalid to compare the responses of people who observed different things or at different times.

There are two basic methods for checking observer reliability following a practice session. Both yield a number representing the proportion-of-agreement, but they differ in the exact values they produce from the same data.

The simpler of the two is the whole-session method. Each observer's total number of responses is individually summed, the smallest obtained sum is divided by the largest, and the result multiplied by 100. Comparisons between particular pairs of observers can be made similarly.

The other approach is the exact-agreement method. Here, the observation session is divided arbitrarily into a series of time intervals. For each interval, a comparison is made between two of the observers. If they have recorded the same things or both have not responded at all, the interval is scored as being one of agreement. The number of intervals-of-agreement is then divided by the number of intervals and the result multiplied by 100.

If more than two observers are being used, this procedure can be carried out for each combination of pairs and, if an overall figure is desired, an average can be computed by summing the obtained values and dividing by the number of comparisons. There is also a variation on this method in which intervals containing no response by either observer are excluded, rather than being counted as intervals-of-agreement.

The whole-session method is the least stringent and therefore will yield a higher figure than either of the exact-agreement variations. Similarly, the all-intervals version of the exact-agreement method is less stringent that the response-interval-only. One study has indicated that the difference between the whole-session and exact-agreement methods is approximately 12 percent and that between the exact-agreement variations, approximately 7 percent (4).

When using exact-agreement, the duration of the time intervals used will affect the resulting figure. Generally, as duration increases, the proportion-of-agreement decreases. This is because longer intervals increase the probability that the observers will respond differently. Carried to its extreme, the interval would become equal to the duration of the entire observation session, in which case it is unlikely that any agreement would be indicated. For this reason, it is better to use intervals that are relatively short in comparison with the length of the training session.

For studies using a large number of observers, the whole-session method is preferred because it is much easier to compute. The exact-agreement method is better when greater stringency is required, particularly when only two observers are being trained. It also tends to make the sources of differences between observers more obvious when they are being compared. There is no clear advantage to either variation of this method, although it might be pointed out that the all-intervals approach uses more of the information contained in the observers' responses.

It should be obvious by now that none of these approaches can uncover the "true" amount of reliability that the observers display. The value obtained is entirely relative to the stringency one decides is appropriate. However, either method is valid for studying the progress made during training. One should expect the proportion-of-agreement to increase across sessions, if the training is effective. In fact, if it is possible to decide in advance how much agreement is required, these reliability checks can be used to determine when the training should cease.

One final observation is that it can be useful to have the trainer record responses, along with the observers, during the practice sessions. Afterwards, the degree to which the trainer's and the observers' judgments agree can be studied. This value should also be expected to increase as the training is complete. When only one observer is used, this is the only way of estimating obtained reliability.

4.8 Procedures in the Field

The major difficulty with conducting behavioral observations in the field is controlling the study's execution. No matter how carefully the observers are trained, they will be likely to make mistakes. They will also display a gradual change in the way they record data as they become more experienced. Such variability threatens interjudge reliability.

One thing to avoid is overworking observers. This may necessitate hiring more observers than originally planned. Observation can become very tedious if performed for long periods without a break and it is desirable that observers be alert throughout the session. Also, avoid scheduling too many sessions on the same day. Performing 16 20-minute observations in a day with 10-minute breaks can be almost as dull as 2 4-hour sessions.

Lastly, avoid overly complex coding schemes and make the recording sheets clear and easy to use. This will reduce the number of recording errors.

To the extent possible, be considerate in setting up the observation schedules. It could be very inconvenient to be asked to make half-hour observations at 6:00 a.m., 12:00 noon, and 7:00 p.m. each day. Try to keep the sessions closer together. Avoid schedules which call for the persons to get up unusually early or to drastically modify their customary sleeping habits. Also, consider the transportation problems that the observers may encounter. Taking these precautions will help to increase the likelihood that they will arrive at the sites on time and, therefore, reduce the chances that they will supply false data.

There is little that can be done to prevent the observers' perceptions of the setting from changing over time. A good training program and the experience gained during the trial run can do a lot to help stabilize performance because the most drastic changes will occur during the earlier periods. However, responses will still undergo some degree of acclimatization as the study progresses and observers become increasingly familiar with the setting and their tasks. Aside from these natural effects of experience, there is another factor that can influence the observers' responses over time. This is known as *demand characteristics*. If an observer gets the impression that his data are not being well received by the analyst, he may shift (without being aware of it) his pattern of responding to one that produces more pleasing results. If the original perception of the situation is more accurate, this is obviously undesirable.

4.8.1 Maintaining Interjudge Reliability

One type of constructive action that can be taken during the study is to assess the observers' reliability periodically. If two or more observers are working together at the same location and time, the evaluation can be performed without notice on the data they are submitting.

In most cases, however, observers will be working alone. It is possible to compare observations of the same site at different hours or different days, but the results will have questionable validity. This would be useful only if one or two of the observers' response patterns were substantially different from the others', in which case the incongruity might become obvious. However, one could not necessarily conclude that these observers were faking or in error. The data could correctly reflect an erratic situation.

When observers are working individually, the best way to assess their reliability during the study is either to perform a spot check or schedule a special observation session for the purpose of testing. A spot check is most effectively carried out by sending the trainer along with the observer. Both make the usual records and then the results are compared. The proportion-of-agreement can also be compared against the value that was obtained during training, if the latter is available. However, the observer's judgment may be more valid than the trainer's after having amassed so much more experience. It is not a good idea to send other observers in place of the trainer, since it is in their best interests to compare their results and, perhaps, make alterations.

The difficulty with either of these assessment techniques is deciding what should be done if the obtained reliability measures have declined. It is not usually feasible to halt the study so that further training can be conducted. The only course of action available is to attempt to deduce the sources of the error and instruct the observers to correct them. To the extent that one's deductions are correct and the observers are capable of following the instructions, this can provide improvement.

Clearly, there is a need for additional methods of controlling the study's execution. The simplest method is to assign an equal number of sessions to each observer, thus minimizing the impact that any single person's bias will have on the data. Also, by distributing the workload equally, the chances are increased that shifts in response patterns will have similar magnitude. That is, it helps assure that the bias due to experience will at least be consistent, if not reduced. Equal distribution of assignments should always be used.

4.8.2 Randomization and Counterbalancing

There are two other strategies for controlling the study's execution. These are randomization and counterbalancing of the observers. *Randomization* calls for assigning the observation schedules in a random fashion. Thus, the data from any particular session may come from any one of the observers, although they should still perform an equal number of observations. This does not reduce the error, but distributes it randomly throughout the results and, therefore, tends to minimize the effects of random errors. *Counterbalancing* requires assigning the schedules so that each observer performs exactly the same observations as the others, over the course of the study. For example, if three observers are being used separately at one location every day at 3:00 p.m., 4:00 p.m., and 5:00 p.m., they would be rotated each day so that at the end of the study each would have performed the same number of observations at each of the hours. The same approach can be used to counterbalance the days on which they observe or locations they visit. In the case of moving observers, the routes can sometimes be counterbalanced by having them visit the same sites in the same order, but starting at different points each time. Counterbalancing has the effect of distributing the error equally and systematically which, like randomization, also tends to reduce its impact on the final results.

Randomization and counterbalancing are equally valid techniques when used properly. The advantage of randomization is that it can be simpler to use. Counterbalancing can require a great deal more effort to accomplish, but because of its systematic approach one can be certain that the error has been equally distributed. Randomization only makes it probable that the error has been equally distributed. To the extent that the distribution is actually random, the result is as good as that achieved through counterbalancing. However, one cannot always be completely assured that it is truly and fully random, since the dependence is upon probability, rather than deliberate systemization.

4.9 Data Analysis

The last major issue to be discussed is evaluation of the results of the study. After all the data are collected the analyst is faced with what may be a distressingly large pile of paper containing a great deal of data. Before proceeding with statistical techniques (see Guideline 5), it is usually desirable to aggregate the data so that the more obvious trends will appear.

One common method of summarizing the results is to generate a table containing total counts, averages, or percentages. Table 2 summarizes some of the results from the study of patients in a hospital ward that was described earlier. The data from the coding sheets (see Figure 3) has been combined and converted to percentage form. The numbers in the table represent the proportion of all patients in the ward who were observed carrying on different categories of activity in different locations and at different times of the day.

In examining this table, several things become apparent. First, the totals indicate that the amount of nonsocial behavior does not fluctuate very much. However, nonsocial behavior in bedrooms appears to steadily decrease as the day progresses, while that in public areas seems to show a corresponding increase. This apparent trend may mean that, while nonsocial behavior remains constant, it tends to move into more public settings during the course of the day.

Notice also that the totals for social behavior show a steady increase. In bedrooms, it seems to remain fairly constant during the daylight hours and then increase substantially at night. However, in

Table 2

Ward Patient Behavior Summary

	Combined Non-social Behavior			Combined Social Behavior		
	Bedrooms	Public Rooms	Total	Bedrooms	Public Rooms	Total
Afternoon	18.9	13.2	32.1	6.5	13.9	20.4
Morning	15.3	19.2	34.5	6.1	23.1	29.2
Evening	13.6	19.8	33.4	10.9	23.6	34.5

Source: Environmental Psychology.

public settings, it appears to be lowest in the morning, increase quite a bit in the afternoon, and remain constant thereafter. Thus, social behavior may also be significantly affected by time-of-day and there may be a differential effect according to whether the behavior occurs in private or in public. All of these observations can be made by studying the table.

It might have been valuable for these researchers to convert their table into a graph. Graphs are particularly good for obtaining a visual estimate of the differences in relative magnitude of various effects (i.e., providing a picture of the data). In complex situations, this can point out things that otherwise would be missed. They also have a unique ability to display interactions that occur in the data. In the case of this study, for example, if social behavior had been graphed with type-of-room along the ordinate, the lines would not move in a parallel fashion across time-of-day.

Graphs also can be useful after statistical analysis is complete, helping to clarify results that seem confusing. However, when drawing a graph, it is important to avoid trying to crowd too much information onto a single page. The resulting tangle of overlapping and intersecting lines may be as confusing as the raw data. Also, remember that one's choice of what to place along the ordinate and abscissa can affect interpretability. Sometimes a seemingly meaningless graph will take on significance if it is "turned around."

The last summarization technique to be considered is mapping, which is useful for studying data on the location or movement of behavior. An example of this has already been provided in Figure 3. There is no requirement that the original data be recorded on maps for this approach to work. If a map of the setting is available and data on location or movement has been recorded, it is fairly easy to mark it accordingly. One approach is to place all of the raw data onto one or more maps. This causes many of the marks or lines to overlap but, unless the crowding is excessive, a pattern will usually begin to emerge. This pattern can then be drawn in simplified form on another map. Another approach is to compute totals, averages, or percentages which summarize the raw data and draw these summaries on the map.

Once the analyst finishes summarizing the data and completes the statistical analysis, there is still the problem of interpreting the results. After reaching a preliminary hypothesis, it can be helpful to examine the published reports of similar studies, if any can be found. When the results are similar, it can be enlightening to discover what the analysts concluded and the reasons for their decision. Perhaps their interpretation is very different from the analyst's, in which case it is useful to evaluate their decision and, perhaps, reconsider one's preliminary hypothesis. When the results of the studies differ, it is worthwhile to consider the possible causes. This may lead to the discovery of an oversight in one's design, which must be taken into account.

The analyst is urged to exercise caution in reaching final conclusions. Remember that all measuring instruments, no matter how precise, produce distorted data to some degree. In the case of naturalistic observation, this distortion may be quite large. It has already been noted that categorization schemes and observer bias can influence results. It is also important to be aware that statistical techniques yield probability statements rather than definite answers. Thus, the most accurate statement that can be made is that if the study is reliable and if it is valid, then it is probable that the conclusion is correct.

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CPTED TECHNICAL GUIDELINE 3

Assessing the Fear of Crime

ASSESSING THE FEAR OF CRIME

1. Introduction

Public concern about crime emerged as a major issue in the mid-1960's. Although crime and criminal justice have been studied extensively since then, public reaction to crime, including the fear of crime, has received relatively little attention. Many believe that fear of crime is a threat to the viability of major urban centers. Crime is cited as a cause of outward migration and deserted commercial districts.

Security-seeking families pack up and move to the suburbs as soon as their finances permit, while shoppers choose the convenience and perceived safety of the suburban shopping centers rather than undertake what they see as the risky enterprise of traveling downtown. A marketing study conducted by the developers of a massive "new town" south of Chicago's Loop found security to be the most sought-after amenity in the central city development, even more strongly desired than quality schools and recreational facilities.

This guideline addresses the issues involved with the measurement of fear or concern about crime and is divided into two major sections. The first covers the rationale and methodology required to measure attitudes toward crime in the CPTED project area. The second provides the methodology for examining the environment as a contributor to fear and concern about crime.

2. The Attitude Construct: Affective, Cognitive, and Behavioral Components of Fear

The CPTED approach to the measurement of attitudes towards crime tends to minimize or avoid usage of the word "fear" for a number of reasons: The construct is ill-defined, difficult to validate in a measurement sense, and subject to respondent confusion. While the word fear suggests an emotional response characterized by increased heart rate, secretion of adrenalin into the bloodstream, cessation of digestive activities, and so on, such responses are rarely, if ever, experienced when an individual reflects upon his attitudes towards crime. More typically, the person's reaction could be better characterized as feelings of annoyance or inconvenience. Finally, fear as an emotional response leads the researcher into the area of emotional theory in search of theoretical underpinnings and insights concerning responses to crime. Psychological theories of emotion are numerous and subject to criticism from many perspectives. A review of this area failed to provide any theoretical perspectives or language that were useful for the measurement of attitudes towards crime in CPTED projects.

The use of the attitude construct to characterize a person's disposition towards crime seems to offer the CPTED analyst far more utility than the use of fear as an emotional response to potential criminal victimization. It is generally accepted that an attitude has three major components: Affective, cognitive, and behavioral. These three components allow various aspects of the individual's reaction to crime in the environment to be kept conceptually distinct for purposes of discussion and measurement. For example, the measurement of attitudes towards crime can focus on a person's knowledge of crime, the sources of this knowledge, how various crime-related information is integrated and used, and so on (the cognitive component). Also, the analysis might emphasize the feelings of discomfort or negative emotional reaction that are experienced by the individual in various parts of the environment or when discussing potential crime problems in the environment (the affective component). The final major component, behavioral, subsumes the many potential responses to crime that can be observed in or reported by the individual, from changes in daily routine and behavioral adjustments to active avoidance of certain areas. Other dimensions associated with the construct of an attitude that could be useful for CPTED purposes include the intensity of feelings and beliefs (how strongly a person feels about something), the salience (the importance of one attitude vis-a-vis others that the individual might hold), and the centrality or overall importance of the attitude in the life of the individual.

Another benefit accruing from the adoption of the attitude construct for examining concern over crime involves the availability of different approaches to attitude measurement. A number of models have been developed and refined in an attempt to accurately and reliably measure different human attitudes. Selected concepts from these approaches touch on such areas as attitude scaling (Likert, Gutman, Thurstone, and others), alternate forms of validational evidence (predictive, construct, content, face, known groups, and others; see Guideline 5, Section 5), the multitrait-multimethod matrix, direct versus indirect approaches, and unobtrusive measures. Although a more detailed discussion is beyond the scope of this section, a large and diverse body of measures and approaches to attitude measurement await potential application by CPTED analysts to the refinement of an instrument to measure attitudes toward crime.

Finally, a very basic and important aspect of the attitude construct concerns the process by which attitudes are learned and how they can be changed. A major component of attitude theory and research addresses these issues, an emphasis eschewed in most work concerning the emotion response. With this perspective, the CPTED team can study how an attitudinal problem has developed in the project area and how a program might be designed to mollify this problem.

The present approach to the conceptualization and measurement of concern about crime can be said to offer the following advantages. First, it is an outgrowth of a review of previous approaches used in the investigation of fear of crime and, as such, it attempts to reduce or overcome a number of inadequacies that have characterized these past approaches. Second, the CPTED approach redefines the individual's reaction to crime from one of an emotional response involving fear or anxiety to that of an attitudinal response. This offers advantages in conceptual, definitional, and measurement-related issues, as described earlier. Finally, it offers a new and useful foundation for future developmental and empirical research projects that deal with an individual's responses to crime.

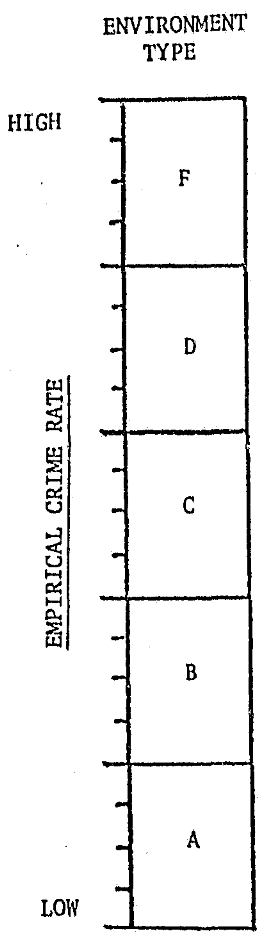
3. Defining Environments by Attitudes Toward Crime

3.1 Empirical Crime Rate (ECR)

Crime occurs everywhere, but within most large cities certain sections of commercial or residential areas suffer from more crime than others. Any area of the environment that can be geographically bounded and defined can be said to be characterized by an empirical crime rate (ECR). An estimate of the ECR is the only statistic available for scrutiny, for the actual ECR can never be measured exactly -- it will always be unknown for any environmental area. Estimates of ECRs can be made using different sources of data (e.g., UCRs, police records, victimization surveys) and different calculating procedures (e.g., by specific or total crime, time of day, by person or household). Throughout the remainder of this guideline, ECR is used as a general concept only, avoiding issues concerning data source and calculation methods.

As the ECR ranges from low to high in various areas, residents or users can be expected to perceive and respond to these areas in different ways. Generally, as ECRs increase, the spontaneity of behavior and activities decreases. The amount of activity may also be reduced, either in frequency, duration, or range. In short, the freedom of the individual is reduced because of the reduction in the number and quality of alternatives for behavior that are available.

For purposes of discussion, environments can be grouped into broad categories based on the nature of the behaviors of the residents or users in response to the ECR of the environment. Figure 1 presents an illustration of these five categories. The parallel of the environment coding



ENVIRONMENT DESCRIPTION

- ACTIVE AVOIDANCE/ESCAPE

  People stay away from a specific area; move away from neighborhoods.

- BEHAVIOR ADJUSTMENT

  People spend less time there, go only with friends or at certain times, do not carry cash, install extra locks or window bars on homes, and so on. Behavioral changes are made in response to crime.

- VERBAL CRIME PROBLEM

  Crime rates and incidents are publicized, "crime" mentioned by more people as a "problem" and "things getting worse"; however, typical behaviors unaffected -- no behavioral changes yet.

- NORMAL BEHAVIOR

  Desired residential/urban areas in America; occasional crime and publicity; people aware of possibility of crime but generally feel secure with low personal risk.

- SAFE ENVIRONMENT

  Special areas, extremely safe (e.g., retirement villages, farming communities).

Figure 1. Types of Environments Based on Empirical Crime Rates

system with an academic grading system is drawn to emphasize the following points: 1) Safe and Normal Behavior environments (categories "A" and "B"), are desirable and sought after; 2) the Verbal Crime Problem environment (category "C"), is average in that it is presently typical throughout the Nation; and 3) the Active Avoidance/Escape environment (category "F"), is a failure because it does not offer a suitable context for human functioning. The utility of these categories and framework, and the methods needed to categorize a specific CPTED project area, will be more fully treated in a later section.

3.2 Subjective Crime Rates (SCR)

Figure 1 raises an important question: How are areas in the environment categorized by individuals when the ECRs for these areas are not known? Although certain estimates are available for examination, few people know the absolute and relative values of these indices for areas in their environment or undertake to ascertain these values. It is apparent that another index functions in lieu of the ECR. This index is found in a person's attitudes toward or concern about crime and can be termed Subjective Crime Rate (SCR). Areas in the environment are categorized with respect to crime by each person's subjective assessment of the nature and scope of crime in each area. Throughout the rest of this guideline Subjective Crime Rate, Subjective Probability of Victimization (discussed in the next section), and "attitudes toward crime" or "fear of crime" will be used interchangeably.

3.3 Probability of Victimization: Empirical and Subjective

ECRs and SCRs can be translated conceptually into a probability of victimization, either empirically (EPV) or subjectively (SPV) based. The SPV can account for an individual's behavioral changes and adjustments in the environment in response to crime problems. The SPV is derived from knowledge of the EPV that is acquired through information obtained by the individual from diverse sources: Various news media, friends, neighbors, past experiences in the areas, the nature of the physical environment, other users of the environment, and other factors. The exact process by which all of this information is integrated by the individual and converted into an SPV is unclear. It is certainly prone to error, with discrepancies between the EPV and SPV becoming larger and more problematical as the information used by the individual becomes less accurate or complete. However, people do voice opinions about crime and victimization probabilities with only minimal information available. Therefore, an SPV can be formulated for almost any environment.

The hypothesized relationships between the EPV and SPV indices for any given environment are illustrated in Figure 2. For purposes of discussion, it is assumed that accurate estimates of both indices are available in similar units of measurement (the actual process of measurement will be discussed later). For a given environment, the indices can be approximately equal, or they can be discrepant to varying degrees.

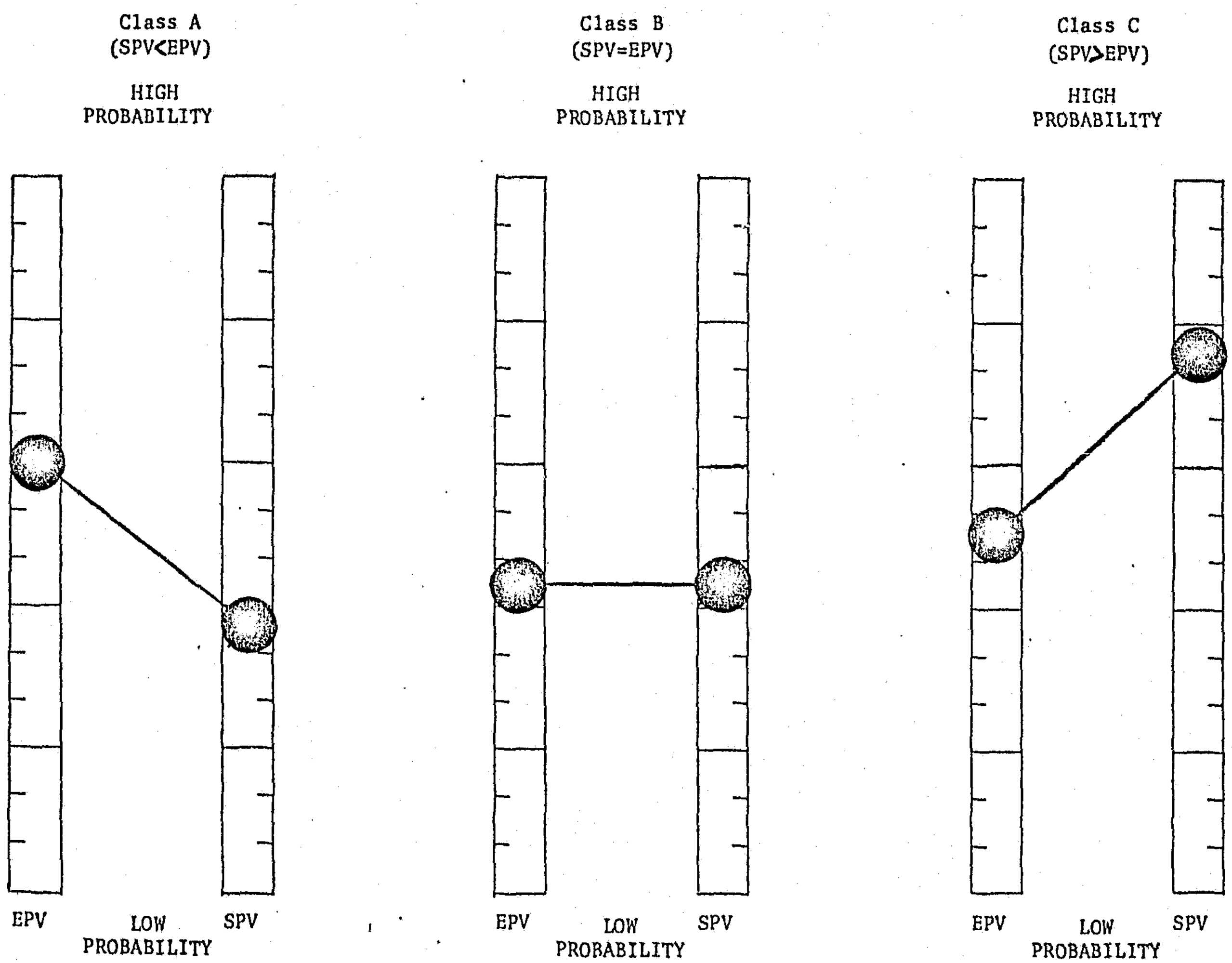


Figure 2. Hypothesized Relationships Between EPV and SPV for a Given Environment

The ensuing discussion points out that the value or usefulness of measuring attitudes toward crime (SPV) is quite limited unless analyzed in conjunction with a concomitant measure of EPV.

Class A situations are those in which the SPV is less than the EPV. This would occur, for example, if people felt little threat of crime in a place in which they should perceive more danger. There are many potential ramifications of Class A situations, including the possibility of activity patterns that both increase and decrease various opportunities for crime. However, Class A will not receive any further attention in the present discussion because the probable incidence of Class A environments in CPTED projects will be so low as to be insignificant.

Class B refers to situations in which the average SPV of the users or residents of an area is a reasonably accurate reflection of the EPV. This classification applies irrespective of whether the environment is relatively safe with low crime or characterized by high crime rates and seen as unsafe. If the EPV of an area is .00001, inclusion in Class B does not imply that a resident would respond with a similar value if asked about the possibility of criminal victimization. Rather, if the project area crime rates were normal, vis-a-vis other environmental areas, the person would be expected to respond "normal" or "average"; if crime rates were higher than normal, individual responses would be "above average," and so on.

Situations in which concern about crime are higher than warranted by the EPV level fall into the Class C category. In this case the SPV is greater than the EPV and people are responding to the environment with more concern than is necessary.

3.3.1 The Fear-of-Crime Problem: A Class C Environment

Heightened fear and concern about crime and the concomitant alteration of behaviors are generally regarded as undesirable and problematical. Confused with this perspective is the suggestion that fear of crime is the cause or source of the problem, which may or may not be the case. Past discussions have generally neglected to distinguish situations in which fear of crime functions as an antecedent or consequent condition, that is, whether fear is the cause of the problem or if it is in turn caused by a high EPV level. The following discussion, using the EPV and SPV concepts, will attempt to deal with and eliminate this confusion.

Excessive concern about crime, as indicated when SPV is high, can be a natural outgrowth of the EPV in an environment. If crime rates are high, then a similarly high concern about crime (SPV) is normal. This does not imply that a high concern level is desirable. One of the worst aspects of high EPV environments is the pervasiveness of worry and concern among members of that environment. However, the important notion for the present discussion is that while overconcern about crime (high SPV) is problematical, it is not the problem. The high EPV is the problem. A concomitant level of concern for one's safety is a reasonable and rational outgrowth of the high EPV.

On the other hand, if the SPV is much higher than the EPV (as illustrated in Class C environments of Figure 2), a situation exists in which the quality of life is reduced because of the belief that crime and the associated problems of the environment are worse than they actually are. The abnormally high SPV is the problem, because the crime rates of the environment cannot account for the high SPV. Thus, it is the discrepancy between the EPV and SPV that defines a fear-of-crime or attitude-towards-crime problem.

3.4 Rationale of CPTED Approach

The operating rationale of the present guideline is that a fear-of-crime problem exists only when the level of fear or concern in the environment cannot be accounted for by the amount of crime. Thus, concern problems exist when there is high concern and only normal crime rates. If, on the other hand, concern about crime is high but crime rates are also high, then concern about crime can be said to be problematical, but not a problem. The nature of crime is the problem and that is what will receive the attention of the CPTED team over the course of the CPTED project.

Restricting the definition of a fear-of-crime problem to Class C situations offers a number of advantages. It allows a precise definition of a potential crime/environment problem that can be identified and addressed by a CPTED team. It defines specific environment assessment procedures to determine the existence and extent of the problem and to focus on possible causes of the discrepancy between EPV and SPV. It suggests different CPTED strategies for situations with discrepant SPV and EPV levels.

Before the CPTED approach to the measurement of attitudes towards crime is described, it should be noted that although the logic and rationale of the approach has received much attention, very limited empirical evidence concerning questions of validity can presently be offered. Estimates of the reliability of the measurement instruments are presently unknown. The use of a subset of questionnaire items to conceptually define the different indices used in the measuring instrument was accomplished in a somewhat ad hoc manner and was not a result of a systematic sampling of the universe of potential questionnaire items. The present approach can provide a good deal of valuable information to the CPTED team, but it must be pointed out that a great deal of research and development effort remains before these procedures can be regarded as a valid and robust methodology for the measurement of attitudes towards crime.

3.5 Reasons for Measuring Attitudes Towards Crime

In the initial crime/environment analysis phase, there are two ways in which SPV rates are useful. First, attitudes towards crime can be used to help the CPTED analyst identify high-crime pockets in the project area. This would involve Class B situations in which high SPVs indicated high victimization rates (SPV=EPV). While these pockets might emerge through a crime/environment mapping procedure (see Guideline 1, Section 3), their identification would certainly be facilitated through the assessment of attitudes towards crime. This information, for example, could come from the EUQ item which requests the person to describe any nearby areas in which he or she would be afraid to walk at night. Second, measuring SPVs can uncover an attitude towards crime problem as earlier defined (SPV>EPV). This discrepancy can be for the project area as a whole or it can occur in certain small subareas within the environment (pockets of fear). Measuring SPVs is an excellent way to locate pockets of fear. Methods for the assessment of environmental correlates of fear of crime (see Section 9 of this guideline) can then be used to discover exactly why areas in the environment with little or no crime are feared by residents or users.

After the crime/environment analysis phase is completed, assessing SPV during later CPTED phases also can be useful. Levels of concern about crime after the completion of major portions of the CPTED project can be compared to preprogram levels to determine whether a change has occurred. SPVs would be the dependent measures to examine the impact of the CPTED program. Any reduction in levels of concern would be regarded as an indication of an improvement in the quality of life in the area. Comparison of the SPV and EPV during this phase can isolate the possible situation in which crime rates decrease but concern about crime remains unchanged. Quite possibly, the CPTED project area could change from a Class B setting (SPV=EPV) to a Class C setting (SPV>EPV), a plausible circumstance because of the potential lag of attitude change behind environmental change. This situation would suggest increased publicity about the nature and results of the CPTED project in the community.

3.6 An Example of the Utility of Measuring SPV

Suppose a crime data analysis of a given CPTED project area uncovers typical or average ECRs. There is no particular crime problem characterizing the area. If SPV were not examined, it could be concluded that the project area has a normal crime profile and would not need additional crime prevention effort. Suppose, however, that a concern-about-crime problem did exist (SPV>EPV). This means that people are experiencing the unpleasantness of heightened worry and concern, and they could be reducing or changing certain behaviors and suffering a reduction in their quality of life when there is no reason for this to be the case. Without SPV analysis, the situation could go undetected. With an SPV analysis, the EPV-SPV discrepancy could be discovered and the causes could be, for example, poor lighting in certain areas compounded by a wave of juvenile delinquency a year ago which area residents have not forgotten. Appropriate lighting and confidence restoration strategies are immediately suggested to overcome the problem.

4. The Environment Usage Questionnaire (EUQ)

The Environment Usage Questionnaire (EUQ) has been developed for the measurement of attitudes toward crime and involves the use of three different methods of assessments: Direct, indirect, and behavioral. Within each method, one or more questions has been constructed to measure attitudes towards crime in the residential neighborhood and the urban setting. In a number of these measures, when two or more questions are used the resultant value represents an average of the responses to all of the questions for that particular attitude and is called an Index. A series of questions were used where possible for the measurement of a specific attitude to increase the internal reliability of the resultant measure. Figure 3 illustrates the different categories of indices and measures presently available in the CPTED approach to the measurement of attitudes towards crime.

MEASURES / ENVIRONMENTS	BEHAVIORAL	INDIRECT SPV	DIRECT SPV
HOME	X Door Locking X Recreation - In Home X Recreation - Away X Recreation - Diversity		X
RESIDENTIAL NEIGHBORHOOD	X Walking ● Use Park	X ●P	X
URBAN DOWNTOWN	X Frequency of Visits ● Duration of Visits	X ●P	X
PUBLIC TRANSPORTATION	● Frequency of Use		●
GROCERY SHOPPING	● Frequency		●

X = Index (2 or more questions)

● = 1 Question

P = Prompted (see text, page 3-19).

Figure 3. Measures of Attitudes Towards Crime in the Environment Usage Questionnaire

The direct, indirect, and behavioral measures represent three different methods that are used together for the assessment of a specific attitude (e.g., one's feelings about crime in the residential neighborhood). With three ways of measuring the same attitude, there is greater confidence that the results of the assessment procedure are a true reflection of the actual existing attitudes towards crime than if only a single method of assessment were used. It is also possible that any one or two of these measures could indicate the existence of an attitude problem while the remaining measure or measures provided a different picture. Issues concerning the interpretation of the different possible outcomes are more extensively treated in a later section.

4.1 Behavioral Measures

Questions that examine the types of individual behaviors that could be influenced by one's overconcern about criminal victimization are included in this category. These items attempt to provide an indication of any changes in the lifestyle or activities of individuals in response to their perception of the crime problem in their environment. Questionnaire items measure the frequency with which certain behaviors occur, the duration of different activities, and the diversity of activities defining a particular individual's lifestyle. For example, with respect to the urban area, one could ask: "How frequently do you visit the downtown area, how long do you typically stay, and how many different places do you go to when you visit?"

4.2 Indirect Measures

Indirect measures attempt to assess the concern about crime and safety through the use of nonreactive, indirect questions. These questions are distinguished from direct questions in that the respondent is unaware of the exact nature or purpose of the questions or the information that is being sought. The use of indirect measurement procedures eliminates many of the problems associated with respondent awareness.

The EUQ uses two types of indirect measures: Unprompted and prompted. An example of the first type is: "What are the <u>good</u> points of this neighborhood?" If the respondent mentions "low crime" or "safe and secure" as his first response, then the response would be scored as indicative of low concern about crime. If the respondent mentioned something about these factors, but not as his first response, then the response would be scored to indicate slightly more concern about crime. If nothing were mentioned concerning low crime, then the environment would receive a still lower score. A number of other questions are included in the indirect measures, from the likelihood that the person will move away in the near future to a request for the individual to list the bad points of the neighborhood. When combined the responses from these questions provide a nonreactive indication of the attitudes towards the crime problem. In each case, the individual remains unaware that the investigator is primarily interested in issues concerning the person's feeling about crime.

The prompted measures involve the use of a deck of nine cards, each of which contains a specific characteristic of a neighborhood (e.g., attractive, convenient, friendly people, low crime, quiet). When the respondent is asked to rank these characteristics to show what he/she likes most about the neighborhood, second-most about the neighborhood, and so on, the location in the ranking of the "low crime" card provides the critical information. If the low crime card is ranked high, this indicates less concern about crime than if this characteristic is ranked at the end of the list. This method is indirect in that the person is still unaware of the exact purpose of the question, but it is prompted in that the issue of crime and safety is raised by the question and must be addressed by the respondent.

4.3 Direct Measures

Direct questions are those in which the subject is immediately aware of the purpose of the question and the nature of the information that is being sought. For example: "In the past year, do you feel that the crime rate in your neighborhood has been increasing, decreasing, or remained about the same as it was before?" Questions in this category (i.e., concerning feelings of safety and perceived chances of criminal victimization), have traditionally been the basis for most surveys, polls, and victimization studies that have attempted to examine fear of crime. Although these questions are subject to problems of respondent awareness and bias, they offer the important advantage of providing more detailed and precise information about the nature and possible reasons for a fear-of-crime problem.

5. Preparation and Modification of the EUQ

Section 8 contains a copy of a questionnaire for measuring attitudes towards crime that has been used in a small research study and is general enough to be applied to many different types of CPTED projects. However, it may be desirable to modify this instrument to meet the specific requirements of a given CPTED project. A number of important issues that should be kept in mind by the CPTED team when constructing such a questionnaire are detailed below.

The CPTED attitudes-towards-crime questionnaire is called an Environment Usage Questionnaire (EUQ). The questionnaire is so titled primarily to avoid reference to crime, safety, and the like -- words that could make the respondent aware of the actual purpose of the questionnaire. The title is appropriate also because many of the questions asked concern the degree to which people visit and use different parts of their environment. Retitling the questionnaire to reference the areas of crime or safety would reduce the validity and value of responses to the indirect measures and should be avoided.

Figure 4 presents a copy of a letter of introduction that can be used by surveyers when conducting door-to-door interviews in a residential area. The purpose of the letter is to briefly describe the nature of the interview and time required to complete it, as well as to substantiate the interviewer's claims that he is working on a bona fide research project. The project description should avoid reference to crime and the fear of crime. Revisions or new cover letters should be composed with these considerations in mind.

5.1 Sequence of Questionnaire Sections

The EUQ should always list the behavioral measures first, the indirect measures second, and the direct measures last. A sequence which

(TYPE ORGANIZATION HEADING HERE)

ENVIRONMENT USAGE STUDY

We are conducting a research project to study the ways in which people use and think about the environment. We are interested in the daily activities of people like yourself, things like where you go shopping, how frequently you go sightseeing, how often you visit downtown, and other activities. The purpose of the project is to relate the architecture and design of the environment to the way people use it so that better environments can be designed and built in the future.

We are conducting short (approximately 30 minutes) interviews with many of your neighbors. We would like to interview you and would appreciate your assistance in this project. While all of the questions are simple and straightforward, you can refuse to answer any question and can terminate the interview at any time, if you wish. All responses will be anonymous (we don't record names or addresses) and all of the data will be grouped together for analysis so that the responses of any particular person will be unknown.

Thank you for your cooperation.

(SIGNED)

____

NAME
TITLE

INTERVIEWERS:
NAMES

Figure 4. Suggested Environment Usage Survey Cover Letter

places the direct questions before the indirect or behavioral indices subjects the measuring instrument to the following criticisms. The respondent's awareness of the purpose of the survey may influence his description of the activities undertaken in the environment. Second, respondent awareness voids the distinction between the indirect and direct measures and the indirect indices no longer remain independent of the direct measures.

5.2 Modifying the EUQ

A broad and inclusive survey form such as the one presented herein might not be necessary for a given CPTED project. For example, the CPTED team might be interested in only the attitudes toward crime in the downtown urban environment, with no requirement to examine similar issues in a residential area. In this case, a suitable instrument could be constructed by simply using those portions of the EUQ that are needed by the CPTED team. For purposes of administration, the different subsections of the EUQ are relatively independent of one another, and almost any subset of indices can be used separately so long as the chronological order of the indices is retained.

Any specific attitudes-towards-crime survey could potentially benefit from a close examination of the behavioral measures in the EUQ as they relate to the specific CPTED project area for which the survey is being contemplated. Additional behavioral items, tailored to the particular environment or crime problem at hand, could be included in the behavioral measures section. The CPTED analyst would want to determine if the behaviors that are presently listed in the EUQ are indeed those types of activities that reflect heightened fear or concern about crime in the particular CPTED project area that is being studied. Those behavioral items that are not appropriate should be eliminated from the EUQ. Replacement items can be generated by the CPTED team through a logical analysis of the situation, and through information obtained during key-person interviews with residents or users of the environment.

The importance of tailoring the behavioral items to the particular area and crime situation cannot be minimized. Every attempt should be made to gain insight into the types and nature of different activities that could possibly be influenced by heightened concern over crime in the project area. Unless this requirement is met, the meaning and interpretation of survey results that indicate no behavioral impact is unclear. It could mean that the CPTED project team is dealing with a Type C environment (see Figure 1), or it could mean that certain behavioral indices were too gross or imprecise to reflect this important information. Thus, a great deal of attention should be devoted to this section before undertaking an attitudes-towards-crime survey.

5.3 Coding Responses

When revising items in the EUQ, or when composing new items for inclusion, a system for the coding of anticipated responses should also be developed. Often the survey responses for a particular question have to be discarded because insufficient attention was given to the manner in which the data would be coded for analysis. This is particularly true with some open-ended items that allow the respondent to answer in words of his/her own choosing. Other coding problems concern the possible interpretation of an individual's response. For example, one indirect measure of concern about crime is the expressed likelihood of a person to move away from his neighborhood within the next year. This response can be coded only if the respondent is then asked why he or she is leaving the area. Without this information, the CPTED analyst does not know if the person desires the move because of perceived crime problems or for reasons unrelated to attitudes towards crime. In the construction of questionnaire items and in the pilot testing of the instrument attention should be given to both coding and interpretation.

When establishing a coding scheme for questionnaire items, the relationship between the numbers assigned to the question responses and the concept being measured should always be positive. For example, a question which asks if a person worries about crime in his/her neighborhood offers the responses of Always, Often, Sometimes, or Hardly Ever. The numbers 1, 2, 3, and 4 can be assigned to the response categories in two different and opposite orders. Since the question concerns amount of worry, with verbal responses ranging from low to high, the low numbers should be assigned to the low response categories (e.g., Hardly Ever = 1, Sometimes = 2).

There are a number of reasons for using the coding rule described above. First, the coding scheme for the EUQ was developed using this rule and using it for new or revised items will ensure compatibility between the new and existing response codes. Second, standardizing the relationship between code numbers and question responses makes the interpretation of the data analysis and statistics much simpler. The analyst can quickly interpret the meaning of the absoloute level of the mean response value for a given question, differences between average values of two questions, and a correlation coefficient between two questions. Finally, it is necessary for every question included in an EUQ index to be coded using the same rule because the responses from these questions must be added together to produce the final index value.

5.4 Qualitative Probe Sheet

A final and important part of the EUQ that should always be used is the Qualitative Probe Sheet (QPS). This is essentially a blank page appended to the questionnaire. It is used by the interviewer to record any notes, ideas, or impressions that may have occurred during the course of the interview. Additionally, the interviewer might ask the respondent to describe or elaborate on earlier comments or might ask specific, open-ended questions.

6. Methodological Issues

Because the EUQ will most likely be used in survey research, the potential user should review the methodological issues relevant to conducting an attitude-towards-crime survey as described in Guideline 4. Presented below is a discussion of methodological issues that are either unique to the use of the EUQ or are included at risk of repetition to emphasize their importance in surveys of this kind.

6.1 The Use of a Pilot Study

Before beginning a survey in the CPTED project area, the survey instrument should be tried out in a small pilot study. In some other environment, data from perhaps 3 respondents per interviewer should be collected using procedures identical to those specified for the major study. These data should be coded and limited analyses should be performed. These steps will help to ensure that the many factors involved with the design and conduct of an EUQ survey have been adequately addressed. Additionally, the pilot work will give the interviewers a chance to practice the administration of the EUQ and to learn the amount of time required for the administration of the particular EUQ that is being used. After the pilot study, the EUQ and the survey procedures should be revised as required.

6.2 Demand Characteristics

There are many ways in which error can occur in an interview situation. One potential source of error is found in the interviewer. Sometimes the particular slant that an interviewer places in the phrasing of certain questions can influence the responses of the person being interviewed. Or the interviewer can choose to record only portions of open-ended responses being made by the interviewee. Although most interviewers attempt to be fair and impartial, many errors can occur without their knowledge. In some situations, it would be ideal for them to be unaware of any hypotheses that are being examined by the CPTED team through this research. For example, the CPTED team may believe that the neighborhood alleyways are contributing to a sense of overconcern about crime in the neighborhood. If at all possible, the interviewers should not be informed about such hypotheses that are being examined. This strategy will help to reduce any unintentional interviewer bias that could result from the knowledge or the experimental hypotheses.

Another source of error in the interview situation involves respondent awareness of the purpose of the research. The design of the EUQ and the suggested procedure for administration were evolved in an effort to overcome many problems associated with respondent awareness, as described earlier. It is imperative that no mention of crime, safety, or related areas should be made by the interviewer until the final portion of the EUQ (the direct measure) is reached. If the interviewee discusses crime or safety when responding to questions concerning the good or bad points of an environment, the interviewer should not dwell on, or necessarily encourage, this line of response. The interviewer should attempt to remain neutral, both in word and action, irrespective of the nature of the interviewee's reflections.

6.3 Defining a Sample

As in any survey, sampling issues will have to be addressed, and the CPTED analyst is directed to Section 7 in Guideline 5 for an overview. Of particular importance in attitudes-towards-crime research are the variables of age and sex of the survey respondents. Very typically, and for a number of bona fide reasons, overconcern or worry about criminal victimization occurs more frequently in the elderly and in women. Unless the CPTED team is examining attitudes towards crime in a specific subpopulation (e.g., elderly women), a survey sample should always be stratified by age and sex. This means that there would be an equal number of males and females that were categorized as old and young, however these categories might be defined. Optimally, there should be

CONTINUED

2 OF 5

at least 15 persons in each of the four possible categories. If these requirements can be met, then two major advantages will obtain. First, the possibility of age or sex moderating a behavior/attitude relationship is eliminated (see Section 7.1.3 for a discussion of this problem). Second, the CPTED team can analyze attitudes towards crime for four different subpopulations. They might find, for example, that old men worry about crime in certain environments, while young women have a different set of problems in different places in the environment.

6.4 Administering the EUQ

The Environmental Usage Questionnaire (EUQ) is designed to be administered in person by an interviewer. If needed, most of the EUQ can be easily converted for use in a telephone interview or a mailed survey. However, this discussion will concentrate on administering the EUQ in a face-to-face interview situation in a residential neighborhood.

When initial contact with the potential respondent is made, the interviewer should introduce himself and provide a brief explanation of his purpose. During this explanation, the interviewer can present a one-page cover letter to the potential respondent (see Figure 4). If the individual refuses to be interviewed, his/her address should be checked on a Sanborn map of the area so that he/she would not be called upon again. In a field study using the EUQ, refusals occurred rarely. Most of those who refused did so only because of the inconvenience of the moment and many agreed to set appointments for the interview at a later and more convenient time.

The interviewer should attempt to gain access to the house because the administration of the EUQ is much more easily accomplished indoors. In the EUQ field study, the interviewers were almost always invited invited inside, with some respondents first requesting to see the cover letter and personal identification materials.

The EUQ is designed to structure the entire interview session through verbatim presentation to the interviewee. All typed information should be read aloud with the exception of instructions to the interviewer (which are capitalized and enclosed in parentheses for easy identification). Each question and the responses available, if any, should be fully presented, as should the transition phrases connecting one EUQ section to another. Responses of the interviewee are recorded by either circling the appropriate response category, or clearly writing down the required information in the appropriate code boxes.

Thirty to forty-five minutes are required to administer the EUQ, depending on a series of factors. The items should be read quickly but not rushed. A certain amount of social interaction with the respondent is appropriate, but extended discussions must be cut short. Some individuals require additional time to think about and respond to the different parts of the EUQ.

One part of the EUQ not common to most survey questionnaires requires additional attention. This is the prompted indirect measure, which consists of two sets of index cards describing neighborhood and city characteristics. Respondents are asked to rank these cards to indicate which aspect they like most about the neighborhood or city, what they like second best, and so on. When recording the rank order of the cards, be sure to double check the direction of the ranks so that the ranks are always copied down from "best" to "worst." In many situations, the recording of this information is facilitated by asking the respondent to turn over the cards and read back the identification numbers.

Retaining the respondent's rank order, the respondent is then asked to divide the cards into three groups: Those things that are seen as good about the neighborhood, those regarded as average, and those seen as bad. Most respondents will retain the initial rank ordering while delineating the three groups, although others may vary their original order. Recording these groupings is sometimes difficult, and analysts should develop their recording scheme during the pilot study. The cards of each deck should be returned to the original ordering before presentation to the next respondent. Finally, it is recommended that requests for demographic data should be made at the close of the interview, by which time the respondent will have usually warmed up to the interviewer and be much more willing to give this type of information.

6.5 Location of Respondent

One important decision faced by the CPTED team concerns the location of the sample of respondents relative to the environment being examined. Attitudes toward crime in the urban or commercial setting can be assessed by surveying individuals (either business people or residents) who are located in the urban setting at the time they are surveyed (in situ) or by surveying individuals while they are in other locations (usually in their homes) about the same issues. Some issues which bear on this decision follow. Individuals surveyed in situ can be expected to be more frequent users of that particular environment than individuals who are surveyed at other locations. Because of this, in situ respondents can be expected to be more familiar with the particular environment. These individuals would be less apt to harbor stereotypes or misconceptions about characteristics of the environment in question. The reverse of these factors would hold for individuals surveyed in other locations who are less familiar and have less information about the particular environment.

Under certain circumstances, a survey of people taken from both in situ and other locations can provide very valuable information to the CPTED analyst. For example, such comparisons could indicate that low frequency users of an urban environment were more fearful of criminal victimization (which could account for their low rate of visitation), or that there was no difference between these two groups on the attitudinal measures. The latter finding would indicate that concern about criminal victimization was not an important factor contributing to the low usage of a downtown urban environment. Other comparisons between the responses of both groups could potentially illustrate sources of misinformation that could be contributing to heightened concern over crime in the nonusers. The survey could pinpoint these areas and a confidence restoration or public awareness campaign could be initiated to improve the situation.

7. Analysis and Interpretation of Data

A major emphasis throughout the development of the CPTED approach to the measurement of attitudes to crime has been on issues concerning the validity of the measuring instrument and the value or usefulness of the data that are collected. This emphasis has resulted in a survey instrument containing three different and relatively independent methods of measurement. These methods function as sources of validational evidence that are structured or built into the EUQ. Thus, evidence of the validity of the EUQ as a measure of attitudes towards crime is not available in the form of an existing large-scale empirical validation research project. Rather, the EUQ is structured through the use of multiple measurement techniques to provide evidence of construct validity and internal consistency in every survey or CPTED project in which it is used. Any CPTED team can then assess, for their own unique situation, the validity and success of their attitudes-towards-crime survey. The one shortcoming of this approach is that the required procedures for data analysis and interpretation may not be as simple or straightforward as might be desired.

7.1 Overview of Analytic Procedures

There are four major steps involved in the analysis of data gathered in an attitudes-towards-crime survey using the EUQ. These steps represent chronological points in the analysis and major questions or areas of interest that must be addressed, and are as follows:

- Step 1 -- Are the direct to indirect SPV indices in agreement, indicating high confidence that the SPV construct was validly measured? Or does discrepancy between direct and indirect SPV indices allow only low confidence? Are SPV levels low, normal, or high?

- Step 2 -- Is there an attitude-towards-crime problem (is SPV>EPV)?
- Step 3 -- Does any behavioral avoidance or adjustment occur in response to the attitude-towards-crime problem?
- Step 4 -- What information is available from the EUQ and other sources that can be used to define the nature and possible causes of the problem?

Figure 5 shows the major findings that can occur at each step of the analysis, and the effects of these findings on the remaining steps in the attitudes-towards-crime analysis process and the overall crime/environment analysis. A more detailed discussion of the activities that are involved in each step is given below.

7.1.1 Step 1: Examination of Direct and Indirect Measures of SPV

The major purpose of Step 1 is to affirm the validity of the SPV assessment procedure and to determine the SPV level. As discussed earlier, the measurement of a concept with two relatively independent methods is generally regarded as superior to the use of one method alone, especially if one of the methods is an indirect approach. Thus, the CPTED team can be more confident that the results of the SPV survey are an accurate reflection of the real attitudes toward crime held by the residents and users of the environment. The analyses outlined in this step are

Step 1: • Do direct and indirect SPV measures agree?

/_/ No — Therefore, low confidence that SPV data are valid.

/_/ Yes — Therefore, high confidence that SPV data are valid.

• Are SPV levels low, normal, or high?

/_/ Low — End SPV analysis.

/_/ Normal, High — Continue SPV analysis.

Step 2: • Is SPV > EPV?

/_/ No — Restrict crime/environment analysis to causes of crime.

/_/ Yes — Define crime/environment analysis to include: a) causes of crime and b) causes of attitudes toward crime.

Step 3: • Is there behavioral impact?

/_/ No — Project environment is Category "C," problems not too severe.

/_/ Yes — Project environment is Category "D" or "F," problems more severe.

Step 4: • Based on above findings, revise and continue crime/environment analysis.

Figure 5. Alternate Outcomes in Analysis of Attitudes-Towards-Crime Data

restricted to the urban and residential areas because these are the only two environments for which indirect measures are presently available.

Figure 6 shows the alternate outcomes that can occur at this stage when comparing the results of the direct and indirect measures. The Low and Normal levels of SPV are equivalent to concern about crime that could be expected to occur in Category A and B environments (see Figure 1), with a High SPV level representing environments in Categories C, D, and F. Essentially, the results from the two measures can be either in agreement or disagreement with each other. If the results are the same (i.e., both measures indicate about the same level of SPV in the environment), then the CPTED team can have high confidence that these results are valid and accurate. Multimethod agreement is the desired outcome and when it occurs the analyst can move to the next phase of the analysis.

However, if the direct and indirect measures indicate different levels of SPV, then the analysis becomes more complicated. One important question concerns the validity of each method taken separately. The direct approach has been extensively used in other polls and surveys. It has face validity but it is subject to many of the measurement criticisms outlined earlier. The indirect method overcomes a number of the measurement problems associated with the direct approach but, as presently defined in the CPTED EUQ, the indirect indices are preliminary instruments that have not been extensively used or studied for purposes of validation. Thus, the CPTED analyst can justifiably ask, "Which index should I believe?"

In the present stage of development and until additional research can be undertaken, the safest procedure for use by the CPTED team when

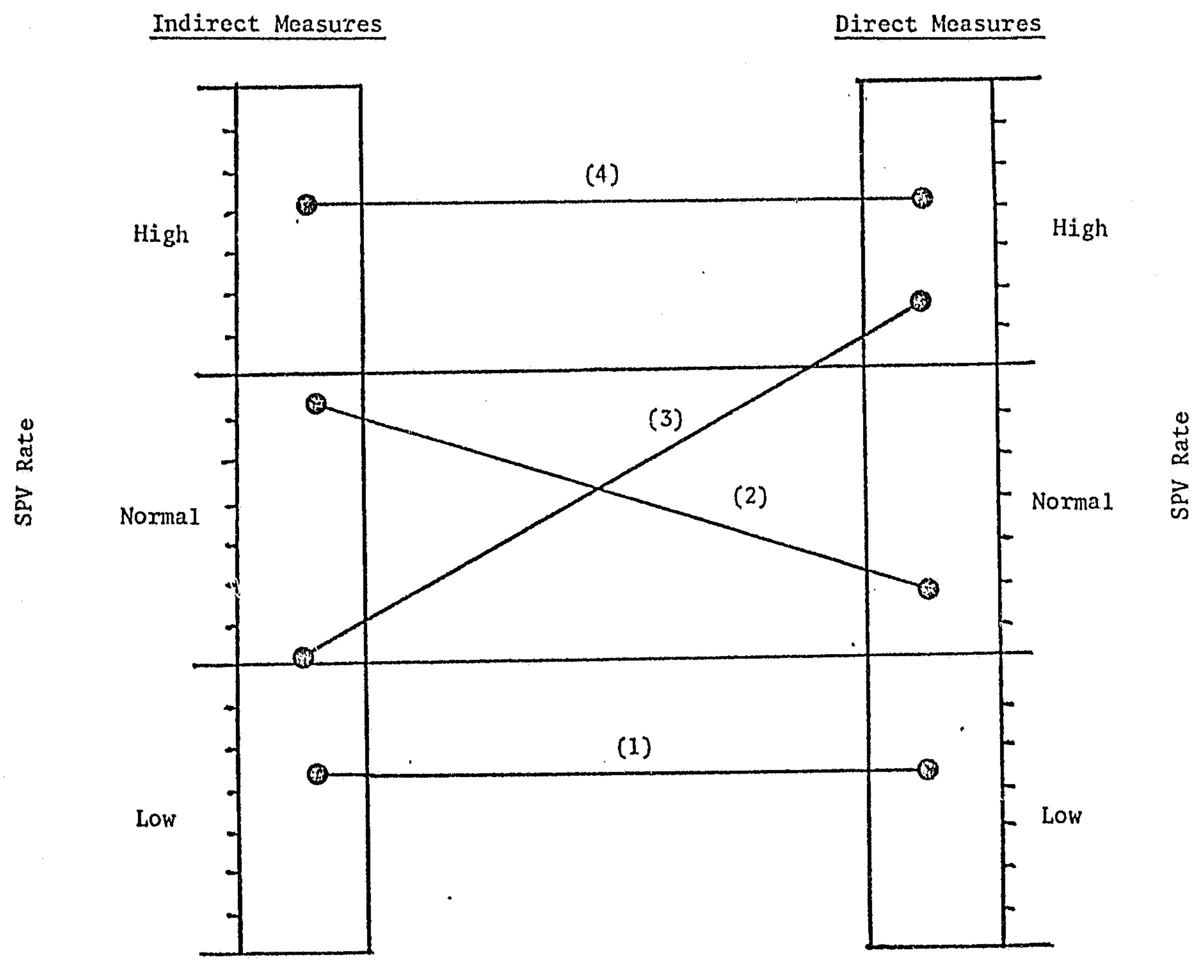


Figure 6. Possible Relationships Between Direct and Indirect Measures of SPV

interpreting discrepancies between direct and indirect measures of SPV is as follows. Discrepancy (2) in Figure 5 can be regarded as very unlikely to occur in a CPTED project. The bias and errors associated with the direct approach all serve to spuriously inflate the SPV level. This occurs because of semantic confusion (as discussed earlier), and because of the respondent exaggerating the crime problem in the hope of encouraging municipal attention to his environment. Further, if one's concern about crime is strong enough to be indicated using an indirect measure, it can logically be expected to be reflected in the direct measure as well. Thus, discrepancy (2) needs no further discussion.

The type (3) discrepancy is most likely to occur and a number of factors influence the interpretation of this outcome. The CPTED analyst should regard the direct measure as indicating the possible existence of overconcern about crime and continue with the analysis accordingly. It would be far worse to allow a potential concern-about-crime problem to remain unaddressed than to pursue a nonexistent problem. This value structure places the higher value on the potential well-being of the citizen than on the most efficient utilization of public funds. The CPTED analyst should be aware, however, that the intensity or importance of concern about crime may not be very high in this situation. With high intensity, one can justifiably ask why the concern did not manifest itself on the indirect measure. Thus, when discrepancy (3) occurs, the CPTED team should continue with the data analysis with somewhat lower confidence that SPV levels are actually high and intense, and with the understanding that further steps in the process may not prove fruitful because of the potential error in the initial SPV assessment.

Once issues of measurement validity have been resolved, the CPTED analyst must address the final question in Step 1, which concerns the absolute level of SPV in the project area: Is the concern about crime at low, normal, or high levels? If SPV levels are low, then the attitudes-towards-crime analysis can be considered at an end. There is no reason to pursue Steps 2, 3, and 4 because: 1) A low SPV rate indicates a "safe" environment (Categories A and B, Figure 1) and precludes the existence of an attitude-towards-crime problem, i.e., SPV>EPV (Step 2); 2) no behavioral impact occurs in Class A and B environments by definition, and no behavioral impact could reasonably be expected (Step 3); and 3) with no crime/environment problems here, no additional information is needed to solve these (nonexistent) problems (Step 4).

Average scale ratings in the "Very Unsafe" category identify high SPV environments, while ratings of normal environments would fall in and between the categories of "Somewhat Safe" to "Somewhat Unsafe". If SPV levels are normal or high, then the analysis and interpretation of EUQ data should continue. Such levels would indicate that the CPTED area was either a Category C, D, or F environment, and that it would benefit from additional CPTED attention. A high level of SPV is the easiest to work with because such a level can be expected to indicate the presence of some major problem in the CPTED domain (i.e., high crime rates or over-concern about crime). SPV rates falling at normal or average levels prove somewhat more difficult. For example, if the EPV rates are also normal, one can justifiably ask whether CPTED monies might more effectively be spent elsewhere. Also, when SPV and EPV levels are normal, those particular aspects of the environment or victim/criminal behavior which act as the causes of crime can be expected to be less salient and more difficult to identify. The higher the rates of SPV and EPV, the more effective the CPTED project can be expected to become.

7.1.2 Step 2: Is There an Attitude-Towards-Crime Problem (SPV>EPV)?

As indicated in Figure 2, the determination of a concern-about-crime problem requires the comparison of EPV and SPV levels to identify the existence and extent of the discrepancy between the two indices. This procedure implies that the two indices are either measured in, or can be converted into, similar scale units, a requirement which can be achieved with only a rather gross degree of precision.

Crime rates from the appropriate sources (e.g., UCR, police data, victimization survey) should be examined to determine how the rate for the project area compares to those of surrounding areas in the city. Is the EPV greater than, about the same as, or less than that of surrounding areas? Since a low-crime environment cannot be expected to be the site of a CPTED project when medium and higher crime areas are available, the low crime category can be eliminated from further discussion. Thus, the EPV for the project area can either be about average or higher than that of the surrounding areas (in the urban, commercial, and residential environments).

Using the SPV levels from Step 1, comparisons between the EPV and SPV indices can now be made. Does the degree of concern about crime seem appropriate for the amount of crime that actually occurs? Does this vary by type of crime? If fear levels are high, are the various crime rates also high? Have any interviews provided information that suggests the existence of a discrepancy (SPV>EPV)? Through extended discussion and analysis of the EPV and SPV data, the members of the CPTED team should be able to reach a consensus on the nature and scope of any concern-about-crime problems that are present in the CPTED project environment.

If SPV and EPV rates are about equal, then no concern-about-crime problem can be said to exist. The crime/environment analysis does not have to address issues dealing with possible causes of overconcern about crime because the EPV rate can be regarded as the primary factor responsible for SPV levels. However, Steps 3 and 4 of the EUQ analysis should be completed because it is necessary to identify any behavioral impacts occurring because of high SPV or EPV levels (Step 3), and to uncover other information useful in the overall crime/environment analysis (Step 4). If SPV>EPV, then the identification of a concern-towards-crime problem requires that the scope of the crime/environment analysis be enlarged to investigate the potential sources of this discrepancy. Of course, Steps 3 and 4 of the EUQ analysis will also be undertaken.

7.1.3 Step 3: Does SPV Account for Behavioral Impact?

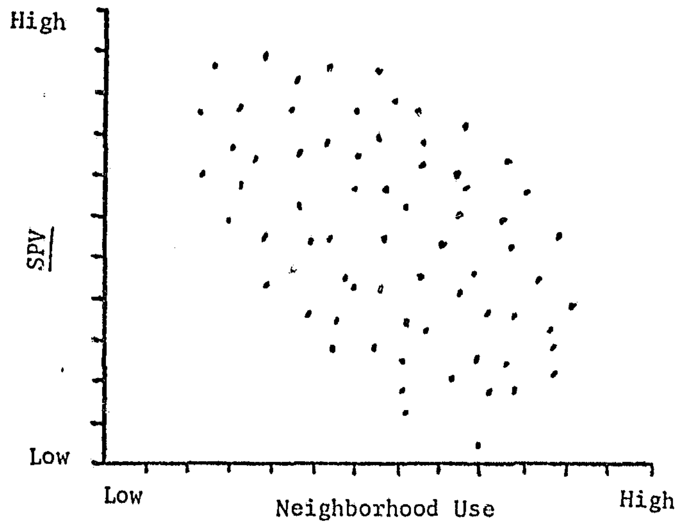
Examining the nature and extent of behavioral adjustments that occur in response to EPV or SPV rates in an area is important for a number of reasons. First, this analysis will indicate to the CPTED team that they are working with a C, D, or F environment (see Figure 1). Categorizing the project area will document the severity of the problem and the requirements of the CPTED anticrime program because a Category C environment suffers from fewer, and perhaps milder, crime/environment problems than Category D or F environments. Second, identification of avoidance and adjustment behavior can help to isolate pockets of fear and specific crime/environment problems. This is so because the nature of the behavioral adjustment usually sheds some light on the reasons for its existence. Finally, even if the environment is found to be of Category C (no behavioral effects can be demonstrated), the analysis of the different forms of behavioral activity on the part of the residents and/or users can show how the environment is used, and may suggest strategies for improving the function and utility of parts of the area.

For a given project area, attitudes toward crime can be said to have a behavioral impact if the SPV measures co-vary with the behavioral measures. This occurs if people who tend to score high on an SPV index (indicating overconcern about criminal victimization) also tend to restrict certain activities. For example, if half of the residents in the survey of the CPTED project area thought that their neighborhood was relatively safe while the other half saw the neighborhood as unsafe and the latter group tended to use the neighborhood less (e.g., walk around the streets less often or avoid the local park), then behavioral impact in response to attitudes toward crime can be said to have occurred.

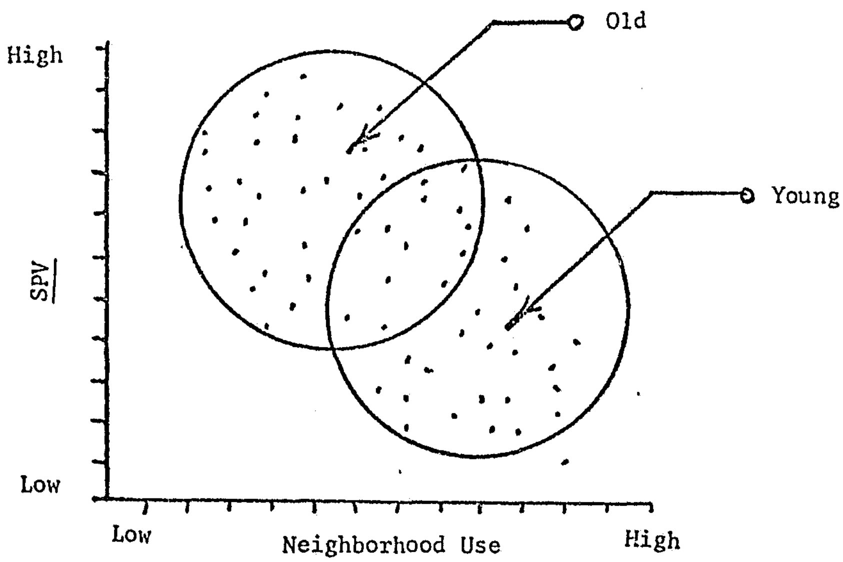
The CPTED analyst can identify behavioral impact by examining the correlation coefficients (r) between the SPV and behavioral measures in the EUQ data (see Guideline 5 for a description of r). In the earlier example, a positive correlation would exist between the perceived safety of the neighborhood (the SPV measure) and use of or walking around in the neighborhood (the behavioral measure). Therefore, after the statistical analysis is completed, an examination of the r values between all of the SPV and behavioral measures of the EUQ will quickly identify the nature and scope of any behavioral impact in the CPTED area that is related to attitudes toward crime.

The analysis required for the assessment of behavioral impact is actually a little more complicated than indicated above. A proper analysis requires examination of not one but four sets of correlations, one set for each of the four combinations possible from the variables of sex (male and female) and age (young and old). The age categories are somewhat arbitrary, but for CPTED purposes could be defined as over or under 45 years of age. Instead of general statements that there is behavioral impact in the project area, the existence and documentation of behavioral effects would be restricted to one of the four subpopulations of residents that are defined above. Again using the earlier example, one might find that older women restricted neighborhood walking as their concern about crime increased, but younger men did not.

Analysis of behavioral impact by age and sex is required because of some problems in statistics and interpretation that occur when the responses from all of the people surveyed are analyzed together. If there is a relationship between walking around the neighborhood and concern about crime in the neighborhood (as depicted in Figure 7), without additional analysis it might be concluded that this represents behavioral



(7a)



(7b)

Figure 7. Age as a Moderator Variable

impact. However, Figure 7 illustrates that it is actually the age of the person that accounts for the relationship. This explanation could occur in some environments because 1) young people are more active than old people, and 2) old people are generally more fearful about crime than young adults. Here, age is called a "moderator" variable because it moderates or controls the relationship between two other variables. If the two variables are again correlated but this time for old and young residents separately, it is possible that no important r values will occur. Thus, while the initial, gross analysis indicated behavioral impact and a Class D or F environment, the required and more precise analysis would eliminate age as a potential moderator variable and show if any behavioral impact did, in fact, exist.

Analyzing behavioral impact by the four subpopulations defined by the variables of age and sex requires that more individuals be surveyed than would otherwise be the case. The more people in each sample category the better, but somewhere between 15 to 20 per category should be regarded as a realistic minimum for valid analysis. With CPTED variables, the correlation coefficient is not a very valid or reliable statistic if computed on less than 15 people.

After the statistical analyses are completed, the presence of behavioral impacts may be demonstrated to some degree. If impacts are found, the CPTED team has learned that the crime problem is having a real, demonstrable, and negative effect on the lives of the area residents or users. This would indicate a severe crime or attitude problem (Category D or F environment) and continued analyses would be pursued as outlined in Step 4 below.

If no behavioral effects were uncovered, on the other hand, the interpretation is not so simple. The immediate reaction is to dismiss the possibility of behavioral impact. However, this reaction implicitly assumes that 1) the measures and indices included in the behavioral section of the EUQ represent valid techniques and 2) that the EUQ measures sample the universe of all possible behavioral indicators, that is, that no important behavioral measures (where impact could be found to occur) were overlooked or excluded. Assumption 1 is tenable, for the face validity of self-report behavioral indices for these types of behaviors would seem adequate, though not noteworthy. However, assumption 2 is more problematical. As described in an earlier section, the behavioral measures presently found in the EUQ were not defined through any systematic or scientifically defensible procedure. There is no way to demonstrate the degree to which the universe of behavioral items was sampled for the EUQ. Thus, a lack of behavioral impact for a CPTED project area can be said to have been demonstrated only for those EUQ behavior measures included in the survey. To say that no impact exists in the area implies that every conceivable behavior and activity was examined with no positive results.

The importance of each CPTED team examining and modifying the behavior measures section of the EUQ is readily apparent. Unless attention is given to this section and behavioral measures are tailored to the particular characteristics of the environment and residents or users, the resulting analysis may be faulty. If this EUQ section receives the necessary attention and planning, the precision of the specific questions can be improved, the scope of the questions can be expanded, and the interpretations of motivations for certain behaviors might be facilitated.

7.1.4 Step 4: Analyzing the Nature and Source of SPV>EPV Discrepancy

The final step in the analysis of EUQ data is an attempt to uncover the reasons for an attitude-towards-crime problem. Success at this stage should improve the effectiveness of the CPTED strategies that are designed to deal with this issue. If Step 2 indicated that no overconcern problem exists, then Step 4 can be eliminated. This discussion is limited to CPTED project areas characterized by an SPV/EPV discrepancy.

The CPTED analyst should understand that the etiology of overconcern or fear of crime in the environment has received only limited empirical study. Few empirical reports exist in the scientific literature and, owing to a number of factors, extensive review of these findings was not possible for the present project. Thus, the discussion that follows should be of value to the CPTED team, but it is the result of a logical analysis of the area and is bereft of solid empirical or theoretical foundation.

Understanding of the source or reasons behind an SPV>EPV discrepancy is facilitated by a detailed analysis of the precise nature of the problem. The terms SPV and EPV have been used in a general and conceptual manner throughout this guideline and they can be defined and measured in a number of different ways. This definition variance can result in the identification of discrepancies in the CPTED project area that are of a markedly different nature. A brief discussion of the factors that can be used to formulate and refine the concern toward crime problems existing in the environment is presented below.

7.1.4.1 Place

The SPV>EPV discrepancy may not apply to the entire project area but rather may be restricted to small subareas within it. Many of the issues relating to the identification and cause of "pockets of fear" are treated in a later section of this guideline. Just as a high crime rate in a subarea of the environment can cause high levels of concern or fear, so too can other factors exclusive of the EPV. However, the definition of the SPV>EPV discrepancy can be refined with respect to subareas in the environment, a refinement that makes the search for possible causes of the discrepancy much easier.

7.1.4.2 Time

Discrepancies may increase or decrease depending on the time of day, or perhaps cycles of longer duration. Thus, if individuals fear crime much more during the evening hours, although the EPV remains unchanged from the daytime, the search for causes of the discrepancy would be restricted to the evening time period. Inadequate lighting is commonly isolated as a major contributor to this problem, although other reasons can apply.

7.1.4.3 Crime

SPV>EPV discrepancies can be computed for the total crime rate of a given area or for the rates of specific crimes. Refinement of an over-concern problem by type of crime makes the ensuing analysis much simpler.

The set of possible factors that could account for overconcern about burglary are different from the list of factors that lead to overconcern for robbery. The examination of discrepancies by specific crime can also provide insights concerning the crime types responsible for a total crime rate discrepancy.

7.1.4.4 Offender

Overconcern might also be related to the threat of victimization that is specific to a certain subpopulation of offenders. Here the discrepancy would vary with respect to the characteristics of the people surrounding or near the potential victim. For example, a woman might feel a greater threat of possible pursesnatch if she is in an area that is also occupied by young teenage males. Overconcern would occur even though the EPV for pursesnatch was not higher in this situation. Refinement of discrepancy by offender population may suggest certain factors which would otherwise go unnoticed.

7.1.4.5 Victim

Finally, the nature of overconcern can be refined by examination of the characteristics of the potential victim. The nonaggressive characteristics and lower physical strength of some women might make them feel that they are more vulnerable to robbery when the EPV shows no difference by sex of the victim. Similarly, older people are generally less able to defend themselves or run from danger and they may feel more concern than young adults even though EPV does not vary with age.

7.2 Sources of Knowledge for SPV

As discussed in an earlier section, the SPV represents an individual's knowledge of and feelings toward the crime rates (ECR) of the environment. The existence of SPV>EPV discrepancy indicates that for some reason or set of reasons peoples' ideas about the nature and extent of crime in the environment are wrong. This section emphasizes the ways that people can either obtain or be exposed to inaccurate information, obtain information in a biased manner, or integrate and use the information about area crime in the wrong way.

Individuals gather information that forms the basis of their attitudes about crime from a number of diverse sources. Systematic examination of these different possibilities can prove enlightening. When considering these sources, emphasis should be placed on sources that can influence a large percentage of the people in the project area. For example, although personal victimization has been found to increase concern about crime, the number of victimized people in the survey sample would be too small in an SPV>EPV area to account for the overconcern problem. Thus, personal victimization should typically receive minimal attention.

People obtain information about crime from members of their family, relatives, neighbors, acquaintances, and, in certain situations, strangers. Information passed along in this manner may be readily accepted and remembered for the sincerity, believability, and lack of ulterior motives of social acquaintances is typically high. Because of this, misconceptions, stereotypes, exaggerations, and misunderstandings can become widely circulated and accepted as fact. Analysis of the common conceptions of residents or users of an environment may serve to identify some problem areas that function to raise SPV levels.

Officials of the local government represent another important source of crime-related information. Many departments of local government such as the Mayor's Office, police, and chamber of commerce, offer information about crime. When crime becomes a political football, with accusations being traded by different parties concerning the nature and severity of the crime problem, the public can be expected to become more aware of the issue. An extended and heated campaign in which the "crime problem" was a primary focus could unintentionally but adversely influence SPV levels.

The public news media provides a substantial amount of crime-related information. Descriptions of various criminal incidents are reported by radio, television, and newspaper sources. The news reporting policies of individual media sources can influence to a large degree the negative impact of these items. For example, are certain crimes reported on the first page or inside of a newspaper? Is the description a factual account or does it emphasize the unpleasant details? Individuals in an environment characterized by a good deal of sensationalism in crime reporting can conceivably be expected to exhibit higher concern levels.

Owing to the macabre or sensational aspects of specific criminal acts, the various news media may have no choice but to convey these facts to the public. Under these circumstances, especially if the case is unsolved and receives extended attention, increased concern levels could occur. If the CPTED survey is made in a period following one of these events, EUQ data could reflect this influence.

Individuals also gather information from their past experiences in the environment. Such information would include one's direct interaction with others, the observation of the interactions and behaviors of others, and the observation of the environment itself. A great deal of information is available and is internalized in this manner. For example, when many people are seen using a park, the observer regards the area as safer than if it were deserted. When property or belongings are left temporarily in one's yard or exposed on a sidewalk, the observer can make inferences about the lack of petty larceny in the area. Thus, the normative behavior patterns of residents or users and other environmental information may contribute to SPV levels.

Another factor that could account for overconcern about crime is the lag of change in personal attitudes behind environmental change. Adjustments in SPV will always lag behind changes in EPV for a number of reasons. Outward indications of decreases in the amount of crime per se in an area are relatively nonexistent. Typical cues are usually found in changes in individual or business activities that occur when such reductions in crime become widely known. Crime rates must be recorded and analyzed over periods of 6 months to a year before statements about changing EPVs in specific areas can be made. This information is disseminated over local news media and by word of mouth. Thus, when a changing SPV begins to emerge in the residents or users of an area, it may be in response to EPV changes that occurred 6 months to a year prior.

In a similar vein, individuals may be unaware of any changes in EPV rates. A crime wave that strikes a neighborhood during one summer may be regarded as a problem for some time to come. This situation was uncovered during a field test of the EUQ in a small residential neighborhood. Crime rates had returned to normal levels but residents still regarded their neighborhood as having a crime problem because of a year-old wave of burglaries committed by teenagers.

Analysis of the above issues can provide the CPTED team with insight into the reasons behind the SPV>EPV discrepancy. The cause of the discrepancy at the most basic level is the lack of consistency between knowledge about the crime situation (SPV) and the crime situation itself (EPV). Thus, the CPTED strategies for eliminating overconcern about crime can be expected to involve public information programs of some type. Areas of inaccurate or incomplete crime-related knowledge must be identified so that these particular areas can be addressed with the appropriate attitude change programs. The control and manipulation of crime-related information in the public domain can be regarded as an important and powerful tool for use in CPTED programming.

7.3 Environment Assessment Questionnaire (EAQ)

The EAQ is an instrument which allows the CPTED analyst to gather information about the environmental correlates of fear and concern about crime in the CPTED project area. Whenever an SPV>EPV discrepancy is found, EAQ data should always be included when analyzing the problem. The EAQ and the associated methodology is described at length in Section 9.

8. SPV Assessment Materials

8.1 Environment Usage Questionnaire (see following pages)

ENVIRONMENT USAGE QUESTIONNAIRE

PART I: TYPICAL ACTIVITIES

I would like to ask you some questions about how you normally use your environment:

(1) Other than for work, do you ever use the bus for transportation? (IF YES) How frequently, that is, how many times per week or month?

________ X ________ [ ][ ][ ] (PER YEAR)

(2) Other than for work, do you ever use the subway system for transportation? (IF YES) How frequently?

________ X ________ [ ][ ][ ] (PER YEAR)

(3) Do you ever use the bus at night? (IF YES) How frequently?

________ X ________ [ ][ ][ ] (PER YEAR)

(4) Do you ever use the subway system at night? (IF YES) How frequently?

________ X ________ [ ][ ][ ] (PER YEAR)

(5) How satisfactory is the local public transportation system? [ ]

1	2	3	4
Very good	Good	Fair	Poor

(6) Where do you typically do most of your grocery shopping?

________ ________ ________ [ ]

(7) How frequently?

________ X ________ [ ][ ] (PER MONTH)

(8) Where do you typically shop when you need just a few grocery items?

________ ________ ________ [ ]

(9) How frequently?

________ X ________ [ ][ ] (PER MONTH)

(10) Do you ever grocery shop at night? (IF YES) How often?

________ X ________ [ ][ ] (PER MONTH)

(11) How frequently do you visit the local park during the daytime?

________X________ [ ][ ][ ] (PER YEAR)

(12) As best you can, tell me about how many times a month you go out and do the following types of recreational activities:

____X____	Dancing	[ ][ ][ ]
____X____	Community Center	[ ][ ][ ]
____X____	Restaurant	[ ][ ][ ]
____X____	Movies	[ ][ ][ ]
____X____	Outdoor sports	[ ][ ][ ]
____X____	Bowling	[ ][ ][ ] (PER YEAR)
____X____	Sightseeing	[ ][ ][ ]
____X____	Club activities	[ ][ ][ ]
____X____	Window shopping	[ ][ ][ ]
____X____	Taverns/cocktail lounges	[ ][ ][ ]
____X____	Theater/concert	[ ][ ][ ]

(13) About how much radio do you listen to each day in your home?

________________ [ ][ ][ ] (HOURS)

(14) About how much T.V. do you watch daily?

________________ [ ][ ][ ] (HOURS)

(15) About how much time do you spend doing recreational reading in your home each day?

________________ [ ][ ][ ] (HOURS)

(16) Other than for work, about how frequently do you visit downtown Alexandria during the daytime?

________X________ [ ][ ][ ] (PER YEAR)

(17) On the average, how long do you usually stay there?

______________ [| |] (HOURS)

(18) What about at night - do you ever go to downtown Alexandria? (IF YES) How often?

______ X ______ [|] (PER YEAR)

(19) And how long do you usually stay there?

______________ [| |] (HOURS)

(20) Do you ever go to any of your neighbors' houses on this street to visit or socialize? (IF YES) How often?

______ X ______ [|] (PER MONTH)

(21) Do you ever walk around your neighborhood for pleasure during the daytime? (IF YES) Other than walking your dog, if you have one, how often do you do this?

______ X ______ [|] (PER MONTH)

(22) Do you ever stroll around the neighborhood alone at night for pleasure? (IF YES) How often?

______ X ______ [|] (PER MONTH)

(23) What about with your children or friends - do you ever walk around the neighborhood at night for pleasure? (IF YES) How often?

______ X ______ [|] (PER MONTH)

ENVIRONMENTAL USAGE QUESTIONNAIRE

PART II: INDIRECT QUESTIONS - NEIGHBORHOOD

Now I would like to ask you some questions about your neighborhood:

(1) How long have you lived in this house?

____________________ [ ][ ][ ] (YEARS)

(2) Why did you leave your old neighborhood?

(1 = TO MOVE TO A LOW CRIME ENVIRONMENT OR TO ESCAPE A HIGH CRIME ENVIRONMENT)
(2 = LIKE IT, NICE, WANT TO RETURN)
(3 = ALL OTHER [PERSONAL, ECONOMIC, ETC.]) [ ]

(3) Why did you move to this neighborhood as opposed to other neighborhoods in this area?

(1 = LOW CRIME MENTIONED)
(2 = LOW CRIME MENTIONED OR NICE AREA, LIKE IT, ETC.)
(3 = OTHER REASONS, CRIME NOT MENTIONED) [ ]

(4) How likely is it that you will move away from this neighborhood in the next few years? [ ]

4	3	2	1
Very likely	Somewhat likely	Somewhat unlikely	Very unlikely

(5) For what reasons? [ ]

(1 = GOOD THINGS [E.G., THIS AREA, HOUSE, FRIENDS, ETC.])
(2 = NEUTRAL THINGS [E.G., PERSONAL ECONOMIC])
(3 = BAD THINGS [E.G., FEAR, CRIME])

(6) Overall, as a place to live, is this neighborhood:

1 Very nice	2 Quite nice	3 Fair	4 Poor	☐

(7) What are the good points of this neighborhood?

(1 = LOW FEAR OR LOW CRIME MENTIONED FIRST)
(2 = LOW FEAR OR LOW CRIME MENTIONED)
(3 = LOW FEAR OR LOW CRIME NOT MENTIONED) ☐

(8) What are the bad points of this neighborhood?

(1 = FEAR OR CRIME NOT MENTIONED)
(2 = FEAR OR CRIME MENTIONED)
(3 = FEAR OR CRIME MENTIONED FIRST) ☐

(9) (GIVE GREEN DECK TO RESPONDENT) Here are 9 cards which describe different characteristics of neighborhoods. Please rank them to show which aspect you like most about the neighborhood, what you like second best, and so on.

(I.D. NUMBER OF CARD)

(10) Now that you have these cards ranked, please divide them into three groups: The good things about the neighborhood, those you see as average, and the bad things about the neighborhood.

(1 = GOOD)
(2 = AVERAGE)
(3 = BAD)

PART II: INDIRECT QUESTIONS - COMMERCIAL BUSINESS DISTRICT

Now I would like to ask you some questions about the City of Alexandria:

(1) How long have you lived in Alexandria?

______________________ [ ][ ][ ] (YEARS)

(2) Why did you leave your old city or town?

(1 = TO MOVE TO A LOW CRIME ENVIRONMENT OR TO ESCAPE A HIGH CRIME ENVIRONMENT)
(2 = NICE, LIKE IT, WANT TO RETURN)
(3 = PERSONAL, ECONOMIC, ETC.) [ ]

(3) Why did you move to Alexandria as opposed to other cities in this area?

(1 = LOW CRIME MENTIONED FIRST)
(2 = LOW CRIME MENTIONED; OR NICE AREA, LIKE IT, ETC.)
(3 = OTHER REASONS CRIME NOT MENTIONED) [ ]

(4) How likely is it that you will move away from Alexandria in the next few years?

Very likely (4) Somewhat likely (3) Somewhat unlikely (2) Very unlikely (1) [ ]

(5) For what reasons?

(1 = LOW FEAR OR LOW CRIME MENTIONED FIRST)
(2 = LOW CRIME OR LOW FEAR MENTIONED
(3 = LOW CRIME OR LOW FEAR NOT MENTIONED) [ ]

(6) Overall, as a city to live in, is Alexandria:

1 Very nice	2 Quite nice	3 Fair	4 Poor	☐

(7) What are the good points about Alexandria?

(1 = FEAR OR CRIME NOT MENTIONED)
(2 = FEAR OR CRIME MENTIONED)
(3 = FEAR OR CRIME MENTIONED FIRST) ☐

(8) What are the bad points about Alexandria?

(1 = FEAR OR CRIME NOT MENTIONED)
(2 = FEAR OR CRIME MENTIONED)
(3 = FEAR OR CRIME MENTIONED FIRST) ☐

(9) (GIVE WHITE DECK TO RESPONDENT) Here is another deck of 9 cards which describe different characteristics of cities. Please rank them to show which aspect you like the most about Alexandria, what you like second best, and so on.

(I.D. NUMBER OF CARD)

(10) Now that you have these cards ranked, please divide them into three groups: The good things about Alexandria, those you see as average, and the bad things about Alexandria.

(1 = GOOD)
(2 = AVERAGE)
(3 = BAD)

ENVIRONMENTAL USAGE QUESTIONNAIRE

PART III: DIRECT QUESTIONS - NEIGHBORHOOD

Now I would like to ask you some questions about crime and safety in your neighborhood:

(1) How safe do (would) you feel walking alone in your neighborhood during the daylight?

1	2	3	4	
Very safe	Somewhat safe	Somewhat unsafe	Very unsafe	☐

(2) What about walking alone in your neighborhood when it is dark? How safe do (would) you feel?

1	2	3	4	
Very safe	Somewhat safe	Somewhat unsafe	Very unsafe	☐

(3) How safe do (would) you feel walking in your neighborhood in the dark with someone you know?

1	2	3	4	
Very safe	Somewhat safe	Somewhat unsafe	Very unsafe	☐

(4) When you think about the chances of getting robbed or beaten up or anything of that sort, would you say your neighborhood as compared to the other neighborhoods in town, is:

1	2	3	4	
Very safe	About average	Less safe	One of the worst	☐

(5) In the past year, do you feel the crime rate in your neighborhood has been:

1	2	3	4	
Much better	A little better	A little worse	Much worse	☐

(6) Are there any areas or places around here - that is, within a mile - where you would be afraid to walk alone at night? (IF YES) Please describe them to me. (PROBE)

(0 = NO PLACES MENTIONED)
(1 = ONE PLACE MENTIONED)
(2 = MORE THAN ONE PLACE MENTIONED) ☐

(7) Do you restrict your children from playing in any areas around here because you fear for their safety? (IF YES) Which areas? (PROBE)

(0 = NO PLACES MENTIONED)
(1 = ONE PLACE MENTIONED)
(2 = MORE THAN ONE PLACE MENTIONED) ☐

(IF YES OR NO) What about at night? (PROBE)

(0 = NO PLACES MENTIONED)
(1 = ONE PLACE MENTIONED)
(2 = MORE THAN ONE PLACE MENTIONED) ☐

DIRECT QUESTIONS - RESIDENCE

(1) When you are away from your home for the day or for an evening out, how much do you worry about someone breaking in?

1 Hardly at all	2 Very little	3 Somewhat	4 Very much	☐

(2) When you are away from your home for a weekend or longer, how much do you worry about someone breaking in?

1 Hardly at all	2 Very little	3 Somewhat	4 Very much	☐

(3) When you are away from your home for a weekend or longer, do you ask a friend or neighbor to keep an eye on your home?

1 Hardly ever	2 Sometimes	3 Often	4 Always	☐

(4) When you leave your (house/apartment), even if only for a short time, do you lock the doors:

1 Hardly ever	2 Sometimes	3 Often	4 Always	☐

(5) At night, how frequently do you lock your doors?

1 Hardly ever	2 Sometimes	3 Often	4 Always	☐

(6) When you or other family members are at home, do you keep the doors locked:

1 Hardly ever	2 Sometimes	3 Often	4 Always	☐

(7) Have you done anything to your house to protect yourself from crime, such as: (PROBE)

More or better locks

Firearms

Adding lights

Taking out insurance

Others

(0 = NO)
(1 = ONE THING)
(2 = TWO THINGS, ETC.)

☐

(8) When you park your car outside, do you lock the doors?

1 Hardly ever	2 Sometimes	3 Often	4 Always	☐

DIRECT QUESTIONS - COMMERCIAL BUSINESS DISTRICT

Finally, I would like to ask you some questions about crime and safety in the City of Alexandria.

(1) As far as crime goes in Alexandria, do you think that during the past year things have been getting:

1	2	3	4
Much better	A little better	A little worse	Much worse

(2) Do you ever worry about crime when you use the bus system here in Alexandria?

1	2	3	4
Hardly ever	Sometimes	Often	Always

(3) What about the Metro subway system?

1	2	3	4
Hardly ever	Sometimes	Often	Always

(4) How many times during the last month have you wanted to go somewhere in town but stayed at home instead, because you thought it would be unsafe to go there? (IF YES) Please describe this place.

(5) In general, how safe do you feel when walking alone in downtown Alexandria during the daytime?

1	2	3	4
Very safe	Somewhat safe	Somewhat unsafe	Very unsafe

(6) What about walking alone downtown when it is dark - how safe would you feel?

1	2	3	4
Very safe	Somewhat safe	Somewhat unsafe	Very unsafe

(7) How safe would you feel walking in Alexandria with a friend in the dark?

1	2	3	4
Very safe	Somewhat safe	Somewhat unsafe	Very unsafe

(8) How safe from crime do you feel when you go grocery shopping, that is, where you do most of your shopping?

1	2	3	4
Very safe	Somewhat safe	Somewhat unsafe	Very unsafe

(9) How safe from crime do you feel at the place where you shop for odds and ends?

1	2	3	4
Very safe	Somewhat safe	Somewhat unsafe	Very unsafe

(10) Are there any places in downtown Alexandria where you would not feel personally safe? (IF YES) Please tell me about them.

(0 = NOTHING)
(1 = ONE THING)
(2 - TWO THINGS, ETC.)

Age__________ Sex__________ Race__________

Others__________

8.2 Construction of Card Deck for Indirect-Prompted Measure

The EUQ contains a prompted indirect measure that consists of two decks of nine index cards on which are typed specific characteristics of the environment. To allow the respondents to more easily hold and view these decks, each environmental characteristic is typed in the upper left corner of the card. For purposes of identification, each deck consists of different colored cards and the cards are numbered on the back. The nine environmental characteristics used for the "Neighborhood" and "City" decks are listed below in the recommended order of presentation.

Neighborhood	City
1. Attractive	1. Good public transportation
2. Well maintained	2. Good schools
3. Clean	3. Prosperous
4. Convenient	4. Clean
5. Friendly people	5. Attractive
6. Safe from crime	6. Safe from crime
7. Quiet	7. Recreational opportunities
8. Well lighted	8. Cultural opportunities
9. Low traffic	9. Friendly people

9. Assessing the Environmental Correlates of Fear of Crime

When people are overconcerned about crime, they may restrict their behaviors and reduce their overall quality of life. For this reason, CPTED projects address both the crime rate and concern in a given environment. This section discusses approaches to environmental assessment that have as their objective the documentation of fear-producing elements in the community environment.

For purposes of discussion, it is assumed that the existence of the fear-of-crime problem (SPV>EPV) has already been found in the CPTED area through the use of the EUQ described earlier. Without formal evidence from the EUQ, it is quite possible that what could appear to be a fear-of-crime problem in an area could actually reflect inadequate measurement techniques. The procedures presented in this section are not designed to determine whether a fear-of-crime problem exists in a given area. Rather, given the existence of SPV>EPV, these procedures will allow the CPTED analyst to search for the environmental sources of the fear-of-crime problem in the CPTED area.

The present discussion may also be of value to the analyst working with a CPTED project area in which no major fear of crime exists. Concern about criminal victimization is present to some degree in every environment. It is possible that a review of the environmental correlates of crime discussed below will allow the CPTED analyst to discover and rectify minor but noticeable problems in his project area.

9.1 Causes of Fear and Concern

There are a large number of factors, in addition to high crime rates, that may be responsible for the fear of criminal victimization in one's residential area or in a place that one could visit. The fear-of-crime problem for a specific environment will be accounted for by some subset or weighted combination of these factors. The following sections describe three categories of factors -- physical, social, and general environmental.

9.1.1 Associating Crime with Physical Characteristics

It might be puzzling to attribute fear of crime to the amount of dirt or litter found in a given area, since litter in the streets appears to have nothing to do with burglary or robbery. However, the relationship between unpleasant physical characteristics and fear of crime can be accounted for by the associational model of environment and behavior.

Briefly, this model suggests that there are strong associations between certain types of behavior and specific attributes of the physical environment. These associations emerge because of the consistency with which certain activities tend to occur in specific environmental settings. After a period of time, the sight of a place, or even the mere name of a behavior setting (e.g., "the ghetto area") will evoke in the mind of the listener a collage of behaviors that could be expected to occur there. The high crime rate of the ghetto area becomes associated with the dirt and litter that also tends to characterize the area.

This association generalizes to other environments. Thus, an urban or residential setting that is somewhat dirty or littered suggests that it could be a likely place for a crime to occur. Since most people fear criminal victimization to one degree or another, it then becomes possible to attribute fear of crime in a particular environment to a series of physical factors, one of which is the dirtiness/litter factor.

Some other physical factors that elicit fear because they tend to be associated with high crime environments are discussed below.

9.1.1.1 Abandoned Spaces

Sometimes, certain areas of an urban environment are unused or temporarily abandoned. Such facilities can include buildings, railroad yards, docking facilities, and factories. Residential areas can contain abandoned homes that are boarded up and awaiting demolition or abandoned public facilities (such as parks or schools).

People can be apprehensive about criminal victimization when they are in an area characterized by abandoned facilities, because deserted structures often attract undesirable individuals (e.g., derelicts and drug addicts) and because fewer people are present to perform informal surveillance functions.

9.1.1.2 Inadequate Lighting

People who are not familiar with a given area will be fearful of going there if the area is poorly lighted. It makes little difference if crime seldom occurs in a particular setting; dark, poorly lighted, and foreboding areas will elicit a fear response of some degree in an individual. Thus, an area can have a fear-of-crime problem for no other reason than inadequate lighting.

9.1.1.3 Poor Maintenance and Repair

Lack of repair and poor maintenance of the physical environment can contribute to fear about criminal victimization in an area. Since rundown areas are typically inhabited by people of low socioeconomic status -- people who, as a group, suffer greater victimization than the general population -- visitors may justifiably feel apprehensive.

This effect can be caused by deteriorated interior environments as well as exterior spaces. One feels much more at ease in a new, well-maintained bus terminal than in a rundown, neglected facility.

9.1.2 Associating Crime with Social Characteristics

9.1.2.1 Social, Ethnic, and Racial Factors

Sometimes, differences exist between the characteristics and background of a potential visitor to an area and the subpopulation that inhabits the area. Ethnic or racial subpopulations often take over -- and call their own -- one section of an urban environment. A visitor to the area may be fearful of crime for a number of reasons: The stereotypes and prejudices that that person holds of the subpopulation, stories or rumors the individual can have heard about that area of town, a lack of familiarity with the environment, and the possibility of inadvertently violating cultural norms of the subpopulation.

9.1.2.2 Undesirable Individuals

People are often fearful of criminal victimization or other unpleasant interactions in an area that is frequented by winos, hustlers, prostitutes, derelicts, and similar individuals. Some people are particularly uncomfortable in this environment, not only because of the possibility of crime but also because they dislike being the recipients of stares, whistles, and shady remarks. Groups of teenagers congregating in recreational or shopping areas are also sometimes viewed as potential threats to personal security.

9.1.2.3 Too Few People in the Area

People feel that they will have a better chance against a criminal if there are other people present who could help them. A widely experienced urban phenomenon finds citizens working in and visiting a highly populated city during the daytime, yet regarding the very same area after 6 o'clock in the evening with fear and apprehension because too few people are there. When fear of crime for a specific area is found to fluctuate depending on the time of day, the reason typically will be related to variation in the number of people found in the environment at different times.

9.1.2.4 Few Social Networks/Low Social Cohesion

The absence of small stores and shops, apartments, and other public use areas in certain neighborhoods precludes the development of informal friendship patterns and social networks. For example, some parts of urban areas are little more than streets and sidewalks which are bounded by the long, monotonous walls of large factory buildings. Small alleyways might separate one building from another. The lack of windows in the brick walls affords little chance of street surveillance from the building. Devoid of factors that encourage social interaction and social cohesion on the part of the occupants, the street and sidewalk areas function only as a transportation corridor.

When in such an area, individuals tend to lose a sense of self-identity and feel quite alone. Just as an individual fears criminal victimization when there is no one around to help him, he will be fearful of crime if he senses disinterest or apathy on the part of those around him. Feelings of alienation or lack of self-identity when in certain urban areas can lead to fear of crime.

9.1.3 Associating Crime with General Environmental Characteristics

9.1.3.1 Inadequate Environmental Information Systems

People are usually a little apprehensive about visiting a new place. As the complexity of the new environment increases, the apprehension of the potential visitor or newcomer also increases. Apprehension is increased further if the environment is located in an area known to have undesirable physical or social characteristics, where a couple of wrong turns or selection of an unsafe parking space could be dangerous.

Lack of knowledge about an environment, or an absence of clear-cut directions on how to use the environment, can increase the chances of criminal victimization. This problem is particularly acute with the elderly (who typically experience more difficulties in physically moving from point A to point B, are slower to learn the intricacies of a new environment, can more easily become confused and spatially disoriented, and represent the most attractive targets for certain types of crimes). Thus, older people may feel particularly threatened and fearful in complex environments that suffer from inadequate environment information systems.

Architects and designers are aware of this and attempt to enhance the familiarization process by providing the user with important information concerning the environment. This information is provided in many forms, including street names and street signs, traffic signals, building addresses, building directories located in the lobbies, the numbering of floors and offices or apartments, schematic signs which instruct "you are here," and instructions on how to get from Point A to Point B.

9.1.3.2 Low or Nonexistent Visibility of Police or Security Personnel

Often, when an environment is characterized by one or more fear-generating factors, the occupants can experience feelings of anxiety if the presence of security personnel is not readily apparent. This is especially true of high-use public areas (such as train stations, subways, airports, large shopping malls, large sporting events, and high-rise apartment buildings). The sight of a uniformed police officer or guard is reassuring because it indicates that help is close by if it should be needed and, thus, criminals will probably go someplace else to commit their acts.

It might be found that, in a particular area, the people expect a much higher level of police or security visibility than is the case. This discrepancy between the expected and actual amount of visibility or interaction with security personnel could partially account for the fear-of-crime problem. Sometimes, simple changes in the routes and areas patrolled can provide greatly increased visibility for the local security forces.

9.1.3.3 Incompatibility Between Design and Function

An incongruence between the original design and purpose of a structure and its present use or function can result in an environment that is difficult to understand and use. For example, this can occur when a large, multistoried manufacturing building is converted for use as a distributor's outlet for retail goods. This incongruence contributes to disorientation, apprehension, and fear of criminal victimization on the part of the users of this environment.

9.1.3.4 High Noise Levels

Certain areas are characterized by high, intermittent noise levels. Such areas include communities surrounding modern airports, train stations, some coastal ship docking facilities, and some factory and manufacturing buildings. Some interior parts of buildings containing energy-generating equipment or other types of operating machinery can also be very noisy. People are sometimes uncomfortable in such areas because the loud background noise can mask cries for help from the victim of a crime. Women may be particularly apprehensive in noisy areas because they feel that screams are the most effective way to discourage an attacker, as well as to summon assistance.

9.1.3.5 Well-Publicized or Macabre Crimes

A small number of well-publicized and serious crimes can make people very fearful and apprehensive about a given environmental area. Such crimes include murders, rapes, serious assaults, and sadistic muggings. Fear about the well-being of one's children will follow a well-publicized kidnapping in a given environment.

If this factor is responsible for the fear-of-crime problem, it can readily be ascertained through discussions and interviews with the residents of the area. One persistent theme that might come out of those interviews is, "I tell ya, we're afraid to walk the streets at night, ever since those assaults occurred last summer." Another way of isolating this factor as the source of the fear-of-crime problem is through the experience and the familiarity of the CPTED team with the environment in question. Staff living in an area will know if a particular community is being plagued by serious crime problems of this nature.

Limited strategies are available to the CPTED planner to reduce fear caused by this factor. There is no direct way to alter the source of this fear. Indirectly, the spirit and morale of the community residents will be improved as they learn about the various facets of the CPTED project that is being designed and implemented for their community. However, that improvement will be lost if the promised implementation does not materialize within the expected time horizon.

9.1.4 Pockets of Fear

Another factor that should be considered during the initial analysis phase is the "pockets-of-fear" concept. The notion behind this concept is that the fear of crime will not be consistent throughout a given environmental area. Rather, there may be small pockets (or clusters) of fear-producing elements that, when sprinkled throughout a given environmental area, result in a threatening or fearful image. For example, a commercial environment might be generally clean and free of litter, while a certain alleyway could be very dirty and highly littered. The buildings, in general, could be well-maintained and in good repair, while three or four buildings scattered throughout the area could be very rundown. Policemen, in general, could be generally visible while, in certain parts of that commercial environment, the police never seemed to be around. Extremely high noise levels could be restricted to small pockets or areas in that commercial setting. One part of the commercial area could be poorly designed, difficult to use, and very confusing and disorienting. While no, one, fear-producing element tends to dominate the environmental area as a whole, the number and variety of small pockets of fear that are present in the area can summate and produce an environmentally based fear-of-crime problem.

The important notion is that the entire area might not be littered -- only *parts* will be littered. The entire area may not be poorly lighted -- only *parts* may be poorly lighted. Winos may congregate at one or two corners or alleyways, buildings may be abandoned in one section of the block, and so on. It is very easy to discover a fear-producing element that characterizes an entire area. After one visit, for example, a litter problem is obvious. On the other hand, it is very difficult to be sure that every pocket of fear in an environment has been identified.

9.2 Finding the Causes of Fear in the CPTED Community

The previous discussion illustrated many factors that might cause fear of crime in an environment characterized by only normal crime rates. If such a problem is found to exist, the CPTED team must examine this list of factors and isolate those responsible for the fear of crime problem. The remainder of this chapter discusses how to do this.

Figure 8 reproduces a questionnaire designed to help assess the fear-producing characteristics of the physical and social environment. There are 15 scales in the questionnaire that address each of the fear-producing factors described in this chapter. Additional scales request information from the respondent concerning frequency of visits to the area, fear of crime in the area, and other data, together with certain respondent biographical characteristics.

9.2.1 Using CPTED Team Members as Observers

Although the questionnaire in Figure 8 is designed for use by visitors to or residents of the environment in question, it can be profitably employed by members of the CPTED team. Indeed, the very important first step of any environment assessment procedure for fear of crime is a subjective environment analysis by the CPTED team. Individual team members should visit the environment in question, spending a day or two there, and direct their observation towards the host of fear-producing factors that can be present in the environment.

ENVIRONMENT ASSESSMENT QUESTIONNAIRE

Instructions

This questionnaire contains 15 environment description scales. Respond to the scales in the following manner. If you feel that the (1)* is VERY unusual or VERY usual, QUITE unusual or QUITE usual, or only SLIGHTLY unusual or SLIGHTLY usual, then check the appropriate scale category. For example, if you thought that the (2) was only slightly unusual, you would check as follows:

			X					
Unusual	Very	Quite	Slight	Neutral	Slight	Quite	Very	Usual

If you feel that the (3) is neutral on a pair of words, then place your checkmark in the center NEUTRAL space.

Although some words may appear similar, they all evaluate different aspects of environments. Respond to each scale individually and please do not be careless for we want your true impressions of the (4).

IMPORTANT:

(1) Place your checkmarks in the middle of spaces, not on the boundaries.

THIS — NOT THIS

___ _X_ ___ ___ ___ ___ ___X___

(2) Be sure you check every scale. Do not omit any.

(3) Never put more than one checkmark on a single scale.

PLEASE PROVIDE THE FOLLOWING INFORMATION ABOUT YOURSELF (5).

*See footnotes next page.

Figure 8. Environment Assessment Questionnaire (Page 1 of 3)

Footnotes for Previous Page

1. Name of environment; e.g., room, building, park, plaza, etc.
2. Same as 1 above.
3. Same as 1 above.
4. Same as 1 above.
5. Possible biographical questions:

Sex: Male ______ Age ______

Female ______

Resident of Neighborhood: Yes ______

No ______

Race: ______________

Transportation to Site ____________________

Address of your job ______________________

Income:			
	0 - 5,000	Year	______
	5,000 - 15,000	Year	______
	15,000 - 25,000	Year	______
	25,000 +	Year	______

Figure 8. Environment Assessment Questionnaire (Page 2 of 3)

ENVIRONMENT ASSESSMENT QUESTIONNAIRE

Describe this (type of environment) as it is at ___________ o'clock in the ___________. You are (alone/with friends) while visiting this area.

	VERY	QUITE	SLIGHT	NEUT	SLIGHT	QUITE	VERY	
Well Lighted	___	___	___	___	___	___	___	Poorly Lighted
Clean	___	___	___	___	___	___	___	Dirty
Well Maintained	___	___	___	___	___	___	___	Poorly Maintained
Beautiful	___	___	___	___	___	___	___	Ugly
Enough Policemen	___	___	___	___	___	___	___	Too Few Policemen
Crowded	___	___	___	___	___	___	___	Deserted
People Friendly	___	___	___	___	___	___	___	People Unfriendly
Many Shops/Stores	___	___	___	___	___	___	___	Few Shops/Stores
Quiet	___	___	___	___	___	___	___	Noisy
Easy to Use	___	___	___	___	___	___	___	Complicated to Use
Buildings Occupied	___	___	___	___	___	___	___	Abandoned Buildings
Unthreatening People	___	___	___	___	___	___	___	Threatening People
People Like Myself	___	___	___	___	___	___	___	People Unlike Myself
Well Designed	___	___	___	___	___	___	___	Poorly Designed
Safe	___	___	___	___	___	___	___	Unsafe

I visit this area about ___________ times per (week/month).

I tend to stay here about (minutes/hours).

Age ___________.

Sex ___________.

Figure 8. Environment Assessment Questionnaire (Page 3 of 3)

The environment assessment questionnaire is very useful in this regard. It provides an inclusive list of factors that should be observed, and the CPTED team member can check the degree to which he believes each factor to be present in the environment. Additional notes and observations should also be made at this time. With these data, profitable discussions can be held among CPTED team members. Each fear-producing factor can be individually discussed. Discrepancies between the checked responses of two individuals upon any specific factor will highlight these factors for attention. Although this is an informal and subjective procedure, it is well organized through the use of the questionnaire.

At this preliminary stage of analysis, questionnaires should be completed by both men and women. A man does not necessarily regard the environment the same way as a woman, and the environmental assessment will be incomplete without these inputs.

During this initial stage of analysis, CPTED team members should examine a number of the variables that could be related to fear of crime in the environment. The environment in question should be analyzed by the team at different times of the day and night. An area that is well-populated and intensely used during one time period can be deserted and perhaps threatening at another point in time. A bright and sunny daytime area can become dark and foreboding at night. Areas partially illuminated by spillover light from shopping centers or recreation fields may be totally dark after these lights are turned off.

Recreation areas that are widely used during the late afternoon and evening hours can be relatively deserted in the morning. The opportunities for fear-producing environmental elements to be variable over time are almost endless. The CPTED team should examine the temporal factor very closely during the initial stage of analysis. This will allow the formulation of ideas and hypotheses about fear in the environment that can be more accurately examined by formal data collection methods.

9.2.2 Residents of the CPTED Area as Observers

After the initial environment assessment is completed by the CPTED team, a more formal analysis involving the residents or users of an area should be made. In this stage, data are collected from a selected sample of individuals through the use of the environment assessment questionnaire presented in Figure 8. These data would be analyzed both to substantiate or reject hypotheses formulated by the CPTED team during the initial stage of analysis, and to uncover new sources of fear-producing stimuli in the environment. Designing a CPTED fear-reduction program without the benefit of a formal analysis is somewhat risky. The CPTED team will be assuming that their impressions and perceptions match those of the residents or users of the environment.

9.2.3 Methodological Issues

The sample of individuals selected to complete the environment assessment questionnaire in Figure 8 should come from the same population as those individuals who previously indicated that the fear-of-crime problem characterizes the environment in question. In other words, it would make little sense to give the environment assessment questionnaire to teenagers or adult male users of a small park when the majority of statements indicating fear of criminal victimization came from young mothers who used the park. Conditions that are fear-producing to one set of individuals may be completely innocuous to others. It is imperative that those people who have said, "Yes, I'm fearful about crime when I'm in that area," are the same people as those who are asked, "Okay, what is it that frightens you about this place?" To do otherwise would be tantamount to asking a person to discuss the possible sources of a problem when, in fact, no such problem exists.

When describing the questionnaire to a potential respondent, no mention should be made of the fact that the data will be used to analyze the fear-of-crime problem in the environment. This knowledge might bias the individual's responses and produce contaminated data. The respondent should become aware of this issue only after he has turned to the relevant section of the questionnaire and reads those items concerning the fear of crime.

In addition to the environment description scales, the questionnaire also contains some open-ended items. These questions are designed to gather information about the location of any pockets of fear in the area. Individuals should be encouraged to respond at length to these items and to include as much information as possible. The CPTED analyst may choose to include all, part, or none of these questions as a function of the time and resources available, as well as the need for this type of information.

Another method that is useful in uncovering pockets of fear involves a short (perhaps 10-minute) debriefing session with the respondent after the questionnaire has been completed. At the start of this session, the CPTED analyst will scan the responses to the environment description scales, isolating scales when responses indicate a potential source of fear of crime. The analyst will then involve the respondent in discussion of these particular scales, asking such questions as, "Why did you place the check mark here? What is it about the environment that makes you feel this way? What part of the building do you find particularly threatening?" Through the guidance provided by the environment description scales, discussions of this nature can often uncover additional pockets of fear.

CPTED TECHNICAL GUIDELINE 4

Use of Victimization Surveys

USE OF VICTIMIZATION SURVEYS

1. Introduction

This chapter gives an overview of the merits and limitations of victimization surveys and provides procedural guidance in undertaking such surveys. The discussion is based primarily on a review of the literature of what seems to work or not work with these types of surveys. It is assumed that the user is generally familiar with the advantages of survey methods but may not be specifically familiar with victimization surveys.

2. Value of Victimization Surveys

Victimization surveys are a data-gathering method for measuring the incidence of crime based on a sample of interviews with users of an environmental setting (e.g., commercial strip, neighborhood, or school). For several years these surveys have emerged as a satisfactory complement to police records. In addition to providing a more realistic estimate of the amount of crime, surveys can reveal precise information about geographic location, the circumstances surrounding crime incidents, the behavior of offenders and victims, the losses and injuries suffered, the attitudinal consequences of incidents, and other data which may not be uniformly available from police incident reports. (See Appendix C for a discussion of the advantages and disadvantages of using police data.) Moreover, surveys offer a potential method for evaluating crime prevention programs independently of police agencies.

A major drawback to undertaking a victimization survey is cost. Of all of the methods described in the AMH, victimization surveys are by far the most expensive because very large samples are required. In the case of CPTED projects, such surveys should be considered as an alternative to an examination of police offense reports rather than as a complement to them. If police data are not available or are incomplete, then the possibility of a victimization survey should be seriously assessed. However, even if the need is established, the CPTED planner should consult with a survey expert to ascertain what the cost is likely to be.

Given the above qualification, there are four basic ways in which surveys can assist CPTED planners:

- Generating accurate estimates of crime rates.
- Obtaining precise crime-environment data.
- Examining citizen responses to crime.
- Evaluating crime prevention strategies.

Each of these is addressed in some depth in the following paragraphs.

2.1 Generating Accurate Estimates of Crime Rates

Police statistics usually underrepresent the total volume of crime in an area, primarily because citizens do not report many crimes to the police.* Surveys conducted by the National Crime Panel (NCP) reveal

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*Not all crimes are equally underreported. Of the Part I index crimes, homicide and auto theft are reported to the police most frequently and larceny least frequently.

victimization rates two to three times higher than those known to the police. In some jurisdictions, the discrepancy between victimization surveys and police records is even larger. For instance, in a survey of three Washington, D. C. police precincts, 7,013 Part I crimes were found, compared to 307 recorded in the official police records. This is nearly a 23-to-1 ratio.

Obtaining more precise estimates is important for a CPTED project because, if there is a large discrepancy or if there is reason to believe that there is one, the analyst could get a false impression of the severity of the crime problem relying on police data alone. The best examples are rape and larceny because they are reported least often, but assault and vandalism are also more commonplace than one might infer from police data alone.

Police data are not necessarily a conservative estimate of crime either. With respect to geographic areas within cities, one cannot assume that a burglary rate of 5.18 per capita per 1,000 population reported by the police for an entire city reflects a "true" rate three times higher (15.54) and, therefore, warrants attention. It can be that, in a particular community, the burglary rate is not so serious as to justify a CPTED intervention program.

Another example is a neighborhood with a sharply increasing crime rate, which suggests that, if crime prevention strategies are not implemented, the community will deteriorate. In fact, the increase can be the result of a higher percentage of crimes being reported to the police. One 1974 victimization survey, which was compared to the U.S. Census survey in 1971-72, showed an actual decline in the burglary rate, whereas the UCR showed an increase. Closer examination revealed that the number of persons reporting burglaries to the police increased from 50 to 70 percent between 1971 and 1974. Thus, police data may reflect improved community/police relations.

2.2 Obtaining Precise Crime-Environment Data

Apart from the problem concerning the accuracy of police records, victimization surveys can provide the CPTED analyst with enough data to discern consistent crime-environment patterns. In the Washington, D. C., study noted in Section 10.2.1, it would be very difficult to try to study robbery patterns based on the 35 incidents reported to three police precincts. However, a great deal can be learned from studying the 1,082 robbery incidents obtained from the survey of the three precincts.

Interviews can also elicit information about the opportunity structure of crimes. In the case of burglaries, precise temporal information (such as month of occurrence, day-of-week, and -- if known -- time-of-day) is useful, because burglars tend to operate according to distinct patterns, and citizens and police patrols can be alerted. Another study showed that 61 percent of all burglaries in a Boston suburb occurred on weekends. Information about the physical characteristics of the environment (such as type and condition of dwelling unit), the place where the burglar entered and exited, and the nature of damage (if any) can also be obtained with little difficulty.

Interviewers can also record environmental features that may have facilitated the incident, such as noting that the offender climbed a trellis to a second-story window, or chose a house with no windows facing it from nearby houses, or selected a street with few outdoor lights. In a Portland survey, the interviewers counted the number of street lights visible from the respondent's doorstep. Thus, victimization surveys can be used to capture numerous details not usually available in police reports.

2.3 Examining Citizen Responses to Crime

One function of victimization surveys is to learn more about why incidents go unreported. A number of studies indicate that victims assume certain attitudes and limitations on the part of the police: Nothing can or will be done even if the incident is reported, the evidence is insufficient, the police do not wish to be bothered, too much time would have to be spent at the precinct or in court, the incident is really a private matter between the offender and victim, or fear of reprisal. Research sponsored by the National Institute of Law Enforcement and Criminal Justice (NILECJ) suggests that, even among those who bother to report incidents, the call comes in after some delay. Presumably, those individuals deliberated first over whether to call the police.
A closer examination of citizen attitudes and assumptions in the CPTED community can help to devise programs that increase citizen response time and, more generally, improve cooperation with the police. A likely result is that the official crime rate will increase, thus necessitating a subsequent survey to assess CPTED effects.

2.4 Evaluating Crime-Prevention Strategies

Surveys are useful for learning what people do to protect themselves. For example, it was found that the burglary rate was lower for households participating in a neighborhood-based property marking program and, further, that members of the participating households were more likely to report burglaries to the police. Ironically, the official data showed little change because these effects tended to cancel out each other. With police records, it is not possible to compare victims with nonvictims, nor are citizen crime prevention activities recorded by the reporting officer.

3. Undertaking a Victimization Survey

When undertaking a victimization survey, there are certain requirements and potential sources of invalidity of which the user should be aware. This section covers the topics of useful information that can be obtained, possible sampling errors, and possible measurement errors attributable to inconsistent or biased interview procedures.

3.1 Capturing Victimization Experiences

Victimization surveys are effective for obtaining information about only certain kinds of experiences. The following criteria are recommended for determining the types of incidents to probe: (a) Incidents involving a weapon; (b) personal attacks such as assault or rape; (c) breaking-and-entering into a home; (d) thefts with losses in excess of $50; and (e) successful auto thefts. These criteria emphasize incidents that are likely to represent salient events for the respondent and are clearly recognized as crimes. For example, in descriptions of circumstances surrounding actual assaults, entries on month and time-of-day are more reliable than in reports on threat of assault. The latter may be a matter of speculation on the part of the respondent, and he may be hazy about details. Similarly, information is more reliable on completed crimes (Has anyone broken into your house and stolen something when you were not home?) than on attempted crimes (Has anyone attempted to break into your house and steal something when you were not home?).

Because of their importance to CPTED planning efforts, it is also useful to find out about victimization experiences with respect to vandalism and stranger-to-stranger threat of assault, in spite of the fact that perceptions of what constitutes threat or willful acts of vandalism vary widely among people.

In the case of threat, it is important to ascertain in the interview exactly what defined the situation as threatening and whether the individual felt personally threatened. Such information is particularly useful for understanding the nature of fear in a given environment. Vandalism also engenders fear and is destructive to the environment, so it is important to establish what was damaged, in what way it was damaged, to what extent it was damaged and, most importantly, what made the respondent think that the damage was willful.

3.2 Suggested Interview Protocol

The structure of the interviews affects the amount of information obtained from respondents. For example, when the respondent is asked whether he has experienced a particular crime and responds "yes," to follow immediately with probes is less effective than screening all offense categories first and then returning to each experienced offense to probe for details. The former procedure tends to produce a "ceiling effect" on the reported number of incidents. The respondent becomes less conscientious during the course of the interview, with the result that the second half of the session will elicit fewer indicents compared to the first half. The respondent may not bother recalling incidents for the interviewer if he is bored or fatigued and knows that cooperation adds to the demands placed on him.

An interview protocol is presented in Figures 1 and 2 which briefly covers a minimum set of victimization information that a CPTED analyst should obtain from a survey. If the respondent has not experienced a crime during the 12-month reference period, the interview is likely to be completed in less than 10 minutes. With two or three such experiences, however, the session may last longer than 20 minutes, depending on the nature and complexity of the incidents involved.

The series of questions is referred to as an interview protocol because issues regarding the design and format of the questionnaire (such as the allocation of space and providing instructions to the interviewer) are being ignored. Moreover, it is assumed that this protocol is preceded by, or followed by, sections concerning relevant demographic and other background information. The analyst can also wish to incorporate this protocol into an attitude survey covering areas such as aspects of fear and evaluation of police services. It is recommended that the user seek consultation from a survey expert concerning the variety of ways in which the format can be structured, sections sequenced, questions worded, responses coded, and methodological approaches and costs associated with each.

In this illustration, the interviewer is instructed to probe only if the respondent (R) answers "yes" to any of the offense questions (1 through 13). For clarification, the *probe* questions in Figure 2 are labeled with letters (A through M). These probes cover the basic points of information necessary to determine degree of severity with respect to each incident, locational and temporal characteristics, and whether the incident was reported to the police. In addition, the respondent is asked to describe what happended in his own words and, if applicable, to describe offender characteristics.

3.2.1 What to Probe

The list of possible probe questions that can be asked in relation to a given incident is virtually endless. However, the number of questions has to be limited. The cost of long interviews is one reason but, more importantly, respondents are willing to devote only so much time to the interview. Interviews that last longer than 45 minutes risk fatigue on the part of both the interviewer and the respondent. Fortunately, few persons are victimized more than once or twice during a 12-month period and, hence, respondents are likely to be tolerant of several probes.

VICTIMIZATION QUESTIONS: Household and Individual Screen Questions

Now I'd like to ask some questions about crime. They refer only to the last 12 months -- between ____________ 1, 19__ and __________ 1, 19__.

(ASK QUESTIONS 1 THROUGH 13. ONLY COMPLETE PROBE QUESTIONS WHEN R ANSWERS "YES" TO ONE OF THE QUESTIONS BELOW.)

1. During the last 12 months, did anyone break into or somehow illegally get into your (apartment/home), garage, or another building on your property? (BREAKING-AND-ENTERING)

   Yes No D.K.

   How many times did this happen? _____

2. (Other than the incident[s] just mentioned) Did you find a door jimmied, a lock forced, or any other signs of an attempted break in? (ATTEMPTED BREAKING-AND-ENTERING)

   Yes No D.K.

   How many times did this happen? _____

3. (Other than any incident already mentioned) Was anything at all stolen that is kept outside your home, or happened to be left out, such as a bicycle, a garden hose, or lawn furniture? (LARCENY)

   Yes No D.K.

   How many times did this happen? _____

4. Did you have any property taken from your car, part or all of your car? (LARCENY)

   Yes No D.K.

   How many times did this happen? _____

5. Did anyone break into or try to break into your mailbox in the past year? (LARCENY)

   Yes No D.K.

   How many times did this happen? _____

6. Did anyone purposely destroy or damage anything belonging to <u>you</u>, including your apartment or car, such as breaking your windows or slashing your car's tires? (VANDALISM)

   Yes No D.K.

   How many times did this happen? _____

7. Did anyone you know enter your home with your permission, such as a neighbor or a repairman, and then steal something? (HOUSEHOLD LARCENY)

   Yes No D.K.

   How many times did this happen? _____

Figure 1. Victimization Questionnaire (Page 1 of 2)

8. During the last 12 months, did you have your pocket picked or purse snatched? (LARCENY)

Yes No D.K.

How many times did this happen? _____

9. Did anyone take something (else) directly from you by using force, such as a stickup, mugging, or threat? (ROBBERY)

Yes No D.K.

How many times did this happen? _____

10. Did anyone try to rob you by using force or threatening to harm you? (ATTEMPTED ROBBERY)

Yes No D.K.

How many times did this happen? _____

11. Did anyone beat you up, attack you, or hit you with something, such as a rock or bottle? (ASSAULT)

Yes No D.K.

How many times did this happen? _____

12. Did anyone try to attack you in some other way? (ASSAULT)

Yes No D.K.

How many times did this happen? _____

13. During the past 12 months, were you sexually assaulted, such as being subjected to exposure, attempted rape, or fondling?

Yes No D.K.

How many times did this happen? _____

(IF YES FOR QUESTIONS 1-13, GO TO PROBE QUESTIONNAIRE. IF NO, GO TO NEXT SECTION OF THE INTERVIEW.)

Adapted from the NCP Household Interview Schedule, U. S. Bureau of the Census.

Figure 1. Victimization Questionnaire (Page 2 of 2)

Probe Questions

Could you answer some questions about this incident for me? (THESE QUESTIONS FOLLOW AN AFFIRMATIVE RESPONSE TO QUESTIONS 1-13. THUS, THEY ARE REPEATED FOR EACH INCIDENT.)

A. What month did this crime happen?

Month_______________ 19__ or 19__

B. What time of day did it happen?_______ AM or PM

C. Could you describe where it took place?
(ASK FOR SPECIFIC LOCATION, SUCH AS INSIDE APARTMENT, PARKING LOT AT STORE, STREET NAME, ADDRESS, ETC.)

D. Could you describe what happened exactly?
(PROBE FOR DETAILS ABOUT ENVIRONMENTAL CIRCUMSTANCES, SUCH AS THE LOCATION OF BYSTANDERS, OUTDOOR LIGHTS IF THE INCIDENT OCCURRED AT NIGHT, WHAT R WAS DOING AT THE TIME, AND OTHER FACTORS THAT HAVE BEARING ON CPTED PLANNING.)

E. Was anything stolen?
What was stolen? (IF YES, LIST)

F. Did you or anyone else tell the police about the crime? (IF YES, SKIP TO H.)

G. Why wasn't the crime reported to the police?

H. Were you injured? (IF YES)
How were you injured?

I. Did you see who did it? Yes ____ NO ____
(IF NO, GO BACK TO VICTIMIZATION QUESTIONNAIRE.)

J. How many persons were there?

K. Could you describe this person (or persons)?

L. Did you recognize (this/any of the) person(s)? Yes ____ No ____
(IF NO, GO BACK TO VICTIMIZATION QUESTIONNAIRE.)

M. Does (this person/any of them) live around here? Yes ____ No ____

(IF THERE ARE MORE INCIDENTS OF THE SAME TYPE)

Now I would like to ask you about the other crime like this one. (GO TO A.)

Adapted from the NCP Household Interview Schedule, U.S. Bureau of the Census.

Figure 2. Probe Questionnaire

Victimization questionnaires are typically replete with "skip" instructions that direct the interviewer to particular clusters of questions, depending on the respondent's answer to a preceding question. The usual format of a survey is first to ask a question calling for a "yes," "no," or "don't know" response and, depending upon the response, to probe for specific information. If further information is not called for in the instrument, then the interviewer is told to skip to another section. Thus, there are probes within probes. As an illustration, probe questions taken from the NCP National Crime Survey Household Interview Schedule are presented below.* The referenced incident is a successfully completed burglary in which the offender was observed.

- Temporal Data:
  - In what month did this incident take place?
  - About what time did this incident happen?
- Locational Data:
  - In what state and county did this incident occur?
  - Did it happen inside the limits of a city, town, village, etc.?
  - Where did the incident take place?
  - (If private dwelling) Did the offender live there, such as a guest or workman?
- Offender Techniques:
  - Did the offender actually get in, or just try to get in the building?

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*Complete NCP interview forms and description of procedures can be obtained from the U.S. Department of Commerce, Bureau of the Census, Washington, D. C. 20233.

- Was there any evidence, such as a broken lock or broken window, that the offender forced or tried to force his way in the building?
- How did the offender get in?

- <u>If the Offender is Observed</u>:
  - Were you or any other members of this household present when this incident occurred?

    (If yes) Did the offender have a weapon, such as a gun or knife, or something he was using as a weapon, such as a bottle or wrench?

- <u>Extent of Injury</u>:
  - Did the offender hit you, knock you down, or actually attack you in any way?
  - (If no) Did the person threaten you with harm in any way?
  - (If no) What actually happened?

    Anything else?
  - Did you do anything to protect yourself or your property during the incident?

- <u>Offender Characteristics</u>:
  - Was the crime committed by only one or more than one person?

- (If one) Was this person male or female?
- How old would you say this person was?
- Was the person someone you know or was he/she a stranger?
- (If stranger) Was he/she white, black, other?
- Were you the only person there besides the offender?

- Extent of Loss:
  - Was something stolen or taken without permission that belonged to you or others in the household?
  - (If yes) What was taken that belonged to you or others in the household? Anything else?
  - (If cash only) Was all or part of the stolen money recovered, not counting anything received from insurance?
  - (If no) Was there any insurance against theft?
  - (If no) Did any household member lose any time from work because of this incident?
  - (If no) Was anything that belonged to you or other members of the household damaged but not taken in this incident?
- Reporting to the Police:
  - Were the police informed of this incident in any way?

- (If no) What was the reason this incident was not reported to the police? Any other reasons?
- Final instruction to interviewer: "Summarize this incident."

If the response to many of these questions had been "yes" instead of "no," the series of probes would be even longer. Thus, the CPTED analyst has to make some decisions as to what information will and will not be sought.

3.2.2 Classifying Incidents

In addition to gathering useful situational information, probes are helpful in classifying crimes more accurately. For instance, while probing an incident concerning household larceny, the interviewer can discover that someone who was home at the time was assaulted as the offender ran out of the house. NCP has a classification scheme that treats the larceny and assault incidents as one crime. Depending upon the extent of injury inflicted, the episode might be written up as "assaultive violence with theft," which is a more serious category than either "without theft, serious assault," or "burglary, something taken." In the NCP classification scheme, there are six major crime categories, each of which consists of subcategories (see Figure 3). Each victimization is classified according to the most serious crime that is reported. The variables of a given NCP definition of crime are consistent with UCR definitions, as shown in Figure 4.

Type of Crime	Conditions
PERSONAL CRIMES	
Assaultive Violence	
With Theft	Theft *or* Attempted Theft *or* Commercial Theft[1]
Rape	Rape—method of attack *or* type of injury
Attempted rape	Verbal threat of rape *or* attempted rape as method of attack *or* attempted rape injuries
Serious assault	
with weapon	Weapon present *and* any injury
no weapon	No weapon[2] and serious injury[3] *or* No weapon,[3] other injury[4] and hospitalized for 2 or more days
Minor assault	No weapon,[2] attacked, and minor injury[5] *or* No weapon,[2] attacked, other injury[4] and not hospitalized 2 or more days
Without Theft	No theft *and* no attempted theft *and* no commercial theft[1]
Rape	Rape—method of attack *or* type of injury
Attempted rape	Verbal threat of rape *or* attempted rape as method of attack or injury
Serious assault	
with weapon	Weapon present *and* any injury
no weapon	No weapon[2] and serious injury[3] *or* No weapon,[2] other injury[4] and hospitalized 2 or more days
Att. assault, w/weapon	Weapon present and threatened *or* Weapon present, attacked, and no injury
Minor assault	No weapon,[2] attacked, and minor injury[5] *or* No weapon,[2] attacked, other injury[4] and not hospitalized 2 or more days
Att. assault, no weapon	No weapon[2] and threatened *or* No weapon,[2] attacked and no injury
Personal Theft w/o assault	Theft *or* attempted theft[6]
Robbery	Theft
with weapon	Weapon present
no weapon	No weapon[2] and threatened *or* No weapon,[2] attacked and no injury
Attempted robbery	Attempted theft
with weapon	Weapon present
no weapon	No weapon[2] and threatened *or* No weapon,[2] attacked and no injury
Purse snatch, no force	No weapon,[2] not attacked, not threatened, purse taken, *and* property on person
Attempted purse snatch, no force	No weapon,[2] not attacked, not threatened, att. take purse, *and* property on person
Pocket picking	No weapon,[2] not attacked, not threatened, property on person, *and* cash or wallet taken
PROPERTY CRIMES	
Burglary	No right to be in home, etc.
Forcible entry	Got in *and* evidence of force
Nothing taken	No theft
Property damage	Something damaged
No property damage	Nothing damaged
Something taken	Theft
Unlawful entry w/o force	Got in *and* no evidence of force[7]
Attempted forcible entry	Tried to get in *and* evidence of force

Figure 3. National Crime Survey Classification Scheme for Crimes Against Individuals and Households (Page 1 of 2)

Larceny	Theft except motor vehicle *or* attempted theft except motor vehicle
Under $50	Sum of stolen cash and property value = $0-49
Under $10	Sum of stolen cash and property value = $0-9
$10-24	Sum of stolen cash and property value = $10-24
$25-49	Sum of stolen cash and property value = $25-49
$50 or more	Sum of stolen cash and property value = $50-19,998
$50-99	Sum of stolen cash and property value = $50-99
$100-249	Sum of stolen cash and property value = $100-249
$250 or more	Sum of stolen cash and property value = $250-19,998
NA amount	Amount of stolen cash NA *or* value of stolen property NA
Attempted larceny	Attempted theft except motor vehicle
Auto Theft	
Theft of car	Theft of car *and* no permission or permission, not returned
Theft of other vehicle	Theft of other motor vehicle *and* no permission or permission, not returned
Att. theft of car	Attempted theft of car
Att. theft of other vehicle	Attempted theft of other motor vehicle

[1] Includes attempted commercial theft.
[2] Includes "Don't Know" if weapon—victim must be present.
[3] Includes knife or gunshot wounds, broken bones, teeth knocked out, internal injuries or knocked unconscious.
[4] "Other" injury—can't tell if minor or serious.
[5] Includes bruises, black eye, cuts, scratches, swelling.
[6] Excludes commercial theft and attempted commercial theft. Victim must be present.
[7] Includes "NA" for evidence of force.

Source: Surveying Crime, p. 203.

Figure 3. National Crime Survey Classification Scheme for Crimes Against Individuals and Households (Page 2 of 2)

UCR	National Crime Panel
Rape	Rape with theft Attempted rape with theft Rape without theft Attempted rape without theft
Aggravated Assault	Serious assault without theft Attempted assault with weapon without theft
Armed Robbery	Serious assault with theft with weapon Robbery, no assault, with weapon Attempted robbery, no assault, with weapon
Unarmed Robbery	Serious assault, no weapon with theft Minor† assault with theft Robbery, no assault, no weapon Attempted robbery, no assault, no weapon
Simple Assault	Minor† assault without theft Attempted assault, no weapon, without theft
(Larceny)*	Purse snatch without force Attempted purse snatch without force Pocket picking

*UCR definition of larceny includes many more types of offenses than the personal confrontation crimes.

†Minor is defined to exclude weapons; presence of weapon automatically classifies assault as serious by NCP rules.

Source: Surveying Crime, p. 206.

Figure 4. Comparison of Classification Schemes Between UCR and NCP for Crimes Against Persons

3.2.3 Wording of Questions

Respondents are not usually aware of distinctions between such crimes as household larceny and breaking-and-entering, or pursesnatch and robbery, or even breaking-and-entering and robbery. Additionally, people have varying notions of what a "mugging" is. Therefore, it is important to ask questions in such a way that it is not up to the respondent to classify crimes. Rather than asking, "During the past 12 months, did anyone burglarize your home?" it would be better to ask, "Did anyone enter your home without your permission and then steal something?" This could be followed with a question about household larceny, "Did anyone enter your apartment with your permission, such as a neighbor or repairman, and then steal something?"

Similarly, it is important to remember that people perceive many events as criminal in nature. For example, a respondent might react to a wino using a neighborhood park bench as a threat. While the interviewer may not be interested in such events, it is desirable for two reasons to probe these incidents rather than go on to another incident category. First, the respondent becomes less certain of what constitutes a legitimate incident and, as a result, may not mention incidents that are important to the interviewer. Second, information about events that are perceived as criminal in nature can provide insights about the respondent's attitudes and behavior.

Persons may respond to a question by telling the interviewer about an unrelated incident. For example, the question, "Did you have any property stolen that you left outside of your home?" might elicit a description of an event concerning a wallet that was stolen in some other part of town. It is preferable first to note the incident in its proper place in the questionnaire, "Did you have anything stolen from you when you were away from home?" and then go back to clarify the earlier question. If the meaning of the question is clarified first, both the respondent and the interviewer may fail to recall the larceny incident away from home when the appropriate question is asked.

3.2.4 Continuous Versus Discrete Incidents

There are some crimes that are continuous in nature, or are perceived as such by the respondent. In some cases, it is misleading to classify frequently observed occurrences as separate incidents. An example is vandalism. A question such as, "Has anyone purposely destroyed or damaged anything belonging to you?" might elicit reports of recurring incidents: "People tear down our fence every time they use the front yard for a short cut to the back alley." Such intermittent incidents should be recorded as a single incident, noting that it is recurrent in nature, rather than attempting to ascertain the actual number of times it happened during the reference period.

On the other hand, some periodic incidents can be considered discrete by the respondent and are best treated as such. For example, if yard ornaments are stolen one time and garden tools another, it is appropriate to probe these incidents separately.

3.3 Sampling Considerations

The first step in undertaking a survey is to define the population from which a sample is to be taken. This is important because the victimization results based on the sample will be generalized to that population. A member of the population is frequently referred to as an element (or sampling unit). Elements can be defined as organizations, owners of business establishments, students, residents, or households. A victimization rate would be based on the number of elements victimized relative to the total number of elements within the defined population.

3.3.1 Selection of Population Subgroups

In most instances, a complete census of the population is not available, in which case a survey of a sample is used to estimate population characteristics. The extent to which one can have confidence that the sample is an accurate reflection of the population depends on the sampling procedures adopted. Sampling plans involving various forms of stratified random samples (such as area probability samples) can be extremely complex and should be designed by experts.

For residential and commercial areas, surveys typically define elements as households and business establishments, respectively. Individuals are then chosen on a random basis within each sampled household or business. For a number of practical reasons, surveys frequently limit the selection of respondents to adults, sometimes interviewing either the head of household or spouse. However, some research has suggested that it is important to survey minors because their experiences with crime are quite different from those of adults and are more widespread than police records indicate (a high percentage of juvenile incidents go unreported). The NCP sampling procedures currently include persons aged 12 and over.

Before conducting the survey, the CPTED analyst should decide what population subgroups in the community should be included in his or her sample because the decision affects the sampling strategy. For example, if he or she felt that is was important to survey elderly persons, it could be necessary to oversample this subgroup because these individuals are not sufficiently numerous to show up in a random sample of the community. A random sample of 200 residents might produce 10 to 15 residents over the age of 60. If the elderly tend to be clustered in a particular section of the community, that section could be sampled more intensely, ensuring that at least 40 such residents show up in the total sample. Oversampling subgroups presents problems in estimating victimization rates for the community. However, there are statistical procedures that take into account oversampling.

With respect to business establishments, the police departments in Chicago and Boston have provided lists from which samples could be drawn. However, subsequent investigation revealed that these lists were not complete, thus presenting difficulties in designing a representative sampling plan. Thus, area probability sampling procedures are preferred, in spite of increased sampling costs.

Area probability sampling is not the most suitable scheme for all commercial enterprises. There are numerous establishments whose members are not tied to a given place and therefore are not likely to be available for interviews. For example, taxi drivers experience a high percentage of robberies but are not likely to be included in an area probability sample. An alternative approach is to obtain a listing of fleet drivers and draw a random sample from the list. However, this would not include those drivers who operate independently of fleets. The task of arriving at a representative sampling plan for such populations requires some creative thinking on the part of the researcher.

The selection of respondents within businesses should include employees as well as owners for each business. Employees are not always able to provide information that owners can, particularly regarding the economic costs of crime. On the other hand, few businesses keep records of crime incidents, and it is usually an employee who is responsible for spotting and reporting incidents to the police.

A typical problem for people who study crime concerns the lack of a sufficient density of incidents. For example, if an investigator wished to study a particular group of victims -- not less than 40 individuals who had been assaulted during the past year -- he would have to estimate roughly the percentage of persons who are likely to have experienced that crime in the sampling area. If only 2 percent are expected to report assaults in any survey, then in order to produce 50 such victims, he would have to interview about 2,500 people. Household crimes occur more frequently, so that a sample of 500 is likely to produce 50 or more breaking-and-entering cases, but personal crimes occur so rarely that, on a per capita basis, very large samples are required to accumulate usable subsamples. As cited earlier, the NCP national sample revealed about 800 robberies among 9,500 black male adults during a 6-month period, which is approximately 8 percent.

3.3.2 Accuracy Range and Confidence Level

A "true" victimization rate for a given type of crime is the rate calculated on the basis of a complete census of the population of interest (school, neighborhood, etc.); that is, if everyone were polled, the true assault rate would be the percentage of persons who reported assaults (this assumes that all members of the population are aware of being assaulted and faithfully report the incident). Since a complete census is rarely taken (it is a costly and inefficient way of collecting data), one can never be certain what the *true* rate is. However, an estimate of the true rate can be inferred from a sample. The accuracy of the estimate depends upon the sample size, the population size, and the obtained sample victimization rate.

For example, if it were supposed that a sample of 250 individuals revealed that 6 percent were assaulted during the year, how confident could the surveyers be that the sample percentage was close to the population percentage? There is a statistical equation that provides estimates of the closeness of the sample rate to the population rate in relation to different sized samples. This equation, which involves the use of a statistic called the standard error, requires that the surveyer define his or her desired accuracy range and confidence level. With respect to the accuracy range, the surveyer may wish to select a sample that will reveal a victimization rate that is accurate within two percentage points, plus or minus, of the population rate. The confidence level estimates the percentage of times one would expect a sample drawn many times to fall within the defined accuracy range. Once the standard error of an estimate is determined, one can derive probable upper and lower limits on the victimization rate that would be obtained in a complete survey. Thus, a sampling plan can be devised that assures that, 90 percent of the time, the percentage of assaults, based on the sample, differs by no more than 2 percent from the population percentage.

Looking at this from another perspective, one could ask, if 100 such samples were drawn, how many times would the sample percentage differ from the population percentage by more than 2 percent? The answer is probably no more than 10 times. These are pretty good odds but, in the case of the assault example, the investigator can discover that, to satisfy his desired accuracy range and confidence level, a sample of no less than 1,000 individuals is needed. If this is too costly, his first option could be to lower the confidence level. He may find that, by reducing the confidence level to 80 percent (which is still reasonably high) yet maintaining the same accuracy range, a reduced sample is probably sufficient. Additionally, if the surveyer decided that the accuracy range could be relaxed (e.g., expanded from 2 to 3 percentage points) then, at the 80 percent confidence level, the sample size could be reduced further.

As an illustration, suppose a surveyer wishes to estimate the burglary rate in a residential neighborhood of 2,775 dwelling units by interviewing heads of household. He would like the sample estimate to be accurate within two percent, plus or minus, 90 percent of the time. He also guesses that the survey will generate a burglary rate of between 100 and 200 incidents per 1,000 households, so he arbitratily selects 150 per 1,000 incidents as the rate to include in the equation for computing the standard error. Using this formula, he would find that a sample of about 600 interviews would probably satisfy his requirements. If he relaxed the accuracy range to 2.5 percent, plus or minus, a sample of 500 would probably suffice; if he relaxed the confidence level to 80 percent a sample of 400 would suffice.

The point of this illustration is that sampling is a complex matter requiring several decisions to be made jointly by the surveyer and the sampling specialist. A related consideration is that large samples are required to satisfy reasonable accuracy ranges and confidence levels.

3.4 Nonsampling Errors

Nonsampling (or measurement) errors refer to factors that reduce the accuracy of a survey even if sampling errors were nonexistent (i.e., a complete census of the population were obtained). Such errors can be traced to the behavior of respondents or interviewers, the design of the survey instrument, or editing and processing mistakes. There are numerous texts that describe the potential sources of nonsampling errors for surveys in general. This discussion is limited to identifying those errors that have been reported in the literature as having application to victimization surveys.

3.4.1 Reference Periods and Memory Decay

Victims often do not recall all relevant events, even those reported to the police a few months earlier. A consistently observed phenomenon is that, the longer the period between an incident and the interview date, the less likely the incident will be remembered. In a sample of individuals who were on record as having been victimized and reported a crime to the police during the prior 12 months, 20 percent forgot to mention the reported incident during the interview. It was observed that the number of incidents recalled was higher during the most recent 6 months than for the previous 6 months.

If the incident is remembered, there are still memory problems about details. Month of occurrence, for instance, is readily forgotten or misreported. The tendency to forget details increases sharply after 3 months have passed. One approach suggests the use of temporal anchors; that is, rather than asking for victimization experiences during the past 6 months, the interviewer might select a significant date as the starting point (e.g., "... since Labor Day...").

It is the popular consensus that the reference period should not be longer than 12 months and preferably less. A 6-month period, for example, would likely produce more accurate victimization details, but fewer incidents would be recalled compared to the one-year period. As a result, there is a trade-off between sample size and recall accuracy.

If 400 interviews generate 50 household-related incidents over a 12-month period, 800 interviews might be required to produce the same number for a 6 month period, or 1,200 for a 3-month period.*

3.4.2 Telescoping

There is a tendency for people to report victimizations that occurred beyond the reference period defined by the interviewer. Such telescoped events are typically recalled as having occurred during the early months of the reference period. Moreover, there is a tendency for people to telescope incidents forward within the reference period (i.e., people recall incidents as having occurred in a more recent month than the one in which it actually occurred). In some cases, there is backward telescoping, where the respondent reports an incident earlier in time than its actual occurrence.

A procedure for dealing with forward telescoping is to define a reference period longer than the one actually used for data analysis (e.g., ask the respondent to recall events during the last 12 months and study rates based on only the last 6). This would control telescoping *into*, but not telescoping *within*, the reference period.

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*Since recall is higher in shorter reference periods, it may be more realistic to expect to achieve the desired criterion (50) with 750 interviews for a 6-month reference period and with 1,000 interviews for a 3-month period.

3.4.3 Purposeful Distortions

Respondents may not wish to reveal certain incidents (such as rape experiences) or, for insurance purposes, they may report excessive harm or losses resulting from a crime. Victims are also reluctant to report incidents involving neighbors or friends.

3.4.4 Demand Characteristics

There is a tendency among respondents to accommodate what they perceive as wishes or expectations on the part of the interviewer. The typical respondent is likely to find himself in the position of repeatedly giving negative replies to questions, since a comparatively small proportion of people are victimized during a 6- or 12-month period. He or she can perceive this as being frustrating to the interviewer and, wishing to accommodate him, may telescope or fabricate events.

3.4.5 Output Restrictions

Some individuals who have an incident to report have manifested an attitude that their role has been fulfilled (i.e., their cooperativeness had been established) and, therefore, it is not necessary for them to jog their memories further.

3.4.6 Proxy Respondents

Some household surveys attempt to gather information from one person about the personal crimes of everyone in the family, but this has proven problematical. Respondents are unfamiliar with the details or can report them inaccurately. For some types of incidents (e.g., robbery with the use of a weapon), it would seem likely that all family members would remember it. The recall of larceny incidents is less likely. Even if incidents are remembered, respondents are hazy about details.

CPTED TECHNICAL GUIDELINE 5

Application of Quantitative Analytic Techniques

APPLICATION OF QUANTITATIVE ANALYTIC TECHNIQUES

1. Introduction

This guideline describes statistical techniques that can be useful for summarizing and interpreting numerical data. Although the illustrative examples in this section are based primarily on police records, it is important to understand that the procedures and principles set forth are applicable to other data sources (e. g., attitude surveys and behavioral observations) from which quantifiable information can be collected.

The operating assumption is that the user has limited knowledge of statistics but would like to know in what ways statistics can be helpful in diagnosing crime-environment problems and in evaluating crime prevention strategies. This chapter is not intended to provide the user with the necessary skills for undertaking statistical analyses. There are many texts available that serve this purpose very well. Rather, the intention is to provide the user with an understanding of how numerical data can be manipulated to extract useful information so that, when the user seeks consultation from a statistician, he does so with a better understanding of what is possible.

The guideline is divided into five technical discussions. The first gives some examples of how data can be organized and presented. The second introduces statistical procedures commonly used to describe the numerical characteristics of a set of data. The third covers methods for testing hypotheses and comparing population samples. The fourth covers sampling methods. And the last focuses on reliability, validity, and related measurement issues.

1. Tabulation of Data

Suppose that a CPTED analyst wishes to determine the crime situation in his jurisdiction. He might go to a local police precinct and, rather than poring through hundreds of Offense Reports, ask the person in charge of crime statistics whether the data in the Offense Reports have already been tabulated and summarized. The CPTED analyst could be presented with a frequency table that gives a breakdown of the absolute number of reported incidents by type of crime and census tract. Table 1 is a frequency table for crimes committed within the County of Arlington, Virginia. The column on the right labeled "Total" and the bottom row, also labeled "Total," are called marginals. The term cross-tabulation refers to a process in which the interaction of two or more categories can be studied. For example, of the 12,041 crimes reported to the Arlington police in fiscal 1975, there were 96 larceny incidents in census tract 1.

Frequency tables can be more than two dimensional. For example, Table 1 could be three-dimensional, with type of crime being cross-tabulated with census tract and fiscal year (e.g., 1974, 1975, and 1976). A fourth dimension might be the time of day. A useful way of presenting tabular data with four or more dimensions is presented in Figure 1. As can be seen, when several variables are being cross-tabulated, the tables become complex and large. Fortunately, computer programs can produce complex tables quickly and inexpensively.

Cross-tabulation is a necessary procedure for discovering relations among variables and identifying crime/environment problems. However, it is up to the analyst to decide what variables to cross-tabulate. In Table 1, only eight types of crime are tabulated. If

TABLE 1

Tabulation of Type of Crime by Census Tract in Arlington, Virginia

MONTH LAST YEAR (8/74 – 7/75)

TRACT	HOMICIDE	MANSL.	RAPE	ASSAULT	ROBBERY	BURG.	LARCENY	VAND.	TOTAL
1	0	0	0	19	6	18	96	50	[illegible]
2	0	1	0	24	3	50	138	82	298
3	0	0	0	13	0	43	77	85	213
4	0	1	0	5	0	23	56	31	116
5	0	1	1	16	5	35	122	68	248
6	0	0	1	13	4	17	93	47	175
7	0	0	0	35	7	71	159	68	330
8	0	0	0	17	11	19	59	17	123
9	0	1	1	49	4	40	133	43	270
10	0	0	0	12	3	32	75	30	152
11	0	0	0	22	6	25	[illegible]	60	137
12	0	0	0	6	7	12	50	23	[illegible]
13	1	2	3	33	4	55	163	120	[illegible]
14	0	0	1	58	15	115	418	127	[illegible]
15	0	0	2	36	9	57	236	82	[illegible]
16	1	1	2	43	16	105	684	55	[illegible]
17	1	0	7	42	29	79	278	58	[illegible]
*18	1	0	6	142	18	72	479	126	[illegible]
19	0	1	0	15	2	21	146	40	[illegible]
20	0	0	1	44	18	115	237	96	[illegible]
21	0	0	0	8	2	15	59	33	117
22	2	0	2	67	16	53	200	85	425
23	0	0	1	42	3	38	106	47	237
24	1	0	1	41	3	34	150	104	334
25	0	0	1	36	13	37	226	91	[illegible]
26	0	0	1	24	8	30	109	34	200
27	0	0	1	21	2	25	82	27	158
28	0	0	4	55	6	49	161	53	328
29	1	0	5	71	32	193	302	82	686
30	0	0	0	11	2	41	65	14	133
31	0	0	1	72	14	68	93	48	296
32	0	1	2	37	15	66	214	50	385
33	0	1	0	6	1	22	33	8	71
34	1	2	1	28	26	53	348	35	494
35	0	1	0	12	15	35	167	32	262
36	1	1	1	26	21	46	183	35	314
37	0	0	0	11	4	38	96	18	167
38	0	0	1	36	13	42	166	31	289
TOTAL	10	14	47	1237	363	1629	6343	2138	12,041

DEFINE: Homicide = Murder & non-negligent manslaughter
Manslaughter = Negligent manslaughter (primarily motor vehicle fatalities)
Rape = Rape by force, attempted rape by force (does not include statutory)
Robbery = All types of Robbery
Burglary = All types of burglary
Larceny = All types of larceny (excludes motor vehicle theft)
Vandalism = All types of Vandalism

NOTE: -This report assumes the reporting address is located in the same Census Tract as the address of the offense. Additionally, the data identified in this report is an accurate representation as of the date the source computer report was issued (i.e. the current master file status). The report does not consider whether or not a case was or was not unfounded.

-Totals for the County may vary ± 2 for some counts were in invalid Census Tracts-system errors.

-These are frequencies for offenses where reports are filed by the officer.

*Census Tract 18 is inflated due to specific geographic locations of certain offenses not being known at the time of the report.

Census Tract	Time of Day	Homicide			Manslaughter			Rape		
		1975	1976	1977	1975	1976	1977	1975	1976	1977
1	T1									
	T2									
	T3									
2	T1									
	T2									
	T3									
3	T1									
	T2									
	T3									
4	T1									
	T2									
	T3									

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37	T1									
	T2									
	T3									
38	T1									
	T2									
	T3									

Figure 1. Four-Dimensional Table Showing Cross-Tabulations Among Census Tract, Type of Crime, Time-of-Day, and Fiscal Year

the analyst feels that motor vehicle thefts are also important, he could have to go directly to the Offense Reports and count the number of auto thefts in each census tract.

Cross-tabulation is also useful for showing relative as well as absolute frequencies. For example, Table 1 reports 6,343 cases of larceny. The apparent magnitude of this number is more clearly revealed when it is compared to the total number of incidents (12,041), thus showing that larcenies represent 53 percent of all cases. Figure 2 illustrates the percentage distribution of all eight crime categories listed in Table 1.

A key distinction between absolute and relative frequencies is that the former provides a basis for analysis, while the latter facilitates interpretation. Numbers tend to take on greater significance when they are compared to one another than when they are studied in isolation. It is useful to know that census tract number 14 has 734 incidents. It is perhaps more useful to know that this represents 6.1 percent of all cases, which is more than double the tract average (2.6 percent).

2.1 Calculating Rates

Deriving insight from frequency distribution comes not only from examining percentages but also from calculating crime rates (e.g., comparing the number of incidents to the number of persons in an area). Crime rates present the absolute number of incidents to a standard population size. If two areas each have 19 reported assaults, one is given the impression that, with respect to this particular crime, the situation is comparable. On the other hand, if the first area has a residential

PERCENTAGE DISTRIBUTION OF CRIMES

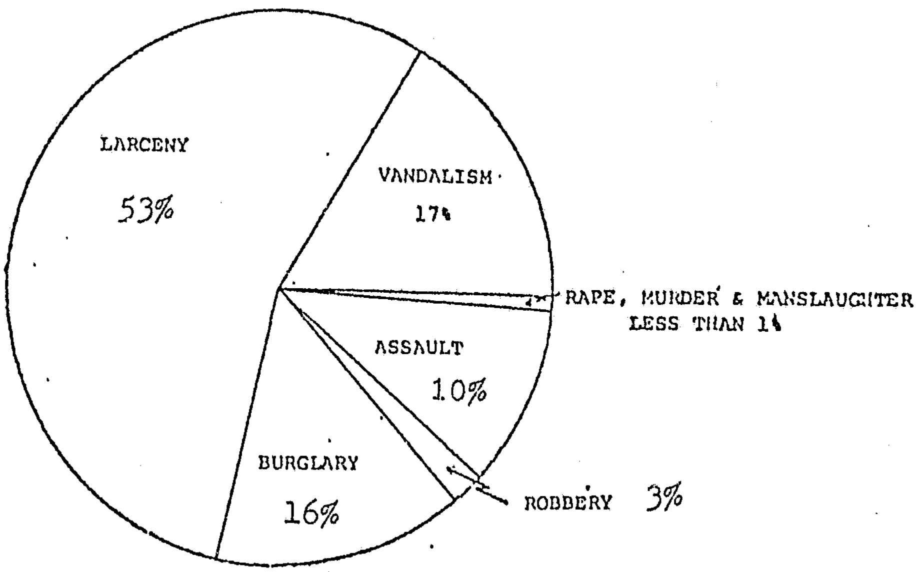

Figure 2. Conversion of Absolute Frequencies into Relative Frequencies

population of 4,500 and the second area 8,500, the per capita rates would be .00422 and .00223 per person for each of the respective areas.

For small geographic areas, these rates typically are standardized to populations of 1,000 -- hence, the figures change to 4.22 and 2.23 respectively. A comparison with the national asasult rate (2.27 per 1,000*) shows that the first area has a high rate, whereas the rate in the second area is normal.

Not all persons are equally vulnerable to all crimes, and not all crimes should be standardized to residential populations. Examples are pursesnatches and burglaries. Women are the target of offenders for the first example and dwellings for the second example; thus, rates should be calculated according to the appropriate target population. The procedure of calculating rates based on the number of targets versus per capita population is often referred to as the opportunity index.

Table 2 provides an example based on reported crime data obtained from the Willard-Homewood Neighborhood in Minneapolis, Minnesota. During 1974, there were 735 reported crime incidents in the neighborhood. Residential burglary constituted 33.9 percent of the reported crimes, larceny 19.0 percent, simple assault 14.4 percent, and auto theft 11.3 percent. Residential burglary exhibited the highest opportunity index, with 9 incidents per 1,000 dwellings.** These results suggested that the focus

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* Estimated rate in 1975.

**The per capita burglary rate was 1.6 per 1,000.

TABLE 2

Reported Crime Data and the Opportunity Index

Type of* Crime	Number of Incidents	Percent of Total Incidents	Opportunities** for the Crime	Opportunity Rate Incidents/1,000
Street Robbery	32	4.3	8800 Residents	0.4
Aggravated Assault	35	4.8	8800 Residents	0.4
Simple Assault	105	14.4	8800 Residents	1.2
Residential Burglary	249	33.9	2775 Dwellings	9.0
Commercial Burglary	41	5.6	***	***
Pursesnatch	26	3.5	2900 Women	0.9
Larceny	140	19.0	8800 Residents	1.6
Residential Robbery	6	0.8	2775 Dwellings	0.2
Commercial Robbery	9	1.2	***	**
Rape	9	1.2	2900 Women	0.3
Auto Theft	83	11.3	***	***
TOTALS	735	100.0		

* The term Type of Crime refers to the Police Department classification of offenses and does not necessarily denote the environmental setting in which they occurred. For example, Commercial Burglary includes all incidents in nonresidential settings.

** While not complete, these opportunity indices are presented to focus attention on the variation in potential crime targets. Rather than always calculating crimes per capita of population, rates should be relative to the number of targets (i.e., dwellings for burglaries, women for rapes, etc.).

***Data not available.

CONTINUED

3 OF 5

of CPTED planning should be on property crimes and simple assaults, since they represented the offenses most likely to occur in the neighborhood.

Another useful comparison, in terms of ascertaining the severity of crime in a particular jurisdiction, is to use the citywide crime data as a frame of reference. Table 3 compares crime rates between the Willard-Homewood Neighborhood and the city of Minneapolis as a whole. The Willard-Homewood Neighborhood data were obtained by analyzing the 1974 Minneapolis Police Department crime reports, while citywide data were obtained from the 1974 Uniform Crime Reports (UCR). Violent crimes include rape, street robbery, residential robbery, commercial robbery, aggravated assault, and simple assault. Property crimes include residential burglary, commercial burglary, larceny (including pursesnatch), and auto theft.

For violent crimes, the Willard-Homewood Neighborhood experienced 9.3 incidents per 1,000 inhabitants versus 9.1 for Minneapolis. The total violent and property crimes rates were 61.1 for the Willard-Homewood Neighborhood and 78.9 for Minneapolis.

A comparison of the proportions of crimes to population between the Willard-Homewood Neighborhood and Minneapolis shows that 2.3 percent of the violent crimes in Minneapolis occurred in the Willard-Homewood Neighborhood, while the neighborhood contained only 2.1 percent of the Minneapolis population. In contrast, only 1.8 percent of the total property crimes in Minneapolis occurred in the Willard-Homewood Neighborhood. Overall, the Willard-Homewood Neighborhood sustained 1.9 percent of the total crimes in Minneapolis versus 2.1 percent of the population. The conclusion from these findings was that the Willard-Homewood

TABLE 3

Rate of Crime/1,000 Persons in the City of Minneapolis and the Willard-Homewood Neighborhood

Crime Type	Rate/1,000 Persons Minneapolis	Rate/1,000 Persons Willard-Homewood	% of Crimes/% of Population (Willard-Homewood to Minneapolis)
Violent Crime			
Aggravated Assault	3.4	4.0	2.4/2.1
Street Robbery (Residential Robbery (Commercial Robbery (	4.8	5.3	2.3/2.1
Property Crime			
Residential Burglary (Commercial Burglary (	24.9	32.9	2.7/2.1
Larceny	33.5	18.8	1.2/2.1
Total Violent Crime	9.1	9.3	2.3/2.1
Total Property Crime	69.8	51.8	1.8/2.1
Total Violent & Property Crimes	78.9	61.1	1.9/2.1

(1) Based on 1974 UCR data for Minneapolis and 1974 police incident reports for the Willard-Homewood Neighborhood.

(2) UCR reporting procedures lump all robberies together; therefore, for purposes of comparison, the same has been done for the Willard-Homewood Neighborhood during computation.

(3) UCR reporting procedures lump all burglaries together; therefore, for purposes of comparison, the same has been done for the Willard-Homewood Neighborhood during computation.

Neighborhood sustained slightly higher violent crime rates and lower property crime rates (due to larceny) than the city of Minneapolis as a whole.

3. Use of Descriptive Statistical Techniques

The illustrations in Section 2 are intended to demonstrate the utility of cross-tabulation and the need to compare absolute frequencies with various frames of reference to interpret the findings. This section introduces the user to some basic descriptive and inferential statistical techniques. Descriptive techniques are essentially the application of various methods for summarizing data. Inferential statistical techniques apply to data gathering situations in which only a portion or sample of the data is obtained. These methods specifically address the problem of how the results from the sample can be used to generalize to the entire data set from which the sample was taken.

3.1 Dimensionalizing Variables

All variables are labels employed to identify cases that fall within preselected classes (e.g., larceny or burglary, census tract 3 or 18, 1974 or 1975). Some variables consist of only two classes, such as sex of victim (male or female). In the example of Table 1, the fiscal year variable could include any number of categories. This latter variable is open-ended because there is no logical beginning or ending point, only an arbitrary one. For example, the analyst might begin with the very first year that crime data were collected by the Arlington Police Department and end with the current year.

Variables can also be classified by their measurement properties. In Figure 1, four variables were identified: Type of crime, census tract, fiscal year, and time-of-day. The first two are examples of nominal variables, and the last two are interval variables. There are also ordinal and ratio variables.

A nominal variable is one that consists of two or more categories into which cases can be classified. The only specified relationship between the categories is that they are different from one another (e.g., robbery with the use of a weapon versus robbery without a weapon). A statistical analysis consists of comparing the number of cases (persons, crimes, etc.) in one category, with another. An ordinal variable allows the analyst to form a scale and compare one category to another with respect to some characteristic (e.g., rape is more serious than larceny). The analyst could choose to rank-order all the crimes according to their degree of seriousness (e.g., homicide, manslaughter, rape, assault, robbery, burglary, larceny, and vandalism). Here, the analyst can exercise personal judgment that is not universally accepted. However, ordinal scales can be fairly objective (e.g., extent of injury could be subdivided into categories of seriousness -- no harm, minor, hospitalization, or homicide). Thus, an ordinal scale defines the relative position of categories.

An interval variable consists of a numerical scale in which it is assumed that the units of measurement are equal but there is no information about the absolute magnitude of the scale (i.e., the scale is based on an arbitrary zero point). If the scale had a "real" zero point, as in the case of measures of length and height, it is referred to as a ratio scale. An example of an interval variable is the Celsius scale in which the numbers 0 and 100 were selected to represent the points at which water freezes and boils, respectively.

Arithmetic procedures (such as multiplication and division) can only be done with interval and ratio variables. One can compare the number of burglaries reported to the police (e.g., 500) to the number obtained in a survey (e.g., 1,500) and make the following statement, "The surveyed number of incidents was three times larger than the number reported to the police," or conversely, "The number of incidents reported to the police was one-third as many as that obtained from the survey."

In the social sciences, many measures are treated as interval variables even though, in some cases, the practice is questionable. For example, an attitude question, such as, "How afraid are you to go out alone at night? (Would you say that you are 'very afraid', 'somewhat afraid', 'a little afraid,' or 'not at all afraid?')," is typically treated as a 4-point interval scale, ranging from 1 for "not at all afraid" to 4 for "very afraid."

Among social scientists, there is disagreement over whether attitude scales are properly interval or ordinal scales. Some take the position that, because one cannot assume that "very afraid" is a quantity four times the magnitude of "not at all afraid," it is meaningless to perform most arithmetic functions (i.e., the analyst should limit his numerical summaries to proportional statements, such as 76 percent said "not at all" or "a little afraid," rather than stating that the average response was 3.4). In this case, the use of an average as a statistic appears meaningless, whereas the proportional statement is useful, particularly if the analysis shows what percentage of persons selected each response category. The analyst not only knows what is the most typical attitude but is also able to discern to what degree the majority reflects the attitudes of everyone who was asked the question. For example, 76 percent could express little fear, but another 20 percent could have said "very afraid." Thus, the analyst knows that there is a significantly large group whose perceptions do not coincide with the majority.

There are different statistical methods for the analysis of data composed of nominal, ordinal, interval, or ratio variables. Procedures for the analysis of interval and ratio variables, known as parametric statistics, constitute the largest class of analytical techniques. They apply to data that have continuous gradations of magnitude (such as length, duration, intensity). If the variables are nominal or ordinal, the appropriate statistical techniques are called nonparametric statistics. These techniques apply to data that are not continuous but categorial in nature such as sex, rank, type of crime.

Parametric techniques are more versatile than nonparametric in the sense that numbers can be aggregated and transformed in a greater variety of ways to help the analyst understand the characteristics of a particular data set. On the other hand, if the assumptions that go with interval variables are untenable for that data set, the resulting statistical manipulations will be worthless. The analyst should always be aware of what scaling assumptions are required for a given statistical technique.

3.2 Frequency Distribution

Suppose the CPTED planner wished to compare high- with low-crime-rate areas in Arlington, using the data in Table 1. His first step could be to construct a frequency polygon, as shown in Figure 3. In constructing a frequency polygon, the analyst has to select a class interval. In this case, a class interval represents increments of 50 incidents (e.g., 0-50, 51-100, 101-150), forming 17 rather narrowly defined classes. (One can always redefine the classes to form wider intervals.)

Since the objective is to compare high- with low-crime-rate areas, the analyst could simply establish two class intervals: Frequencies above the average for all tracts, and frequencies below the average. The average or mean is a measure of central tendency. Other measures of central tendency are the median (the frequency level above which and, correspondingly, below which 50 percent of the tracts fall) and the mode (the most frequent number in a distribution). The average is appropriate for interval scales, whereas the median and mode are suitable for ordinal scales. It is meaningful to talk about the mean age of an offender group, but not the mean sex of that group. The mode (the most frequent sex) would be the only appropriate central tendency statistic.

Rather than having just two classes, the CPTED planner might choose to have four classes to which he could assign semantic labels with respect to levels of crimes (e.g., very high, high, low, and very low). These labels can be operationally defined any number of ways. One

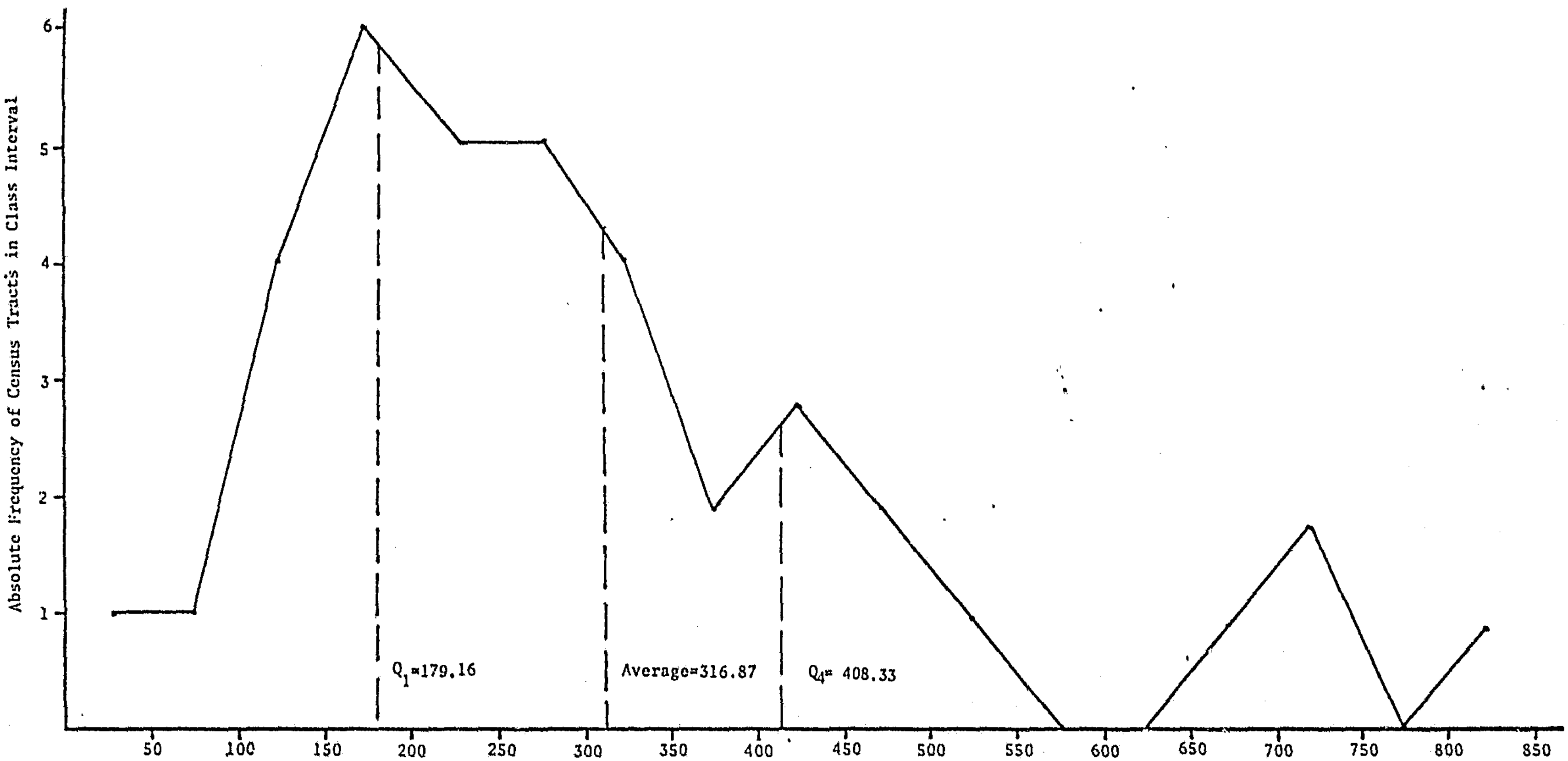

Figure 3. Class Interval (Increments of 50 Incidents)

possibility is to group the census tracts into quartiles. Quartiles are directly analogous to the median. Rather than finding a point that has half the census scores above or below it, one can calculate a quartile, which has one-fourth of the scores of lesser magnitude. Similarly, the third quartile represents scores having three-quarters of the cases below it in magnitude. For the data in Figure 3, the first and fourth quartiles are 179.16 and 408.23 respectively. The first quartile includes ten census tracts and the fourth quartile, nine census tracts.

The advantage of working with quartiles is that the analyst can compare tracts with high and low crime rates relative to the geographic area in which the tracts are located. The rationale is that the tracts with less than 180 incidents must have something in common to account for the low crime rate and, similarly, tracts with more than 408 incidents must have something in common to account for the high crime rate. Intuitively, this logic appears to apply to the tracts in the first quartile because of the high degree of consistency in frequency levels among them. However, as Figure 3 shows, the fourth quartile consists of two distinct peaks (a bimodal distribution), which suggests that tracts within the range of 400-600 incidents are different environments with different populations from those tracts with more than 600 incidents.

3.3 Dispersion

There are methods for measuring the extent to which numbers in a data set differ from one another. First, there is the range, which shows the extremes of variation within a given class interval of a frequency distribution. A range is usually less than a class interval. For instance, the interval, 151-200 incidents, actually ranges from 152 to 197, and the interval, 201-250, ranges from 206 to 248. With respect to all 38 census tracts, the range is from 71 to 846 incidents, not 0 to 850. (It should be noted that areas in Arlington with roughly comparable populations differ in crime level by more than a 10-to-1 ratio.)

Whereas measures of central tendency (average, median, mode) describe what is typical for a particular data set, measures of dispersion show the extent to which the individual cases differ from each other and from the measure of central tendency. The average is calculated by summing all incidents and dividing by the number of census tracts. Thus, as shown in Figure 3, the average for Arlington is 316.87 incidents per tract. However, the frequency distribution is unbalanced, with 13 tracts above the average and 25 below. Tracts 14, 16, 18, and 29 are largely responsible for this imbalance. For this distribution, the median is a more representative indicator. Fifty percent of the cases are above and below 229.17.

As a matter of principle, an analyst should use a measure that captures as much information about the distribution as possible. Two useful dispersion measures are the variance and the standard deviation (which is the square root of the variance.) However, this measure requires the assumption of interval scaling. It is calculated by subtracting the difference of each score (number of incidents in a given tract) from the average of all cases (tracts) and then averaging the differences. In the present example, each score (189, 298, 218, etc.) is subtracted from 316.87. For mathematical reasons, it is easier to square each difference score and to sum the squares. The larger the standard deviation, relative to the range of the distribution, the greater the dispersion of cases around the average. The utility of the standard deviation is that the analyst knows that 68.3 percent of all the tracts are within one standard deviation of the average and that 95.5 percent of all the tracts fall within two standard deviations (see Figure 4).* It is clear from the Arlington County example that the average is a poor measure of central tendency because of the comparatively wide standard deviation. If the cases were clustered around the average, the standard deviation would be narrower.

If the standard deviation is as large as or larger than the average, it means that there is a large amount of variation in the data. Hence, reliance on the average (or any other measure of central tendency) is risky in terms of drawing conclusions from the data. For example, if a study shows that the average length of time is 18.3 minutes between a victimization experience and a call to the police, but the standard deviation is 43.7 minutes, then the analyst can be sure that the distribution

*These percentiles are based on the assumption that the frequency distribution under investigation is bell-shaped (or normal). The extent to which the actual distribution is not normal affects the accuracy of these percentiles, but studies have shown that most unimodal (single peak) distributions satisfy the criteria for normal distributions.

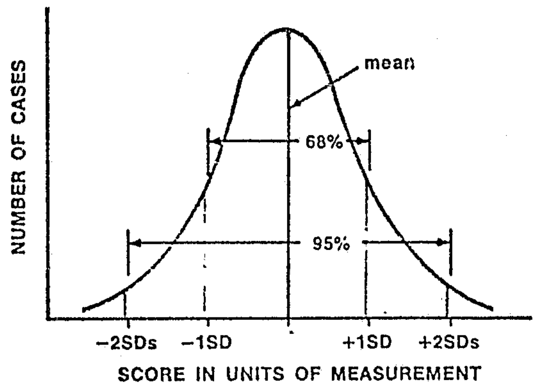

Figure 4. Standard Deviation as a Measure of Dispersion

is platykurtic (flat) in nature. One might also expect it to be multimodal (i.e., there may be one group of victims who report crimes within the first 10 minutes, another group that waits about a half-hour, and a third that waits until the following day). Further, whenever there is an open-ended scale with a zero point, the distribution tends to be positively skewed, because the linear distance in time between 0 and 18.3 minutes is much shorter than 18.3 and 120 minutes. Figure 5 is a hypothetical example.

In cases where the standard deviation is smaller than the average, the analyst can rely more on the average as a valid indicator. Suppose that a study shows that once a crime is reported, the police arrive within 12.2 minutes on the average, and the standard deviation is 4.1 minutes. This means that approximately two-thirds of the calls are responded to between 8.1 and 16.3 minutes and, in approximately 19 out of 20 cases, one can expect the police to show up between 4 and 20.4 minutes after the call.

3.4 Correlation

Thus far, the discussion has focused on one dimension at a time. If the analyst wished to examine the degree of correspondence between two variables (such as crime levels and other variables in the census tracts), he would use correlational techniques. Correlation measures the strength of association between two dimensions (e.g., one could correlate for each tract the number of burglaries with the number of unoccupied houses during working hours or the number of pursesnatches with number of elderly women). Correlations are useful because, if two variables

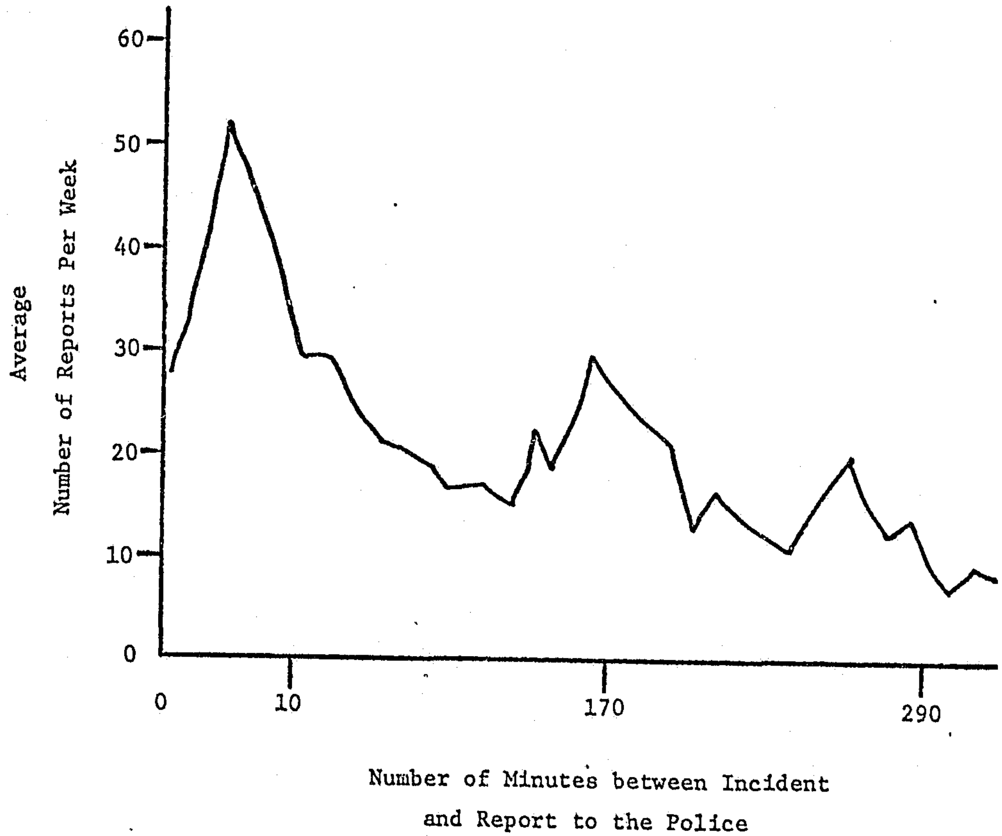

Figure 5. Number of Reports to Police Following Incident Per Week (Hypothetical Distribution)

are highly associated, knowing the statistical characteristics of one allows the analyst to predict the other with some accuracy.

Suppose the analyst wished to measure the degree of association between burglaries and the number of houses left unoccupied during the day. If it is assumed that the latter information is available to him, he could begin by normalizing both dimensions by computing the burglary rate and the percentage of unoccupied units for each tract, as shown in Table 4. The product-moment correlation coefficient $\underline{r}$ is a common measure of association. This measure is used when the variables involved conform to interval scaling assumptions.* The statistic $\underline{r}$ is useful for showing the extent to which the variance of one variable can be attributed to the variance of a second variable. If $\underline{r}$ is squared ($\underline{r}^2$), the resulting value can be interpreted in terms of the percent of variance of one variable, which is predictable, from the variance of the other variable. In this example, $\underline{r} = .30$, which means that there is an association, but it is not very strong (i.e., knowing the variance of one dimension accounts for approximately 9 percent of the other, $.30 \times .30 = .09$).

If two variables are not associated, the expected $\underline{r}$ would be zero and the variation of one variable could in no way be determined from the

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*Other types of correlation have been developed for nominal variables (e.g., the contingency coefficient) and ordinal variables (e.g., rank-order correlation).

TABLE 4

Use of the Product-Moment Correlation Coefficient r (Hypothetical Data)

Census Tract	Burglary Rate per 1,000 Dwellings	Percentage of Unoccupied Units During Working Hours
1	6.39	80.9
2	7.56	76.3
3	35.58	61.2
4	7.65	49.2
5	8.61	67.9
6	12.69	63.5
7	13.86	85.9
8	15.57	22.8
9	19.29	89.7
10	20.10	86.7
11	4.59	51.3
12	4.61	33.5
13	31.14	86.8

$r = .30$

$r^2 = .09$

other. If $\underline{r} = .92$ then $\underline{r}^2 = .85$, which means that the analyst knows 85 percent of what he has to know to predict the variance of one variable when he knows the variance of another variable.

One has to be careful about inferring causal relationships. Suppose that a study shows a correlation of .83 between the percentage of persons over 60 years of age and the robbery rate. It is important to realize that the statistic only shows an association between variables. In no way is a causal relationship established. For example, a logical interpretation is that, as the percentage of elderly increases, the robbery rate is likely to go up. This seems reasonable because the elderly are inviting targets for offenders. However, an alternative causal inference is that a program to reduce robberies will reduce the elderly population. This seems unlikely. Correlation only describes relationships; it is up to the analyst to exercise some judgement if he wishes to infer causality.

The same study could also show a negative correlation of -.71 between the percentage of elderly and the burglary rate. A negative correlation describes an inverse relationship -- as one variable increases (percent elderly), the second is likely to decrease (burglary rate). This relationship is plausible, given that burglars tend to look for vacant houses and the elderly are at home more than other population subgroups.

A coefficient can range from a "perfect" negative relationship of -1.00 to a "perfect" positive relationship of 1.00. A perfect relationship means that the behavior of one variable can be completely predicted by the behavior of another. If the data were plotted on graph paper, each cross tabulation of the two variables would be represented by a dot and all of the dots would form a straight line. Figure 6, which is called a scattergram, shows examples of a perfect positive and a negative relationship (a and b in Figure 6). It should be noted that the angle of the slope is not related to the strength of the association.

Few scattergrams, however, look like a and b because few relationships are perfect. Typical examples are c , showing a negative correlation, and d , a positive correlation (i.e., the cluster of dots tends to slope downward from left to right in c and upward in d . When r = 0, only a vertical or horizontal straight line can be detected (e and f). Thus, only sloping lines indicate that there is an association between variables.

The scattergram f is a special case. In each of the examples of Figure 6, it is possible to draw a line through the cluster of dots in a way that characterizes the relationship between X and Y . In the case of a and b , this is easy since the dots themselves form a line. In c and d , it is more difficult and, in e and f , there does not seem to be a straight-line relationship.

The statistical procedure for plotting a line that best describes a relationship is the method of least squares. The value of the method of least squares is that, if the analyst knows that two variables are

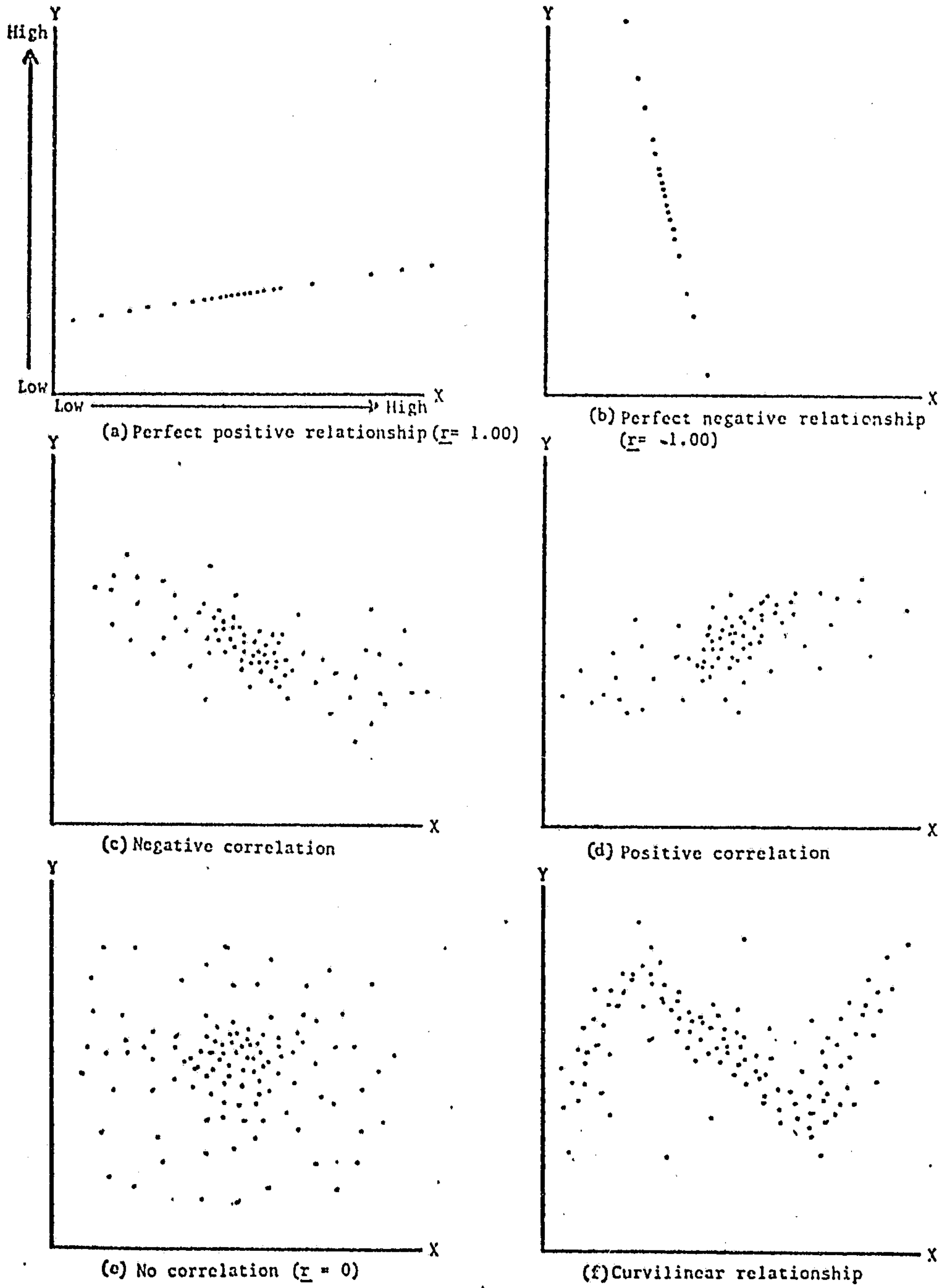


Figure 6. Examples of Scattergrams

highly correlated, he can use the statistical properties of the line to predict variable Y from X or X from Y . If he wishes to predict Y from X , the method of least squares locates the line in such a position that the sum of squares of distances from each dot to the line is a minimum. Distance from data points to lines are taken parallel to the Y axis (see Figure 7). If Y were being predicted from X , the same procedure is followed except that the distances are taken parallel from the X axis.

Correlations only describe linear relationships. The r coefficient is an indication of how closely the dots surround the best-fitting line. The more the dots fall on or near the line, the higher the correlation between the two variables. If the relationship is basically curvilinear, such as f in Figure 6, then r is misleading because, even though there is a distinct pattern between X and Y , the r value is low. Therefore, it is always better to look at both a scattergram and a correlation coefficient to interpret the data meaningfully.

When variables are very highly correlated (e.g., greater than .90), the chances are that one can view them as being essentially the same variable measured from two different perspectives. In low-income areas, for example, the percentage of single-parent households and the percentage of families on welfare are highly correlated because, to qualify for welfare, it helps to have only one parent in the household.

3.5 Multiple Correlation

It is also possible to compute the correlation among three or more variables. This process, which is called multiple correlation or multiple

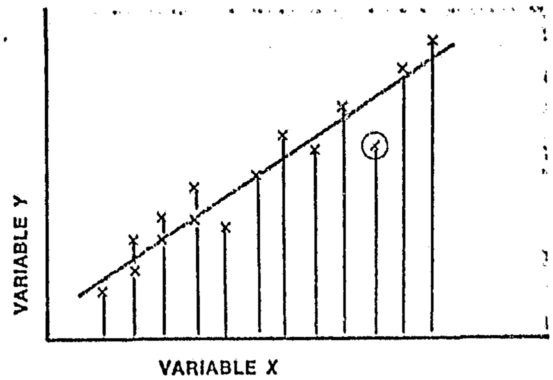


Figure 7. Determination of the Least-Squares Line to Predict y from x

regression, combines several frequency distributions into a single value *R*, representing their degree of association; *R* ranges between zero and +1.00. Multiple correlation is used to analyze the relationship between a dependent (or criterion) variable and a selected group of independent (or predicted) variables. A good CPTED-related illustration is a study of social and physical predictors of crime in New York City housing projects. Essentially, the researcher wished to evaluate the comparative influences of five types of variables on crime. In this example, only the indoor felony rate (see Table 5) is examined. With multiple correlation techniques, one can have as many independent variables as he or she chooses. The values in the main body of Table 5 represent product-moment correlations between a given combination of variables (e.g., r = .51 for percentage of population receiving welfare and indoor felony rate).

The strategic question asked was: If one independent variable (percentage receiving welfare) accounts for about 26 percent of the variation of the indoor felony rate (r = .51), how much of the variance of this rate is accounted for when all five independent variables are considered simultaneously. It was found that increasing the number of predictor variables from one to five increased the ability to predict indoor felony rates from r = .51 to R = .68. When the multiple regression value is squared, R^2, the resulting value (.46) indicates the percentage of variation in the indoor felony rate accounted for by the combination of these five independent variables.

TABLE 5

Indoor Felony Rate Predicted by Physical and Social Variables

Independent Variables	Correlation (r) Indoor Felony Rate
Physical Design	
Building Height	.36
Project Size	.27
Project Social Composition	
Percentage Receiving Welfare	.51
Percentage Female Head on Welfare	.44
Neighborhood Characteristics	
Number of Projects	.25
Multiple Regression (R)	.68 $R^2 = .46$

Source: U.S. Department of Justice. Law Enforcement Assistance Administration. National Institute of Law Enforcement and Criminal Justice. Design Guidelines for Creating Defensible Space, by Oscar Newman. Washington, DC: Government Printing Office, April 1976. S/N 027-000-00395-8.

In spite of the number of variables involved, the payoff to the analyst may not necessarily be high. In the example above, the ability to predict indoor felony rates doubled but, even so, less than half of the variation in the indoor felony rate is attributable to these five selected variables.

Another correlation technique is partial correlation, which is useful for holding several variables constant by statistical means to study the relationship between two particular variables. A hypothetical example is the correlation of crime rate with the percentage of black residents. Suppose an analyst finds that $\underline{r} = .50$. The analyst might infer that increases in the black population cause increases in crime rate. Suppose the analyst also finds a high correlation (e.g., $\underline{r} = .75$) between crime and the percentage of families below the median income level. The question then is, what is the correlation between percentage of black residents and crime rate when one holds constant the percentage of families below the median income level? The analyst might find that, by holding the income level constant, the $\underline{r}$ value for percentage black and crime rate is reduced. This procedure allows the analyst to appreciate the relationship between crime and level of income, apart from the question of racial composition.

3.6 Canonical Correlation

Canonical correlation is an extension of multiple correlation. It generates a generalized correlation between two groups of measurements, labeled predictor (independent) and criterion (dependent) variables. For example, an analysis of crime/environment relationships in a residential neighborhood could include the following predictors: (a) Number of vacant lots; (b) number of fenced residences; (c) number of unused buildings; (d) average lighting from streetlights; (e) average upkeep of flower gardens; and (f) condition of public spaces (such as alleys). The criterion variables could be measured on the basis of a victimization survey covering the preceding 12 months. They could consist of: (a) Frequency of violent crimes; (b) frequency of property crimes; and (c) average cost of property crimes.

3.7 Factor Analysis

In factor analysis, a *factor* is a conceptual label given to a composite measure of many variables. The analytic procedure culls a small number of factors that can be used to represent the essential characteristics of a large number of individual measures. Suppose the CPTED analyst wished to compare census tracts in Arlington with respect to population and housing characteristics. The U. S. Census Bureau has recorded hundreds of population variables. For CPTED purposes, however, the analyst might decide that a preselected subset of variables is pertinent to crime. In the following example, a subset of 52 variables was selected. Although the magnitude of the data analysis problem has been reduced considerably, it would still be useful to determine whether these 52 variables could be grouped into a small number of representative factors.

The procedure begins by generating a correlation matrix of all 52 variables. In a sense, factor analysis attempts to cluster the intercorrelations in a coherent manner. There are several ways of factor analyzing a correlation matrix (principal factors, method centroid method, diagonal method, statistical estimation method, etc.). However, a discussion of these techniques is beyond the scope of this chapter. In the case of Arlington, the principal factors method was used, with the result that 8 factors were generated accounting for 90 percent of the variation of the population measures among the 38 census tracts.

Table 6 shows the results. It is customary to say that a variable "loads" on a factor from -1.00 to +1.00. The concept is analogous to correlation coefficient. Rarely, if ever, will a variable load 100 percent on a given factor. Usually a variable loads to some extent on all of the factors but with some factors the loading is higher than with others. A factor becomes distinguished when variables load on it highly, say .70 or so, and the same variables load much less, say .30 or less on other extracted factors. The analyst attaches a label to each factor using, as a guide, the cluster of measures that load highly. The third column in Table 6 indicates which variables load highly on particular factors and the fourth column offers suggested labels. All of the factors, with the exception of Factor VI, clustered the variables in a meaningful fashion. (Occasionally factor analysis produces conceptually meaningless clusters.) Thus eight factor scores (composite measures) were obtained for each census tract. These factor scores can now be substituted for the 52 variables so that, in subsequent analyses of Arlington population data, each tract can be represented by 8 rather than 52 scores. The procedure will be more efficient then, and will be as effective as a separate analysis of all 52 variables.

TABLE 6

Factor Analysis -- Arlington Census Tracts

Factor (Cluster of Variables)	Percent of Variance Accounted for	U.S. Census Variables with High Loadings on Factor	Suggested Conceptual Label
I	33.7	All persons* All housing units	Size of census tract
II	28.9	No. of children 5-15* No. of families with children	Family size
III	11.7	Median income Average income No high school diploma (-)** No. of families below poverty (-)**	Income & education level
IV	5.2	Males between 20-25	No. of young adult males
V	3.7	Housing without adequate plumbing Houses built earlier than 1939 (Two variables)	Age of housing
VI	2.9	(No variables with high loadings)	----- ***
VII	2.0	High school enrollment (Only variable)	High school enrollment
VIII	1.9	No. of units built since 1969 (Only variable)	No. of new housing units

Total Variance = 90.1%

*To save space in the case of Factors I and II, only two of many variables with high loadings are included.

**The symbol (-) means that a variable loads negatively on a factor.

***Sometimes this process produces a "factor" that does not have variables with high loadings; hence, there is no basis for deriving a conceptual label.

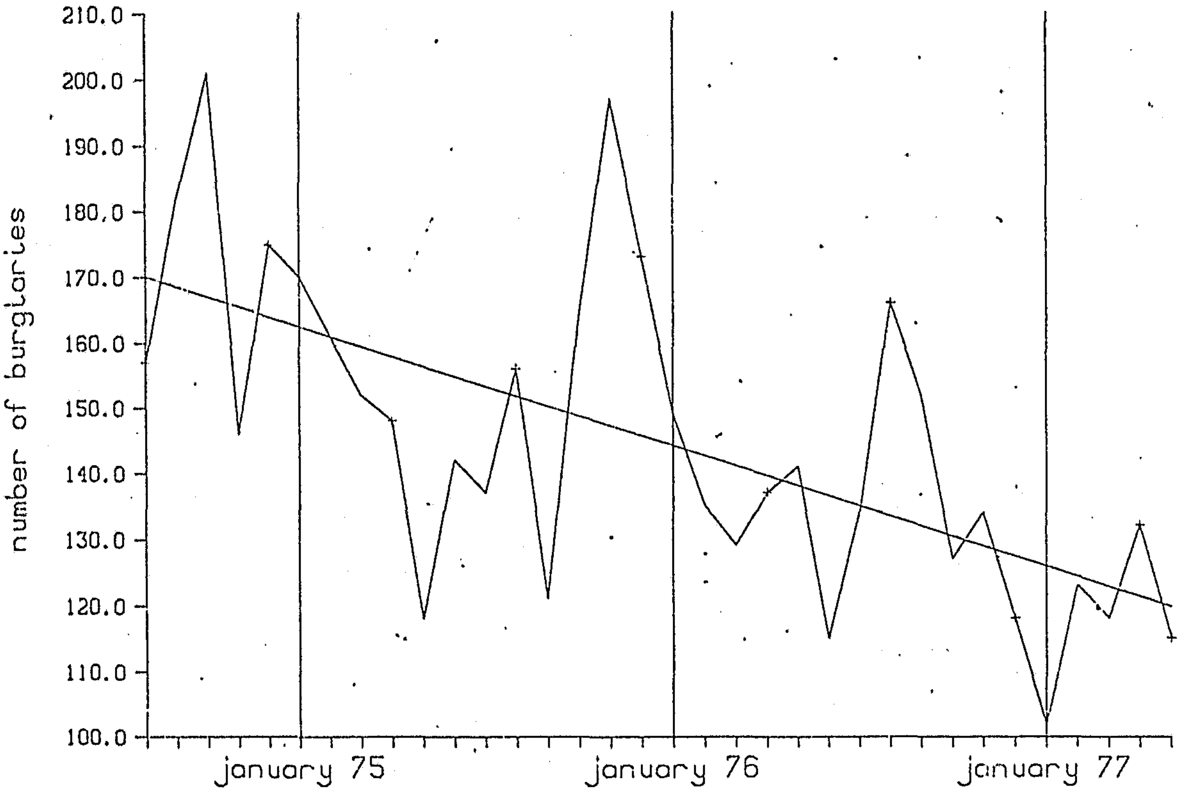
3.8 Time Series Analysis

The statistical principles and formulas used in computing correlations and regression lines are useful for time series analysis, where frequencies of a given event (e.g., crime) are examined in relation to a time dimension. The problem can be conceptualized in the following way. Imagine that, for every month for a total of 34 months, there is a frequency distribution of burglaries from the 38 census tracts in Arlington (see Figure 8), For each month (labeled variable X), the analyst plots the average number of burglaries (variable Y). The resulting path of averages is referred to as a regression equation of crime on the time dimension. This equation provides the analyst with the necessary information to plot a straight line that represents the best linear approximation of the overall trend. This trend line gives the analyst an idea of what has happened in Arlington over the past 34 months and permits him to project what the average number of incidents may be during the next several months.

4. Use of Inferential Statistics

Inferential (as opposed to descriptive) statistical techniques apply to situations in which a sample of the data has been obtained.* The analyst's task is to evaluate the representativeness of the sample in terms of being able to make a statistical statement about the entire data set from which the sample was taken. Another major difference associated with inferential techniques is that two or more samples can be compared to one another with respect to a predefined hypothesis about the nature of the relationship between the samples.

*A brief discussion of sampling methods follows in Section I.5.



Source: Arlington (Virginia) Police Department.

Figure 8. Trends of Burglaries for the Period 8-74 to 5-77

Data collection efforts, particularly those associated with evaluation research, often require a comparison of two or more means, proportions, standard deviations, or other numerical characteristics obtained from separate samples or from the same sample under separate conditions. For example, a study could focus on the number of pedestrians before and after a street lighting program. The investigators might select, on a random basis, a sample of 10 evenings during the month prior to and 10 evenings during the month following the installation of lamps to count the number of people. Table 7 shows some hypothetical results. Although the study shows an increase in the average number of pedestrians after the streets were lighted, the investigators must ask themselves whether this difference would be found with a larger sample, (e.g., 30 days) before and after.

4.1 Hypothesis Testing

The statistical procedure of hypothesis testing is counterintuitive. One generally thinks of a hypothesis predicting that different outcomes will be observed under different conditions. One then assumes the opposite to be true and attempts to disprove that assumption. Specifically, the assumed hypothesis (known as the null hypothesis) states that there will be no difference under the different conditions. Positive results from the statistical analyses take the form of demonstrating that the null hypothesis is unlikely and an alternative hypothesis (one that predicts a difference) is more likely. In other words, the null hypothesis is a tentative assumption that the different effects observed under different

TABLE 7

Number of Persons Observed on the Streets per Sample Day

Sample Day	Before	After
1	680	690
2	660	670
3	620	680
4	670	650
5	650	730
6	730	660
7	690	720
8	590	690
9	660	660
10	680	580
Total	6,630	6,900
Average	663	690

conditions are not the result of the respective conditions but are the result of random varations or chance.

Tests of significance can be applied to the difference between data samples. A *t* test (applicable to two variables) could be applied to the two distributions. If there were three or more such distributions, an *F* test (applicable to three or more variables) could be applied. These are but two examples of the variety of tests that could be used.

Sometimes a test of significance is applied to assess the difference between a statistic characterizing the relationship between two sets of data and a fixed value. A significance test for *r* , for example, determines whether the correlation coefficient is different from a fixed value of zero. If *r* is different from zero, the two sets of data are correlated; if *r* is not different the two sets of data are not correlated.

To determine whether a sample statistic is significantly different from a fixed value or from another sample statistic, the analyst has to select a significance level. The significance level is the probability of obtaining a value of a statistic (i.e., a difference) given the null hypothesis. The accepted level in sociological and psychological research is .05 (or 1 in 20).

One aspect of significance tests that is important to the CPTED analyst is the cost of making a wrong decision. There are two ways of making a wrong decision, the first of which is concluding that a CPTED project was effective when it was not. The significance level in this case is the probability of making this kind of mistake (this is known as a Type I error). The cost of such a mistake must be assessed in terms of the time, effort, and money spent on the project and its relative payoff. For example, the analysis of a community beautification effort primarily aimed at reducing fear of crime could reveal a lowered vandalism rate due to a supposed increase in community pride, cohesiveness, and identity. Even if this conclusion is in error, the community residents still gain a more pleasant environment, albeit at the taxpayer's expense. With this example, a higher significance level, say .15, is tolerable in the sense that the consequences of committing a Type I error are not necessarily bad.

The second wrong decision (Type II error) consists of affirming the null hypothesis when it is false. The selected measurement points associated with the community beautification program may not appear to impact fear of crime but, in fact, they do. The effects of discontinuing the beautification program could be estimated on the basis of the social cost of fear that could have been prevented had the program been continued. Again, the probability of making Type II errors is lessened by increasing the significance level (e.g., from .05 to .15).

In summary, tests of significance allow the investigator to decide whether two or more separate data sets are the same or different with respect to the risk of making a wrong decision. If the consequence of concluding that the samples are different (i.e., different program conditions produced different effects) has limited economic or social cost implications for a community (e.g., a street lighting program), the investigator could prefer to make a Type I error rather than a Type II error. If, on the other hand, the consequence could be costly in social and economic terms (affecting the nature of the designed environment and social interaction patterns), the investigator could prefer to risk a Type II error.

4.2 Statistical Designs

This next section covers a variety of statistical approaches. The first design, analysis of variance, is discussed in much greater detail than the other designs because many of the statistical concepts and assumptions apply to them, as well. The exceptions are the discussions of dummy variable regression and contingency table analyses, which present a fundamentally different approach to data analysis.

4.2.1 Analysis of Variance

Analysis of variance (ANOVA) deals with ratios of variability among different samples obtained under different conditions. It is suitable for establishing whether, and to what degree, a given prevention approach works in different settings. It is an efficient approach because fairly small samples are required for each condition.

The ANOVA design is used to assess the effects of one or more controlled factors, each with two or more levels, upon a single dependent measure. The levels of the factor are nominal or ordinal (i.e., there does not necessarily have to be a quantitative relationship between levels). If there is a quantitative relationship between levels, the analyst can choose to divide the sampling units into groups, thereby removing quantification (e.g., grouping families into high-, middle-, and low-income groups), or he or she can use analysis of covariance (when other factors are at most ordinal) or a regression analysis (when all factors are interval).

There are many variations on the basic ANOVA design, each arising from different data and experimental design considerations. These variations are not discussed here because the analyst should meet with a statistician to discuss specific design requirements necessitating a variation from the basic ANOVA and to determine computational procedures.

As an example of how ANOVA could be used, suppose that an investigator is interested in determining whether street lighting is associated with the number of persons using public streets. He is also interested in possible territorial displacement effects (i.e., are streets without lights used less as a result of other streets being given lights?). His research plan consists of observing particular streets in the evenings. To conduct this study, he has to make decisions about the type of dependent variables involved, the nature of the sampling, and statistical units, and the definition of experimental factors. The investigator could have made the following decisions:

- Dependent Variable -- Total number of people observed on the street by data collectors patrolling in a car between 7:30 and 8:45 p.m. over a 2-week period.
- Sampling Units -- 4600 through 5300 blocks of North Belle Boulevard; 4600 through 5300 blocks of North Vine

Street; 1700 through 2400 blocks of West Maine Terrace; all for 2-week periods commencing at the times specified in the definition of the second factor, below.

- Statistical Unit -- Number of people observed, summed over the 2-week period and within the specified neighborhood sampling unit.
- Factors -- Neighborhood (target neighborhood, probable displacement neighborhood, and a comparison neighborhood matched to the other two but geographically separate), and time period (1 month prior to, 1 month following, and 9 months following lighting installation.

This example is indirectly concerned with behavioral manifestations of the fear of crime. The project hypothesis is that more people will be observed on the lighted streets from which one could infer a reduced fear of crime.

Figure 9 presents some hypothetical results. There is an interaction effect between two factors, specifically in the form of an increased number of people observed in the target sampling unit, with a concomitant decrease in the displacement sampling unit (with respect to the trend in the nonadjacent sampling unit). This indicates territorial displacement.

Time Period	Street	Number of Pedestrians Observed
One Month Before	North Belle	350
	North Vine	400
	West Maine	275
One Month After	North Belle	425
	North Vine	395
	West Maine	285
Nine Months After	North Belle	595
	North Vine	250
	West Maine	280

Research Hypotheses:

- More people will use lighted streets after implementation.
- Fewer people will use nearby unlighted streets.
- There will be no change over time in the "control" neighborhood.

Figure 9a. Hypothetical Results of the ANOVA Test

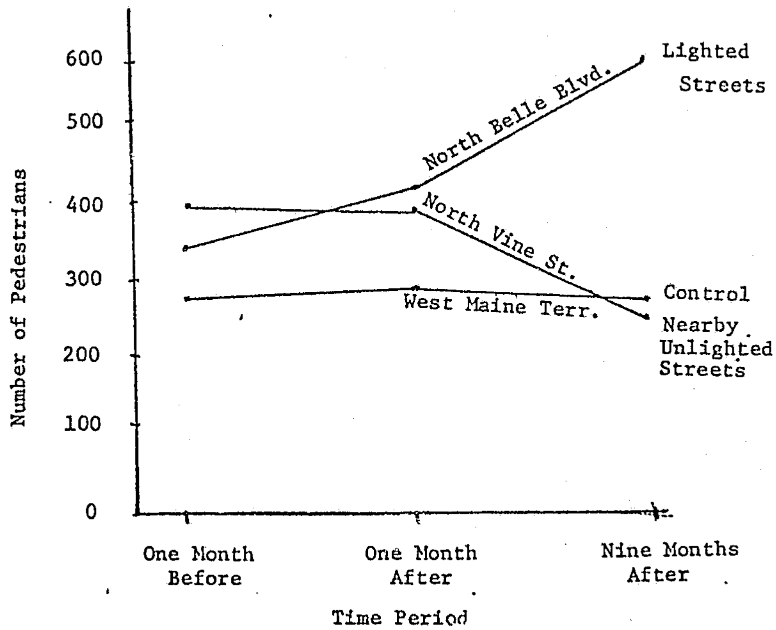


Figure 9b. Graphic Display of ANOVA Results

There are four basic assumptions underlying ANOVA. First, the statistical units must be independent (i.e., the probability of obtaining a particular value for a statistical unit does not change given the value of any other unit). This generally does not present much of a problem, but it ought to be intuitively checked. The second assumption is that the dependent variable is measured on at least an interval scale.

The third assumption demands attention: The dependent variable must be distributed normally within the levels of a factor (if one factor is used) or within the cells (if more than one factor is used). The analyst should plot the scores obtained and observe whether they deviate much beyond the normal, bell-shaped curve. If major deviations are detected, the results of the $\underline{F}$ test may not be useful, Figure 10 illustrates the theoretically normal distributions of three levels within one factor. The large distribution represents the dispersion of all three levels combined.

A major problem with respect to police data is the relative low frequency of crimes within a sampling unit; many of the statistical unit scores will be zero. One method of getting around the low-frequency problem would be to sum incidents over sampling units or over time.

The last assumption is termed homogeneity of variance (i.e., the variances within all levels of a factor or all cells of two or more factors are equal). With respect to Figure 10, the dispersion of the three smaller distributions should be more or less similar. Fortunately, there are methods of testing and adjusting for variance heterogeneity (situations where the distributions are not similar).

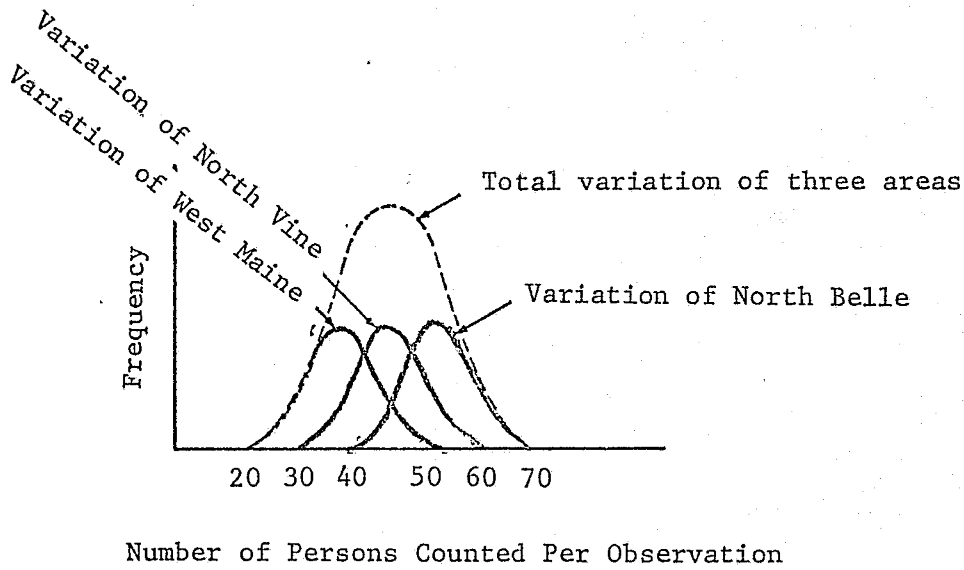


Figure 10. Theoretical Distribution of the Number of Persons Counted per Observation

4.2.2 Multivariate Analysis of Variance

Multivariate analysis of variance (MANOVA) is an extension of ANOVA that has the additional feature that numerous dependent variables can be analyzed simultaneously. When confronted with the choice of whether to use a MANOVA or several univariate ANOVAs, the analyst should select the former. By controlling for intercorrelations between the dependent measures, MANOVA can yield significant differences while the individual ANOVAs may not. Univariate ANOVAs can be used following a MANOVA as a sort of post hoc examination to discover which of the dependent variables were greatly affected by the CPTED project and to what degree.

The following is an example of MANOVA:

- Dependent Variables -- Fear-of-crime survey score, community identity survey score, community involvement score (number of organizations belonged to).
- Sampling Unit -- Head of household (selected by simple random sampling method).
- Statistical Unit -- Vector of three survey scores provided by the sampling unit.
- Factors -- Neighborhood (target, displacement, comparison), time period (1 month prior to lighting, 1 month following lighting but prior to the initiation of a blockwatch activity, 3 weeks following the activity initiation, and 4 months following the initiation).

The above represents an additional research design factor -- the assessment of both lighting and blockwatch activity. The sequence of implementation is fixed in such a way that each activity can be evaluated both separately and together. The above experimental design is amenable to analysis by ANOVA; however, use of the MANOVA techniques makes possible the simultaneous assessment of all three dependent measures.

4.2.3 Dummy Variable Regression

An extension of regression analysis, known as dummy variable regression analysis, is of particular interest to CPTED evaluations because it allows the assessment of categorical data. This approach is the first of two to be discussed that are somewhat "backward" in nature (i.e., it takes an incidence of crime as the sampling unit rather than a unit where or upon whom a crime might be perpetrated). The value of this type of approach is that it circumvents many of the problems of low-frequency data and the consequent violations of distribution assumptions.

An example of dummy variable regression is:

- Sampling and Statistical Unit -- A given type of crime.
- Dependent Variable -- Estimated cost of losses per victim of the sampling unit crime.
- Independent Variables (Scheme for Classification) -- Target (residence, business, other), neighborhood (target, displacement), time of day (morning, afternoon, evening, night), time period (prior to, during and after program implementation).

This example is discussed further in Section 4.2.4 on contingency table analysis.

4.2.4 Contingency Table Analysis

Contingency table analysis is particularly appropriate in CPTED analysis. Like dummy variable regression, an incidence of crime can be considered the sampling unit but, while dummy variable regression requires an interval measure, all variables can be nominal in contingency table analysis.

All variables are treated as categorical in nature. The variable scales could be nominal or ordinal, or they could consist of an ordinal categorization imposed on an interval (or ratio) scale. An example is:

- Sampling and Statistical Unit -- A crime (e.g., household property incident).
- Variables -- Time period (before, during, and after program implementation), neighborhood (target, displacement, comparison), type (breaking-and-entering, larceny), location (inside, outside, including garages and sheds), building density (less than 12 dwelling units per acre, 12-30 units per acre, more than 30 units per acre), time of day (day, night), period during week (weekday, weekend).

In this example (the cross tabulation chart is shown in Figure 11), four forms of crime displacement can be examined: Type, territorial,

				BEFORE				DURING				AFTER			
				DAY TIME		NIGHT TIME		DAY TIME		NIGHT TIME		DAY TIME		NIGHT TIME	
				WEEK DAY	WEEK END	WEEK DAY	WEEK END	WEEK DAY	WEEK END	WEEK DAY	WEEK END	WEEK DAY	WEEK END	WEEK DAY	WEEK END
HIGH BUILDING DENSITY >30 DU's PER ACRE	BREAKING AND ENTERING	TARGET	INDOORS												
			OUTDOORS												
		DISPLACEMENT	INDOORS												
			OUTDOORS												
		COMPARISON	INDOORS												
			OUTDOORS												
	LARCENY	TARGET	INDOORS												
			OUTDOORS												
		DISPLACEMENT	INDOORS												
			OUTDOORS												
		COMPARISON	INDOORS												
			OUTDOORS												
MEDIUM BUILDING DENSITY 12-30 DU's PER ACRE	BREAKING AND ENTERING	TARGET	INDOORS												
			OUTDOORS												
		DISPLACEMENT	INDOORS												
			OUTDOORS												
		COMPARISON	INDOORS												
			OUTDOORS												
	LARCENY	TARGET	INDOORS												
			OUTDOORS												
		DISPLACEMENT	INDOORS												
			OUTDOORS												
		COMPARISON	INDOORS												
			OUTDOORS												
LOW BUILDING DENSITY <12 DU's PER ACRE	BREAKING AND ENTERING	TARGET	INDOORS												
			OUTDOORS												
		DISPLACEMENT	INDOORS												
			OUTDOORS												
		COMPARISON	INDOORS												
			OUTDOORS												
	LARCENY	TARGET	INDOORS												
			OUTDOORS												
		DISPLACEMENT	INDOORS												
			OUTDOORS												
		COMPARISON	INDOORS												
			OUTDOORS												

Figure 11. A Tabular Chart for Use in Contingency Table Analysis.

target, and temporal.* The "type" variable might be further broken down to consider various tactics used by the criminal.

The major problem with this design is the possibility of low crime frequencies, and one of two things can be done if this occurs. First, one could exclude the factors of least interest (for example, time period could be reduced to "before" and "after"). Similarly, if the project is aimed at target hardening, the "location" variable (inside, outside) could be ignored.

An alternative approach is to collapse the levels of a factor (e.g., collapse building density into two levels -- less than 25 dwelling units per acre, and 25 or more units per acre) or to ignore one level of a variable (e.g., exlude daytime incidents).

5. Sampling Methods

This section briefly describes different sampling techniques that can be used in CPTED data collection efforts. The key to most sampling techniques is randomization. By employing some form of randomization, certain factors that might bias the results of an analysis are controlled. Generally, random sampling (also known as probability sampling) implies that each sampling unit within the target population has some calculable probability of being included within a sample.

5.1 Simple Random Sampling

The basic form of probability sampling is simple random sampling. Here, the probability of selection for each sampling unit is the same,

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*See Section 8 of Appendix B, Volume IIIA, for a description of the forms of crime displacement.

i.e., the probability is equal to the number of units to be included in the sample divided by the number of units in the target population. Simple random sampling could be employed with different populations -- individuals, families, residences, buildings, commercial establishments, blocks, or other categories of sampling units.

The chief advantage of simple random sampling is that there is no requirement for advanced knowledge of the characteristics of the target population (e.g., distribution of old versus young, apartments versus houses, grocery stores versus gas stations). The representativeness of the target population by the sample is assured, especially with large samples. The disadvantages of simple random sampling depend on the characteristics of the target population and the sampling unit. A major drawback is that a listing of all sampling units is required. While this may be a small consideration with blocks as sampling units, it is problematical when individuals or households are the sampling unit. The cost of obtaining complete lists of names and addresses is high. A second major drawback is that this method is less efficient than stratified sampling (see below), i.e., a larger sample size is necessary to attain the same level of reliability of statistical estimates.

There are variations of simple random sampling. The first, known as systematic sampling, employs quasi-randomization. Every nth (3rd, 10th, 25th) sampling unit following (or preceding) the first unit in a prepared list is included in the sample. The degree of approximation to true randomization depends upon the extent to which the list of sampling units is itself in random order. If residences or blocks are listed according to some geographic order, the assumption of randomization is untenable. If, on the other hand, residences are listed on shuffled cards, then the selection process is closer to genuine randomization.

A second variation is known as proportionate sampling. Here, the probability of selecting a given sampling unit is proportional to the relative size on some smaller scale. For example, if the sampling unit is the block, the probability of selection might depend upon the number of houses, commercial establishments, or residents within the block. Two pre-sample listings are required -- one for blocks and one for the smaller sampling units (e.g., buildings). The choice of this method over simple random sampling depends upon the measurements being taken. If the CPTED analyst is investigating property crimes, for instance, he can assume that more crimes will occur within blocks that have a larger number of buildings because there are more crime opportunities. However, the selection of sampling units depends on the analyst's purpose. If he is investigating violent crimes, proportionate sampling based on the number of buildings per block may not be useful, because this would exclude those blocks with several vacant lots. Muggings might occur most frequently on these blocks because they provide escape routes for offenders.

A variant of both proportionate and simple random sampling is known as cut-off sampling. Part of a pre-sample list is arbitrarily eliminated from inclusion. The remaining listed units are then sampled with either the simple random or proportionate methods. One particular application of cut-off sampling could occur when the CPTED analyst is only interested in commercial burglaries. Select blocks within the target neighborhood might consist primarily of apartment complexes. Since these blocks would have few businesses, they would be excluded, and sampling would be performed on the remaining blocks.

5.2 Stratified Sampling

The foregoing techniques have assumed little knowledge about the demographic or environmental characteristics of the target population other than what it consists of -- blocks, addresses, etc. The use of simple random sampling precludes analysis of certain variables that could have a statistical relationship with the dependent measure (e.g., racial and age composition, socioeconomic status, simultaneous consideration of commercial and residential structures, and the like). Considering these variables might be useful in an analysis of covariance, canonical correlation, multiple regression, or contingency table analysis. These sampling methods employ stratification of the target population into various groups based on the different levels (strata) of the factors being considered. Samples are then drawn from each stratum. Depending upon what one wants to do with the data, the within-strata sample sizes should be proportionate to the size of the stratum within the entire target population. This method, known as proportionate stratified sampling, provides the best estimates of the true population values in relation to a given measure.

However, disproportionate stratified sampling can also be used. A special case of disproportionate stratified sampling occurs when the within-strata sample sizes are equal. While this makes the estimates of population values less accurate, it facilitates a comparison of sample characteristics among the different strata. Equal sample sizes present a distinct advantage for performing analysis of variance and related statistical techniques.

Another variation is optimum allocation stratified sampling, where the sample size is proportionate not only to the size of the population stratum, but also to the variability within the stratum. This method is more efficient for estimating population values, but it makes between-strata comparisons more difficult. It also requires some a priori estimate of within-strata variability and, therefore, may entail additional work.

There are three problems concerning stratified sampling methods. The first is the choice of stratification variables. This is a theoretical rather than methodological concern. For example, one might stratify commercial establishments on the basis of annual income, number of employees, size of building, or proximity to the nearest transit station. It could be meaningless to stratify by some demographic variables (e.g., proprietor's age). Thus, the choice of variables to be stratified depends on common sense. The results of previous studies can also provide some guidance.

The second problem is more methodological in nature, and it concerns the number of stratification variables and the number of strata within a variable. The chief problem is sample size: There must be a sufficient number of sampling units within each stratum to allow for a reliable estimate of the population stratum. If a given sample stratum has too few sampling units, it can be combined with other strata, or that stratum can be dropped from analysis altogether.

The third problem is also methodological in nature: What are the relative sizes of the strata within the target population? The sizes must be known prior to sampling in order to conduct proportionate or optimum allocation stratified sampling. Census data might be used to construct the strata, but even if such information exists for the stratification variable of interest, it may be inaccurate, especially if there is a high population turnover rate within the target neighborhood. There is a way around this problem, and that is to determine the stratification after the sample data has been collected by some other method (e.g., simple random sampling). In principle, postsampling stratification is as good as prior stratification.

5.3 Cluster Analysis

Another type of sampling technique is called cluster sampling. Cluster sampling is useful for simplifying tasks. As a first step, the target population is divided into groups or clusters. This division is arbitrary. For example, a cluster may be defined on the basis of several contiguous blocks. It is assumed that the characteristics of a cluster are representative of the strata within the entire target population (e.g., the neighborhood project site). It is also assumed that each cluster is similar to every other cluster. These assumptions can be checked by examining existing census records and comparing the distribution of variables among the clusters. The examination may show that one cluster has some feature that distinguishes it from the rest (e.g., it may consist primarily of highrise apartment buildings, it may have primarily black or elderly residents, it may contain a much-used bus stop, or it may lie adjacent to a garbage dump).

Once clusters are defined, the next step involves an exhaustive sampling of units within each cluster. This should not take long, given that the reason for defining the cluster to begin with is to reduce the size of the sampling task.

5.4 Panels

Panels are a cluster of sampling units obtained by some method which are then observed and measured on repeated occasions. This saves the trouble of creating new samples. The approach is useful for time series analysis, permitting the analysis of temporal fluctuations and, in particular, the impact of a project. The major problems with panels are mortality and maturation. Individuals, households, or businesses may fail to cooperate at some point after selection and data collection have begun, and changes observed from one time period to the next may be brought about by repeated measurement rather than the result of actual changes in the project environment or population.

5.5 Combination of Methods

More than one sampling method can be employed. For example, two methods might be used to collect two different kinds of data. Simple random sampling could be employed for crime incidence reports, and cluster sampling could be used for fear-of-crime surveys. Sampling can also be carried out in two different stages, such as doing a postsurvey stratification to determine which businesses in a commercial district are most frequently victimized and then forming a cluster out of some of these victimized businesses for evaluation of CPTED strategies. Since clustering is arbitrary, the businesses need not be spatially contiguous.

6. Measurement Reliability and Validity

Data can be collected in many ways: Observing events and environmental characteristics, examining records and archives, distributing questionnaires, and conducting interviews and experiments. To be useful, any form of data collection must focus on variables that are relevant to the issue at hand. Some general guidelines for determining relevance include theories, previous research, and experience. For example, CPTED theory suggests that neighborhood cohesiveness is a relevant variable to measure. Previous research may confirm this notion and suggest that cohesiveness could be measured by observing interaction among neighbors, examining membership records of community groups, and measuring residents' attitudes towards their area. However, one can learn (e.g., by talking with community leaders) that information gathered from these sources would not be relevant, or that other information would be more relevant. Some exploratory work should be done to identify which factors should be selected for study and which should be ignored.

Every data collection technique must produce information that is not only relevant but also correct. Two crucial aspects of correctness are: Reliability (in general, the extent to which a measure gives consistent results), and validity (in general, the extent to which a method measures those things and only those things that it is supposed to measure).

The idea of reliability is familiar to most people. A car that starts every time is reliable; one that starts only sometimes is unreliable. Likewise, if one measures fear of crime by responses to a questionnaire or by observation of street traffic at night, these measures of fear will have some level of reliability. The question is, How does one ascertain how reliable these measures are?

Before answering this question, however, it is important to consider the idea of validity as well. Reliable results are not necessarily valid. For example, a reliable scale for weighing bags of flour can be poorly calibrated, in which case the scale would give the same wrong information each time. That is, the bag of flour can actually weigh 6 pounds, not 5 pounds. Similarly, a reliable questionnaire on fear of crime may not reflect people's true feelings (e.g., they may not wish to appear fearful), and it may reflect other irrelevant factors (e.g., they may be in a bad mood).

In addition to being reliable and valid, a measurement technique should also be sufficiently sensitive to make distinctions that are fine enough for one's research purposes. For example, a yardstick can be sensitive enough to distinguish among the widths of buildings but not strands of hair. Unless one is using a standardized technique, there is no way of knowing in advance how sensitive a measuring device will be. Therefore, it is recommended that every technique be put through a trial run.

For example, if one wishes to observe pedestrian traffic, one should pretest the selected observation method by comparing traffic in high- and low-pedestrian-use areas of a city (e.g., downtown and suburbs). If the method does not reveal any differences in comparing extreme cases, it probably would not be sensitive enough to use elsewhere.

On the other hand, there is no point in developing a measure that provides information that is more highly refined than is useful -- especially if the extra refinement is obtained at high cost. If the research purpose requires only the amount of pedestrian traffic, it could be unnecessary and confusing to collect more detailed data (such as the speed of walking and characteristics of walkers). In general, a balance must be achieved between the level of sensitivity needed for diagnostic and evaluation purposes and the level that is afforded by various techniques.

It should be noted that there are no fundamental reasons why one type of method is generally more sensitive than another (e.g., observation of behavior is not necessarily more or less sensitive than a personal interview). Sensitivity, as well as reliability and validity, depends upon the care in constructing a measurement device rather than the method.

The factors of relevance, reliability, validity, and sensitivity apply to all types of measurement. No measurement procedures or devices in the social sciences are perfect in terms of these criteria. The degree of imperfection in measurement can be referred to simply as "error." The outcome of any measurement is determined by two basic factors: The true characteristics of the event, object, or behavior being studied; and various sources of measurement error. Almost without exception, when measurements are taken, some variations in the data will be found (e.g., because of individual differences among people, the scores on a fear of crime scale obtained from them would likely differ for each person). The basic measurement problem is determining how much of the variation in data is due to true individual differences and how much of the variation is due to error (e.g., the person misunderstanding the scale or the researcher recording the wrong number). Thus, in a survey of fear of crime comparing two different areas of a city, variation in people's scores might originate from such factors as: (a) Actual differences in fear stemming from real differences in criminal activity; (b) actual differences in fear stemming from differences in other characteristics (such as ethnic group or economic status of the people living in the two areas); (c) differences due to a vast array of temporary factors (such as people's mood or weather conditions); (d) differences due to variations in how the scale was administered and how the questions were interpreted; and (e) differences due to accidental errors in data coding or analysis that perhaps follow from the investigator's biases.

This list does not exhaust all possible sources of variation in measurement, but it should illustrate the fact that errors can take many forms. In general, however, error is of two basic types. *Constant error* refers to something that *systematically* affects data [e.g., factors included in item (b) above]. When constant error factors are identified and recorded, their effects can be controlled and eliminated by certain data analysis techniques. *Random error* varies *unsystematically* from one situation to another [e.g., factors mentioned in items (c) and (d) above]. As will be shown in the sections below, the question of validity usually involves both constant and random factors, while reliability usually involves only random sources of variation.

5.1 Reliability

As stated earlier, reliability refers to the degree of replication or consistency of two or more observations of an event made under the same conditions. If a measure is valid (see Section 5.2), one can be rather confident that it is reliable. In practice, investigators usually do not know in advance whether their planned methods are valid. Unless satisfactory validity has already been determined, the reliability of a measure should be ascertained before using it in a study. Reliability in measurement is crucial, because it sets an upper limit on the extent to which a measure can be expected to predict other measurements. For example, if one were investigating the relationship between the use of public transportation and fear of crime, one could develop a fear of crime scale. If the scale is unreliable (i.e., if the same person obtains a different score on the scale each time he answers it), then, in a sense, the scale does not even predict itself. Therefore, it would not predict anything else (e.g., use of public transportation) with any more accuracy than it can predict itself.

To understand the idea of reliability, it is helpful to think of it as a dimension that can range from 0 % to 100 %. That is, any measure has reliability, ranging from none at all to perfection. Therefore, all measures fall somewhere in between. There are several statistical procedures (e.g., correlation coefficients) that allow an exact numerical interpretation of the degree of reliability on this 0 % to 100 % scale. The closer reliability gets to 100 %, the more confident one can be in making predictions and drawing conclusions on the basis of the measurements obtained. Before the various aspects of reliability are discussed, it should be noted that the degree of reliability of measurement is affected by the type of object, event, behavior, etc., that is under study.

It is easier to calibrate objective data than subjective data. Hence, the recording of events (e.g., the number of police calls received during the day) is potentially more reliable than the assessment of perceived variables (e.g., public attitudes toward crime prevention programs). Extra precautions to ensure reliability should be taken when dealing with more abstract variables.

Although reliability is a relatively simple idea, it has two fundamental aspects that, in turn, have implications for how reliability is determined when using different research approaches and methods. These aspects are: The stability of a measure (which is based on the consistency of measures over two or more time periods), and the equivalence of a measure (which refers to the consistency over two or more observers at the same time). Each of these aspects merits some special attention.

5.1.1 Stability

Since stability refers to fluctuations in measurement over time, an immediate problem is to determine how much of this fluctuation is due to actual changes in the object of study and how much is due to error in measurement. If some important event occurs between two applications of a measurement, whether planned or unplanned, any difference in measurements could be due to that event. Thus, to the extent possible, stability should be assessed under circumstances in which unintended dramatic intervening events are minimized. Moreover, even though genuine changes may naturally occur in the object being studied, it must be assumed that, despite such changes, there is some average level of the characteristic being measured. The basic question then becomes, How many measurements are needed to determine this average? The greater the number of repeated measurements, the more accurate the estimate of the average will be. In practice, when measurement consists of observations of behavior, a large number of measurements are made. In the case of interviews and questionnaires, usually only two measurements are taken. If, on the other hand, the procedure entails observing pedestrian traffic in two areas of town, it would be well-advised to make dozens of observations on different days, at different hours and times of the year. Reliability would be determined by the degree of variation in the number of pedestrians observed. If there is as much variation within each area of town as there is between the two areas, the measure will not be very useful.

In the case of a questionnaire, the test/retest method is typically used. In this method, the same persons complete the same questionnaire on two occasions, and the similarity of scores is determined by some statistical technique (such as a correlation coefficient). This approach is typically used in before/after studies. However, there are several problems with the test/retest method. People can remember how they responded the first time and will simply duplicate their responses, perhaps to appear consistent. Or taking the questionnaire the first time can, in itself, change a person's thoughts and actions. A person may not have realized how fearful he was of crime until after completing the fear of crime questionnaire. This can inflate his scores on the retest.

5.1.2 Equivalence

Another aspect of reliability deals with the extent to which different investigators, using the same methods to measure the same objects of study at the same time, yield similar results. This aspect is also referred to as an interrater reliability. Equivalence is usually of most concern when using observational methods. For example, one could be studying public attitudes regarding law and order by observing the frequency of pedestrian violation of traffic signals. Two observers, stationed at the same corner, would record the behavior of each person who crossed the street, using some set of categories, (e.g., those who violate versus those who do not). The observations would be compared later to determine the degree of agreement.

Agreement can be determined in several ways. A simple way is to compare the percentage of agreements relative to the total number of observations. Obviously, the higher the percentage, the more reliable the observations would be. In practice, the percentage agreement that is considered acceptable varies, depending upon the complexity of the observation categories and the amount of disagreement accepted by the investigator. In general, percentages over 90 % are considered good and percentages below 70 % are viewed as inadequate. However, these criteria are quite arbitrary. Equivalence can be increased by thorough training of observers as well as by continued checking to ensure that the criteria being applied remain constant.

Reliability is an essential consideration when conducting an evaluation. It refers primarily to freedom from unknown, uncontrolled, and random variations in measurement. The various aspects of reliability have different implications for different types of research approaches, and statistical techniques are available for determining the level of reliability of the various methods. In case of doubt, efforts should be made to determine the reliability of one's measures and to revise them if they prove deficient.

5.2 Validity of the Measures Used in a Study

Whenever an evaluation is being planned, certain basic questions arise. Are the projects to be implemented going to have the intended effects, and are those effects due to the reasons that formed the basis of the program design -- or for some other reasons? Are the measures used to evaluate the program measuring what they are supposed to measure? Will the results of the evaluation demonstrate that the project could be applicable in other areas, or will the conclusions drawn be limited to the particular time and place in which the project was implemented? Answers to these questions involve the notion of validity. In Appendix D potential threats to the validity of evaluation findings were discussed focusing on environmental factors that may limit the types of conclusions one can infer from the data. In contrast to this earlier discussion, this subsection focuses on validity issues regarding measurement errors, i.e., a conclusion can be invalid simply because the supportive data are not valid. With respect to measurement issues, there are two basic types of validity that should be considered: Predictive validity and construct validity.

5.2.1 Predictive Validity

In answering the question as to whether a particular measurement actually measures the variables of interest, one can take a pragmatic approach. Interest is centered on the usefulness of a measure in accurately describing the object of study and predicting its future state. In other words, concern is not focused on the reasons that a particular measure seems to be working, but only about whether it works. When dealing with the evaluation of social action projects (as opposed to testing theories), the pragmatic approach is a reasonable one. To use a familiar illustration, if a project designed to reduce fear of crime and increase patronage of local stores is being investigated, it is essential to have a valid measure of fear of crime. If those people who should, for some inexplicable reason (such as owning Fords as opposed to other automobiles) show high fear on the measure actually have high fear, and if they also avoid patronizing local stores, the variable of whether people own Fords has predictive validity.

The essential feature of predictive validity is that there must be a highly valid and reliable criterion with which a measurement device can be compared. Herein lies the great dilemma of validation -- that is, what criteria, if any, are there for validating a measure? One solution to this dilemma is to use the known-groups method. In this technique, one first identifies groups of people who are known, perhaps on the basis of their activities, to be quite different in terms of the variable of interest. For example, one might hypothesize that people who own watchdogs are more afraid of crime than cat owners. Showing that these two groups score differently on one's "fear" scale would be one indication of the scale's predictive validity. However, the obtained difference does not necessarily mean that the hypothesis is verified. It is very possible that the "fear" scale and type of pet ownership are reflections of something else. Nevertheless, it does not matter what the "something else" is as long as the scale predicts behavior.

5.2.2 Construct Validity

This type of validity deals with the issue of whether the data really do measure the variables (constructs) that they are assumed to be measuring. Often, there can be interest not only in predicting a single kind of behavior but in using a measure to determine the underlying reasons for the behavior in terms of some set of concepts. One can observe the expected effects of a project on some variable such as store patronage, but are these results due the CPTED project or some other influence?

Suppose that, in examining records such as crime statistics, it is observed that there is an apparent decrease in the crime rate. The issue of construct validity raises the question as to whether crime statistics represent an accurate picture of the actual crime rate. Given that a sizable proportion of crimes is never reported, a shift in crime statistics can reflect a change in reporting practices rather than a change in the actual amount of crime. Similarly, the publicity surrounding an anti-crime program could produce a change in reported fear of crime, not because actual levels of fear have changed but because people may feel that their fears should change and they have no other way to express this feeling. Unlike predictive validity, construct validation involves the ability to predict a great variety of behaviors. If fear of crime is reduced by a project, this should be reflected in many activities in addition to responses to a questionnaire.

How is construct validity assessed? An effective way of assessing construct validity is to determine how different measures of the hypothetical construct are related to each other and to similar measures of other constructs. Two kinds of relationships should be examined. First, to what extent do different measures of the construct relate to each other and yield similar results? This issue is sometimes referred to as convergent validity (i.e., how well the different measures converge on the same conclusion). Second, to what extent can the construct be discriminated from other apparently unrelated constructs? This issue is sometimes referred to as discriminant validity. To gather this kind of information, the construct in question must be measured by two or more methods and the other construct must be measured by these same methods. For example, if a project is geared toward increasing concern about street crime, the construct of concern could be measured by several methods (such as interviews, questionnaires, and content analysis of letters to newspaper editors). If concern about street crime were to be discriminated from concern about some other social issue (such as concern about white collar crime) this second construct would be assessed using the same methods. It is important to realize that these measures can be tapping something other than the variable of interest (e.g., concern about urban blight rather than crime). The major points are that any single measure may not be reflective of the variable of concern, and that a variety of measures of the same variable is highly recommended whenever possible.

CPTED TECHNICAL GUIDELINE 6

Decision Aids and CPTED Evaluative Criteria

DECISION AIDS AND CPTED EVALUATIVE CRITERIA

1. Introduction: Purpose and Philosophy

Faced with an array of candidate CPTED program alternatives, how does the decisionmaker identify the most attractive design for implementation? At the heart of this issue is the need to express a final preference, despite disparate performance measures as well as levels thereof. There are two components to this problem. The first entails constructing an acceptable basis for assessing the absolute or relative merits of a set of proposed programs. This framework must be broad enough to factor in key attributes of an operational, economic, social, and political nature. The second involves establishing a methodology for accomplishing the multidimensional trade-offs, ultimately collapsing the individual program assessments into a uni-dimensional ranking of preferences -- a step which, despite the inherent complexity of choice, decisionmakers ultimately do complete. The methodology itself must suit the state-of-the-art in CPTED practice, especially in respect to theoretically validated relationships, the expected level of measurement, and the availability of data.

This chapter attempts to provide assistance in both these matters. Before delving into methodological details or systematically linking the present effort to the issues addressed in the other segments of the Program Manual, however, some discussion of the philosophy behind the approach is in order, lest false expectations of optimism be raised or unbridled pessimism remain unquelled. First, implicit in this presentation is the belief that with regard to complex choices involving the allocation of scarce resources, we can do better than "muddle through." That is, it is better to explicate objectives and performance measures to identify where one's aiming than to proceed aimlessly, in which case any path should do. While maintaining an appropriate balance between rigor and relevance, it is better to have systematic decision-making and evaluation than to leave a legacy of no audit trails to capitalize on, nor any idea of how much or why goals were missed.

Second, it is not our intention here to overstate the case for systematic analysis via the eclectic techniques of operations research, cost-benefit / cost-effectiveness analysis, or the planning-programming-budgeting-system paradigm. Even the strongest advocates of these methods have widely acknowledged the often severe impacts of externalities. These uncontrollable forces outside the system's scope can importantly influence and sometimes dominate the system's behavior. Moreover, the problems of systems analysis do not end with either unrecognized or uncontrollable exogeneous events, such as political pressures. It may be presumptuous, especially in a criminal justice context, to talk meaningfully in system terms. True, one can identify components such as police, prosecution, courts, probation, corrections, and parole. One can also cite or hypothesize common objectives such as improvement of public safety and equity in the legitimized role of inflicting punishment. However, on an operational level, the fact is that actual behavior of these components is hardly systematic. They behave more as a loose organizational confederation, linked incidentally by law, with individually conflicting objectives and interacting operations, and little explicit or certain feedback regarding the attainment of goals. Thus, in part, police strive to maximize probability of detection and apprehension of criminals; prosecutors to heighten likelihood of conviction; courts to improve assurance of a fair trial and equitable punishment; corrections to minimize escape, maximize control, provide humane containment, reduce recidivism through rehabilitation; and so on. While the latter goals are patently conflicting -- and within one system component at that -- the others become so through their operational manifestations. Further exacerbating the meaningfulness of "system" and the tractability of analysis, one might argue that the scope of the system, such as it is, should include educational, social, religious, economic development, and other organizations since causal linkages can be reasonably hypothesized or demonstrated vis-a-vis criminal justice goals. Even if the the systems paradigm were applied, and at the proper scope, there would be substantial difficulties in attempting to quantify the nature of relationships. These stem from uncertainties about basic crime characteristics (e.g., level, rate, spatial and temporal trends, displacement and/or escalation, morbidity or mortality, demographic factors, tactics, and even type; etc.), from insufficient knowledge of causative factors and the extent to which they operate, as well as from the grossly inadequate information on the way in which criminals, victims, and anti-crime elements interact. The analyst's task is thus complicated not only by the primitiveness of the state-of-the-art, but by the diversity of crime types, offender methods, victim characteristics, and the profusion of conditions under which crimes occur.

Our third point, then, is that in the face of such obstacles, subjective judgments regarding CPTED strategies obviously will not be displaced by any purely objective, mechanistic algorithm for program choice, a naive aspiration in itself since value judgments inhere in the selection of objectives, criteria, thresholds of acceptability, model, scope, and methodology. What we can offer, and what such complexity as CPTED demands but has seldom received, is a systematic approach. That is, an approach which defines objectives and goals, identifies functions to be accomplished, translates those functions into detailed social-system requirements and specifications for component performance, and evaluates actual performance, dynamically amending any of the aforementioned in regard to unacceptable disparities in achievement. What we can offer is a framework which makes the decision questions explicit, identifies the relevant data, indicates how it is to be collected, and presents a method for bringing the information to bear on the decision -- in short, imposes a plan and a structure to complement the subjective elements of decisionmaking. No doubt, final preferences will be predicated on less than an exhaustive consideration of all the variables involved and will represent a suboptimization at best. For the foreseeable future, we will have to face the disturbing realities that "optimal" allocation of resources to crime prevention programs will depend in part on nonquantifiable and sometimes even unknowable considerations, and that short-term optimal or simply satisfactory designs may quickly become irrelevant as environmental circumstances shift and objectives change. The undue quest for precision is not only unrealistic and perhaps self-defeating, it may come at the expense of timely decisionmaking and more social experimentation supported by sound longitudinal evaluation; it may also overemphasize the quantifiable elements of a problem at the sacrifice of other salient factors. Very likely therefore, we will wind up revealing more about the true dimensions of complexity and choice in a given CPTED situation than substantially reducing the decisionmaking chore. Our contention is that this is the stuff out of which progress emerges and that, in any case, the alternatives to this mode of rational decisionmaking share most of its shortcomings, but few of its advantages.

Our concluding point amalgamates the preceding concerns regarding the state-of-the-art in CPTED theory and practice and the benefits and concomitant limitations in applying systems methodology to problems as challenging as crime control. The point is that the analytical aids which we present must avoid simplism on the one hand and a paralysis of complexity on the other. Our selections and presentations of various decision aids are guided by this and the practical wisdom that decisionmakers don't vote for what they don't understand.

2. Relation to Systems Approach and Program Manual

The systems approach provides direct assistance in relating the decisionmaking concern of this chapter to the companion issues addressed throughout the Program Manual. In a somewhat simplified manner, Fig. 1 depicts the major tasks entailed in conducting a systems analysis. Before turning to the subtask labelled "selecting 'best' program," the focus of this chapter, some system concepts and terminology will be described which will enable us to appreciate the unifying framework which Fig. 1 presents.

A system is a set of resources organized to perform designated functions in order to fulfill desired ends. The system's life cycle begins with the perception of needs and terminates when it is deactivated or scrapped, the overall life span being divisible into periods of planning, acquisition, and usage. During these phases, the system consumes limited, valuable resources such as personnel, facilities, materiel, and information. The fact that these resources are valuable and could be allocated for attainment of other human needs leads to the non-triviality of the problems of design and choice of alternative system configurations -- particularly in complex social systems which draw upon significant quantities of such resources.

A hierarchy of elements can be identified in any system. If two or more systems are interrelated, they can be considered jointly as yet another system, or "supersystem." In this broader context, the original systems may be viewed now as "subsystems." In turn, each of the subsystems may comprise other subsystems. The lowest level of these, beyond which decomposition is not necessary or useful, is called a "component." Clearly, systems will always be embedded in what CPTED theory refers to as broad-sense environmental systems, including those of a legal, political, social, economic as well as physical nature. Systems about which design and implementation questions must be made will often have significant interactions with these environmental systems, usually being much more influenced by such interactions than vice-versa.

The systems approach recognizes the interdependencies and constraints which bind a system together and requires that the scope of the system be sufficiently extended to encompass those interrelationships most relevant to the design problem. In order to maintain meaningfulness and tractability--

OVERVIEW OF THE SYSTEMS APPROACH

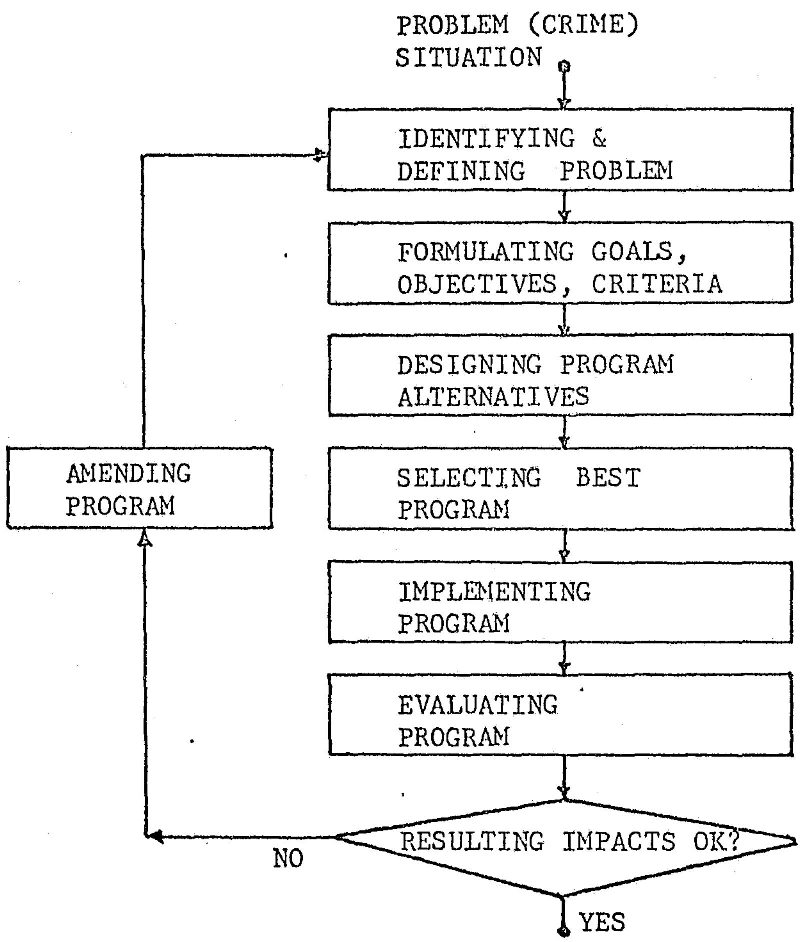


FIGURE 1

since it can be argued that everything is somehow connected to everything else in the world -- the analyst must make difficult judgments regarding proper scope and level of detail. Despite the present inevitability of "component" rather than "whole system" treatment, and of suboptimum or acceptable designs rather than optimum programs, the astute analyst can strive to discover those key components whose performance measures are consonant with the overall system's, and whose increases are followed by improvements at the system level as well (ceteris paribus). Inevitably, then, we should recognize that for analysis of social systems to be a manageable process and to provide timely policy inputs, some considerations will always have to be left out. The point is that although such judgments will be unavoidable, we can at least begin by considering the whole problem and then, as the modeling and analysis proceed, we can deliberately and judiciously decide which facets to retain and which to set aside. In so doing however, it is crucial that the objectives and performance criteria which we apply to the suboptimization be consistent with those applicable to the fuller problem.

As Fig. 1 suggests, the novelty of the systems approach to providing advice and selecting a course of action lies in its emphasis on articulating the whole problem, in attempting to clarify objectives and assumptions, in searching for alternative solutions, explicitly recognizing performance criteria and uncertainties in their validity and values, and in systematically applying quantitative methods, judgment, and intuition to cull out the predicted best alternative for implementation. This choice of best, in turn, consciously factors in implementation or "realizability" concerns. While there are many opportunities for repeating and refining portions of this analytical process, Fig. 1 indicates that overall iteration, closure, or feedback arises through longitudinal evaluation of the chosen option. In the course of such comparison of actual performance with objectives, amendments may be suggested in the program, the program's goals, or both, with the new objectives and program alternatives potentially necessitating repetition of the entire analytical process. These changes may be triggered by the desire to fine-tune a successful program, to fix or scrap a failing one, or to accommodate new needs or heightened levels of aspiration.

The first step in the systems approach entails problem definition, a deceptively difficult step, albeit an obviously important one. Working on the wrong problem is not only a clear waste of analytical resources, but improper problem formulation can lead to seriously exacerbating the situation and further waste of precious implementation resources. In the present context, designing programs to ameliorate crime conditions and fear of crime, we know that dimensioning the problem is no mean task. The difficulties are hardly eliminated by gathering victimation data to complement archival UCR statistics, nor are the difficulties limited to this obvious need. Community values and representativeness of community interest groups will also affect problem identification, since their views and opinions concerning needs will be normally solicited during the CPTED pre-planning phase. The problem identification stage should end with a high degree of articulation, specificity, and realistic scope to keep the problem limited to manageable proportions and to keep the remaining design steps relevant.

Once the problem is adequately dimensioned, CPTED and other crime prevention techniques can be brought to bear to create an array of candidate options for a decisionmaker to consider. However, before an alternative can be selected for implementation, and even before appropriate options can be synthesized, goals, objectives, and performance criteria must be elicited and developed. Incorrect or imprecise specification of these prevents development of meaningful solutions on the one hand and identification of the superior, inferior, or unacceptable alternatives on the other. The problem here is that in creating public systems, there are often multiple, conflicting, unclear, and even latent objectives. Morevover, the objectives, goals, and evaluative criteria employed are, in part, reflections of the values held by the decisionmaker -- the decisionmaker being a single person or perhaps an elected body presumably acting on behalf of "the community" towards which the prospective program is aimed.

Assuming there is a concensus of interests, commonality of goals and priorities, and aggreement on criteria, one may be yet faced with the knotty problems of conflicting objectives (a frequent public sector phenomenon) and the necessity of using proxy criteria and surrogate measures. For example, in the usual circumstance of a broadscale crime problem, an appropriate top-level goal may be to improve public safety (i.e., below improved quality-of-life, of course). Appropriate subgoals may be the reduction of violent acts such as robbery and non-violent property crimes such as burglary. Accordingly, specific objectives may be to reduce the rate of each of these by 5% and 10%, respectively, in the year following program implementation and with minimum inconvenience to the community served by the program. Even in this modest statement, we see many of the aforementioned problems. First, assuming that these goals or objectives would be agreeable to the majority (i.e., that felony assaults might be deemed more important than burglaries), it is not clear that such reductions in burgalries might not exacerbate the robbery situation in the target community (setting aside the still more difficult displacement problem and the suboptimization issue which it engenders). Second, the objective, " with minimum inconvenience," is not clear. If it means restricted usage of certain facilities or increased taxes, this would be more understandable, although not completely so, and may even admit of quantitative measurement. If it means "little" loss of privacy (e.g., following the use of surveillance measures or patrols in semi-private spaces), the objective is still far less clear and perhaps not amenable to measurement. Third, although the two crime objectives are relatively clear and the performance measures of robberies and burglaries per thousand population during the given year seem suitable criteria, the actual measurement of the numerators and denominators of these terms are well known to suffer unreliability, instability, incomparability, and costliness problems. Fourth, assuming that reduction of fear or maintenance of current police force sizes and visibility were important, but latent objectives, the decisionmaker might well opt for an alternative that was not best vis-a-vis the explicit objectives and performance criteria which guided the synthesis of program alternatives.

Having completed problem formulation, elaboration of goals, objectives, and performance criteria -- processes which are assisted by the planning guidelines set forth elsewhere in the Program Manual -- the CPTED specialists are then in a position to enter the most creative stage, that of designing program alternatives. This array of candidate alternatives may comprise radically different approaches, variations on a basic strategy, or both. During these synthesis activities, the specialist can draw upon CPTED theory, as well as the strategies and specific directives also described throughout the Program Manual. As Fig. 1 indicates, this synthesis phase is followed by analysis and comparison of alternatives with respect to the agreed upon performance criteria. Once the performance estimates have been accomplished, a decision must be made as to which alternative to finally implement, the primary task which the remainder of this chapter addresses. Before illuminating the complexities of multi-objective decisionmaking and describing specific decision aids and their limitations, the reader's attention is drawn to the last two tasks identified in Fig. 1, viz., program implementation and program evaluation. Here too, a large body of material has been provided in the Program Manual to assist in these non-trivial tasks, tasks which are individually crucial to success not only in immediate program terms, but in the broad sense of building CPTED theory and improving its practice.

3. Guidelines for Erecting CPTED Goals and Performance Criteria

3.1 Introduction

Decisionmaking centers on the element of choice -- selecting alternative courses of action. It is a process which is routinely carried on by individual decisionmakers at any level of an organization. The need for decisionmaking arises because of actual or perceived discrepancies between an existing or anticipated situation and the organizational goals toward which a decisionmaker is mandated to direct his efforts. As our discussion of the systems approach emphasized, system or policy alternatives are normally characterized by several attributes, features, or qualities by which their relative desirability is to be judged. The attributes are directly related to a set of performance criteria which are derived from specified program objectives. The multi-attributive decision situations which such complex alternatives engender are themselves complicated by the fact that some alternatives will appear preferable when certain goals and their associated attributes are examined, while others will become so as other attributes are considered. As the number of relevant attributes and proposed alternatives grows, the decisionmaking problem becomes increasingly less tractable for the decisionmaker: there are too many comparisons to make, and the dimensions or attributes of comparison are incommensurable.

Section IV explores these matters more deeply and relates them to several decision methodologies which vary in their informational needs, assumptions, and abilities to preserve the multidimensionality which inheres in such decision problems. The remainder of this section addresses the question of what an appropriate goal fabric might look like in the context of crime prevention and what might constitute a reasonably comprehensive set of program attributes or performance parameters.

3.2 Goals, Objectives, Policy/System Alternatives, and Attributes

Throughout our discussion we shall define a goal as a general direction that enhances a societal group's welfare or "quality of life." While we will often use the terms goal and objective interchangeably, "objective" has the connotation of being a targeted level of a particular goal. A policy or policy alternative, or simply alternative, is a specific course of action designed to accomplish an overall goal. How the benefits of the policy's implementation are distributed requires a specification of different <u>interest groups</u> in society. These are groups of individuals or organizations which share common views about an alternative's consequences. Typically, these might be further classified as to whether they are program <u>users</u>, <u>operators</u>, affected socio-economic classes of <u>society</u>, or implementing <u>agencies</u> with control over resources and with regulatory powers, an obviously non-mutually exclusive set of categories.

At this point, we also need clarification of the term "attribute." General goals or policies can be translated into program or system performance objectives. These objectives, in turn, can be subdivided into individual performance subobjectives. These subobjectives and the appropriate physical units for measuring their performance are called <u>attributes</u>. We shall also interchangeably refer to these as program features, characteristics, properties, dimensions, factors, performance measures, performance parameters, or figures of merit. These all signify subdimensions of benefit that are expected to be provided at varying <u>levels</u> (the actual value of an attribute) by the program alternatives on the one hand, and desired by users, operators, societal groups, and agencies on the other. The crucial point is that once attributes and units of measure are identified, it becomes possible to characterize system demands and impacts as well as to specify system and subsystem performance objectives designed to satisfy such demand and accomplish such impacts. It also becomes possible to evaluate proposed alternatives in specific performance terms, the necessary precursor to determining which alternative is best.

3.3 Structuring Objectives and Attributes

Initially, goals or objectives should be stated in very broad terms. The idea is to be comprehensive at first and then, through a process of successive elaboration, to narrow these objectives down into a highly articulated statement of desired performance. This specification forms the basis for eventual evaluation of alternatives. In the context of crime prevention, for example, the initial overall goal might be to improve public safety, itself subsumed by enhanced quality of life. This higher level goal, which might encompass criminal victimization, injury due to fires, transportation vehicles, and environmental hazards, might be confined to security improvement vis a vis crime only. This, in turn, could be further decomposed into subobjectives concerned with increased risks of criminal detection, apprehension, and conviction. Still further, these could be disaggregated into increased surveillance and police response capacity, etc. By this point, if not earlier, conflicting objectives might start to emerge in the form of preservation of privacy, low cost, high system durability, and so on.

Before we suggest a specific evaluative framework which factors in such concerns, we note more generally that the list of overall performance objectives should possess the following properties. First, it should be comprehensive in the sense that no major performance objective is omitted. Second, to the extent possible, the listed objectives should be mutually exclusive or independent. As we shall see in the discussion of decision methodologies, this independence or non-complementarity assumption is very important to establishing trade-offs and minimizing "double accounting" of system benefits in assessing the total worth or performance of an alternative. Third, the initial list should contain performance objectives of only the highest level of importance in order to provide a sound basis from which to derive lower-level objectives and their attributes.

Once the list of top-level objectives is completed, we can proceed to the next task, operationalizing the key objectives. This is accomplished by disaggregating each objective into a tree-like structure of lower-level objectives and attributes. At this stage we have consciously defined each objective's intent and have evolved a utility or worth structure in the form of a set of attributes by which to judge the merits of any set of proposed alternatives. The final step in devising the set of key attributes is to select a physical unit of measure for each attribute. This provides a concrete physical interpretation for the performance characteristics and thereby establishes a link between the real world of physical or procedural alternatives and the subjective preferences of decisionmakers. That is, attributes provide a tangible, observable measure of what alternatives can <u>deliver</u> (or are delivering, as in post-implementation program evaluation), as opposed to the stated subobjectives which simply reflect what a decisionmaker subjectively <u>desires</u>.

Selection of physical performance measures requires informed judgment. Well-defined attributes and readily measurable units should be chosen which reflect the intended meaning of the lowest level objective being considered; i.e., they should have "face validity" and admit of easy measurement. The process for obtaining a final list of such measures will usually be iterative and follow steps along the following lines:

(1) Locate an objective or attribute in the list without an attached measure (i.e., find an incomplete branch on the hierarchical tree of objectives).

(2) In the context of the application (e.g., CPTED), determine whether a given objective is to be interpreted directly by a physical performance measure or to be further subdivided (if the latter, go to step 3, else skip to step 5).

(3) With respect to the applications context, subdivide the given objective into 2 or more subobjectives and attributes (together with the other objectives and attributes of the list these now constitute an expanded master list).

(4) Select any of the new attributes which emerged in step 3 and return to step 1.

(5) In the context of application, select a physical performance measure relevant to the subobjective being considered.

(6) Move backwards up the current branch of the hierarchical tree of objectives until encountering the first level containing an uncompleted branch. If not at a top-level objective, select the incompleted branch and return to step 1; else go to step 7.

(7) If all major performance objectives and their associated attributes have been completed at the top level of the tree, the process terminates; else select any incomplete branch and return to step 1.

3.4 Security System Concepts and a Preliminary Attribute Framework

As a precursor to scoping out an attribute framework to use as a basis for assessing and comparing CPTED alternatives, we shall introduce several security system concepts.* The term "security system" will be used to denote an entity which interacts under external constraints with specific threats and protective elements to accomplish criminal deterrence and apprehension. "Threat domain" will denote the specific criminal activities to be curtailed by the security system; its description includes such factors as forcefulness, frequency, scale, modus operandi, etc., and their translation into physical characteristics. "Protective domain" will signify the specific property and persons to be safeguarded as well as the precise locations and times involved. Finally, the "constraint set" will include the technical descriptors of the relevant social, political, economic, technical, environmental, etc., factors that circumscribe the threats, the protected personnel and property, and the security system itself (i.e., to the extent such technical representations are possible).

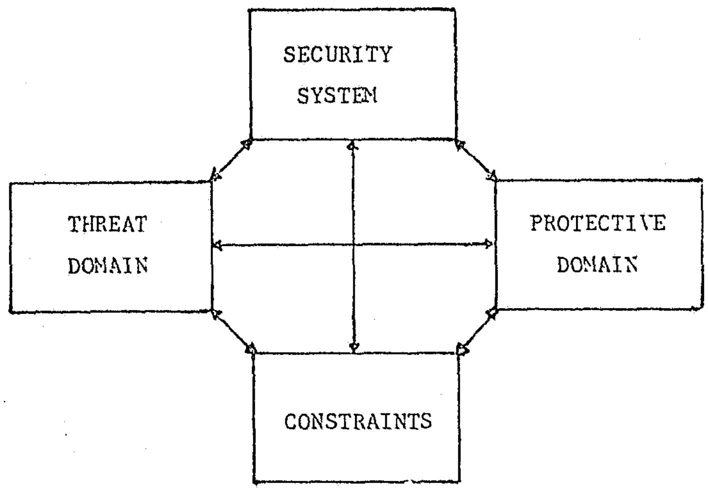
*Another security model, the OTREP model, is elaborated in the Program Manual.

This definition leads to a broad operational view of a security system and includes the notions of security held by several agencies. The property owner, for example, considers a security system as a conglomeration of components which jointly act to reduce personal loss. The police would add the notion that a security system should enable the apprehension of offenders. An insurance underwriter would view a security system in terms of its ability to facilitate recovery of stolen goods; an attorney, in terms of providing evidence for conviction; a social worker, in terms of deterring or denying antisocial behavior; etc. Despite the variety of viewpoints, one can attempt to state broadly what a security system is in a way that considers all these dimensions.

Fundamentally, the measure of effectiveness for a security system should be the degree to which thoughts of crime are not translated into actual deeds, and, failing this, the extent to which attempted crime is not successful. To be effective, then, a security system must act as a deterrent, provide resistance, and afford apprehension capability. Two strategies are commonly employed to deter or resist criminal acts and to make them self-defeating: (1) Decreasing the real or apparent opportunities for crime; and (2) Increasing the perceived risk of apprehension and penalty. Since these deterrents and denials do not always suffice, an ability to apprehend and penalize must be actually present, generally in the form of the capabilities summarized in Fig. 1B. Security effectiveness is reflected in the successful, collective accomplishment of all the enumerated objectives. In order to apply numerical or judgmental ratings to alternative security proposals, however, these objectives must be translated into effectiveness measures, or security system attributes, as discussed earlier.

Figure 1C is a preliminary attempt to generate and partially operationalize a set of security system attributes. Although not exhaustive, the list should suffice to evaluate most aspects of security design commonly of interest. As will become apparent in the definitions which follow, the proposed security criteria lack complete independence, a feature which will hamper further analysis as explained earlier and elaborated more fully in Section IV. Once operationalized, it is clear that the numerical or qualitative assignments which are ascribed to the attributes will depend heavily on the applications context, varying with the specific threat category, the protective domain, and the operational constraints.

SECURITY SYSTEM INTERACTIONS AND OBJECTIVES



OBJECTIVES AND FUNCTIONS

- Detect and Discriminate the Crime
- Actuate and Transmit an Alarm Condition
- Annunciate and Decode the Alarm
- Command and Control Forces
- Transport Forces to the Crime Area
- Search and Examine the Crime Area
- Identify, Locate, and Arrest the Criminal
- Provide Evidence to Aid in Conviction
- Recovery Property and Reduce Morbidity and Mortality

FIGURE 1B

ILLUSTRATIVE SECURITY SYSTEM PERFORMANCE MEASURES AND UNITS

FIGURE 1C

ATTRIBUTES

- Security-Effectiveness
  Deterrent Probability
  Detection Probability (sensitivity, spatial & temporal coverage)
  Discrimination & Identification Capacity (false alarm/dismissal rates)
  Alarm Transmissibility (probability of reception)
  Response Capacity (response time and manpower/force level)
  Reliability (system failure rates)
  Survivability (susceptibility/likelihood of destruction)
  Adaptability (probability of accomodation to changing threats and countermeasures)

- Implementability
  Availability (for purchase and use by target date)
  Installation Feasibility
  Public Acceptance

- Compatibility
  Convenience of Use
  Privacy Incursions
  Aesthetic Appeal

- Operability
  Management Requirements
  Dependence on User Cooperation
  Modularity (ease of system expansion)
  Safety
  Repairability (ease of maintenance)

- Cost-Benefit
  Research & Development Cost (equipment,maintenance,administration before production)
  Capital Cost (equipment,maintenance,administrative costs during production)
  Operating Cost (equipment,maintenance,administrative costs during use)
  Scrap Value (residual value at end of use)
  Expected Total Benefit (value of reduced crimes: morbidity,mortality,property,etc.)

Some of the attributes described in Fig. 1C require additional definition. We have previously described deterrence as the capacity to prevent threat initiation and to make criminal activity self-defeating. A deterrent capability can consist of real physical barriers as well as suggested ones. The combination of these physical and psychological obstacles should heighten the potential perpetrator's imagined and actual chances of apprehension and conviction.

By detection , we mean discovery of the existence of characteristics indicative of a threat. By this definition, detection differs from the usual connotation of entrapment, identification, or verification. Detectability is linked instead to system sensitivity and to spatial and temporal coverage.

Closely related to detectability is the capacity for discrimination, i.e., the ability to distinquish real threats (the desired "signals") from innocent activity ("noise") and to classify uniquely each threat signature. It is discrimination capacity which makes the human an indispensible element of high security systems. Humans are more readily adaptable to elusive threats and are far better at real-time pattern recognition than currently available physical mechanisms. Because random noise introduces uncertainty into all real security systems, an obvious trade-off exists between these detection and discrimination functions or attributes. By accepting a sufficiently high false alarm rate, the false dismissal probability can be made arbitrarily close to zero. Thus, the level at which a detection threshold is set always results in a compromise between mistakenly announcing or ignoring an alarm. Both types of error can be simultaneously reduced, of course, if one is willing to wait for more information about the possible criminal act in progress. The selection of the proper threshold for a given amount of information will depend on the relative importance or costs associated with the two types of errors.

The alarm process requires only intelligible annunciation, usually after transmission to a command-and-control center removed from the crime area. The alarm can be based on detection alone, discriminated detection, or both. Once an alarm is made, the system must respond forcefully enough to abort the threat if the net gain fr[illegible]ing so exceeds some preassigned criterion or threshold. Since it may be necessary to do this repeatedly, the system's "duty cycle" must match the highest anticipated threat repetition frequency to minimize failures do to spoofing or repeated real attack. Moreover, the system's response time must be less than the total crime duration if on-site arrest is to be made. The response mode itself might be any of a number of forms: from no action, to a simple electromechanical or chemical trap, to an elaborate security guard or police contingent. In any case, the forcefulness or manpower level associated with the response should be commensurate with the threat.

System reliability is an attribute which pertains to the assurance of meeting a prescribed confidence level for system operability, usually expressed in probability terms. Reliability is also closely related to the requirements of repairability and maintainability, perhaps even the capacity for self-diagnosis and fault indication, if not for self-repair. These attributes are broken out separately under the major attribute heading, operability.

The system must also fulfill a specified probability of satisfactorily functioning in the face of numerous countermeasures and evasive tactics: sabotage, vandalism, unintentional and purposeful jamming, etc. This is what is meant by survivability. We distinquish this from adaptability which connotes the ability of the system to cope with changing or elusive threats for which it was not specifically designed. For simplicity, the features we have called reliability, survivability, and adaptability might be crystallized into one attribute called, perhaps, durability.

When these criteria of performance are further coupled with implementability, compatibility, operability, and cost-benefit characteristics, we then obtain a fairly comprehensive attribute set from which to judge the merits of proposed design alternatives. The next section addresses the issue of how a decisionmaker decides which alternative is best considering all the relevant attributes and estimated levels which have been assigned to all of them . All of the methodologies will be illustrated in terms of the five majors attributes just considered, i.e., security-effectiveness, implementability, compatibility, operability, and cost.

4. Decision Aids and Treatment of Uncertainty

4.1 Introduction

The primary concern of this section is how to select from an array of candidate CPTED alternatives the best one for implementation. We assume, therefore, the satisfactory completion of the precursory stages of problem definition, identification of goals, objectives, and performance criteria, as well as synthesis of suitable options. To answer the question of best, the decisionmaker must refer to the goals and criteria explicated earlier in the systems analysis process. Despite this rationality and systematicness, the decisionmaker's task will be hampered by two factors present in every significant social design problem. The first of these has to do with uncertainty, the second, with limitations associated with our capacity to process information.

Often we do not know precisely an alternative's outcome before its implementation. There may even be problems in accurately assessing a program's impact after it has been put into operation, as elaborated elsewhere in the Program Manual. The reason for the a priori uncertainty stems from the fact that the program's outcome may depend on the occurrence of events and conditions beyond the decisionmaker's control (so-called "exogeneous" events or "externalities"). Another form of uncertainty relates to the actual levels, as opposed to the predicted or estimated levels, associated with the performance measures by which a program is judged. That is, either because of ignorance regarding certain variables and their interactions, or because of their inherent randomness, we may not know a priori the exact outcomes, but only a distribution of possible outcomes and their associated probabilities. The term decisionmaking under risk is given to the latter circumstance. When even the probabilities are unknown, the term decisionmaking under uncertainty pertains, obviously a higher state of ignorance. Figure 2 illustrates this hierarchy of certainty-to-uncertainty. The expressions of varying (un)certainty apply generally to any aspect of program performance or outcome variable of interest.

Because of our limited ability to assimilate and process information relating to complex systems, even when high levels of certainty are present and computers are available to assist, decisionmaking can still be very difficult. As we have seen in the previous section, a common type of such complexity which frequently occurs in social systems and public policy problems

FIGURE 2

HIERARCHY OF UNCERTAINTY:

FORMS OF EXPRESSION & SPECIFICITY

STATEMENT	LEVEL OF UNCERTAINTY & SPECIFICITY	DECISION CONTEXT
Program alternative A is estimated to cost $1.5M.	Complete uncertainty; no expression of likelihood is provided.	UNCERTAINTY
Program A is estimated to cost $1.5M; however, analyst is not certain about the figure.	Nearly complete uncertainty; a vague caveat regarding uncertainty of the estimate is provided however.	RISK
Program A is estimated to cost between $1.1M and $1.9M.	Uncertainty is made more explicit and a range (interval estimate) is provided to express the magnitude of uncertainty. However, no probability or confidence measure accompanies the interval estimate. It remains uncertain whether the analyst believes the true cost has a 1%, 50%, or 100% chance of falling in the range. Nor is it clear whether the true cost is more likely to be nearer $1.1M than $1.9M.	
Program A's cost has a strong probability of costing $1.1M - $1.5M -$1.9M where $1.1M and $1.9M are the estimated lower and upper cost limits and $1.5M is some central measure.	Uncertainty is made still more explicit by adding a qualitative probability measure to indicate degree of confidence associated with the interval estimate. It is not clear what measure of centrality (mean, median, mode, etc.) is conveyed vis a vis the $1.5M figure.	
Program A's cost is estimated to be in the interval $1.1M to $1.9M with probability 0.90 and with $1.5M being the estimated modal value.	Uncertainty regarding the interval estimate is now given a quantitative expression, and the sense of centrality is made precise (in this case, the most likely or modal cost). The probabilities associated with other ranges of cost remain unknown however.	
Program A's cost follows the following probability distribution (density function) with parameters...	Uncertainty is completely characterized by providing the entire probability distribution (density function) for cost. Probabilities corresponding to any cost estimate can be derived from the graph or the analytical expression for the cost density function by computing (integrating) the area under the appropriate portion of the function. Presumably, the function is known exactly.	
Program A's cost is known to be exactly $1,405,671.15.	Cost is known with complete certainty to the nearest penny.	CERTAINTY

stems from the multiple objectives and therefore multi-attributive nature of such systems and issues. That is, system or policy alternatives are normally characterized by several attributes, features, or qualities by which their relative desirability will be judged. As Fig. 3 illustrates, such complexity forces us to construct and manipulate some simplified model of the problem situation in order to assess the relative merits of proposed policy or program alternatives. Choice is then guided by estimated values of the performance criteria, the criteria having been established from an elicited set of desired objectives. While this is not the only path open to the decisionmaker, it is the only practical one. Choice could proceed on the basis of implementing and observing all the alternatives in the real world. The one which worked best would then be implemented permanently and the rest dropped. The expense associated with such a wholescale trial-and-error approach, if not the anticipated public reaction to program abandonment, usually precludes this decisionmaking strategy however. It is also possible for selection to proceed on a purely intuitive basis, but for reasons articulated previously it would not be clear that judgmental information was systematically or comprehensively incorporated in the final decision.

4.2 The Multi-Attributive Decision Problem

In order to set the stage for the specific choice methodologies which follow, we assume that the CPTED project team have completed three tasks. First, that from a set of elicited goals and objectives, a companion set of program attributes or performance measures has been established. Second, that corresponding to the program objectives and the specific attributes which reflect them, a set of program alternatives has been synthesized. And third, that through the use of expert judgment, predictive models, or combinations of these, each candidate program alternative has been given a performance rating on each attribute. Each of these ratings may be either a single value (point estimate), or a range of values (interval estimate). To simplify exposition, our illustrations will initially assume that only point estimates have been made. Later, we shall readdress the case of interval estimates, as well as the problem of acquiring the estimates themselves.

Figure 4 provides a mathematical overview of the table of performance values which have been obtained.* In order to keep our discussion concrete, we present

*Throughout this chapter, formal mathematical notation and definitions will be used to provide clarity, rigor, and conciseness beyond that given in the verbal descriptions. The reader who is unacquainted with the mathematics involved or doesn't find the formalities helpful can skip these with no loss in conceptual understanding.

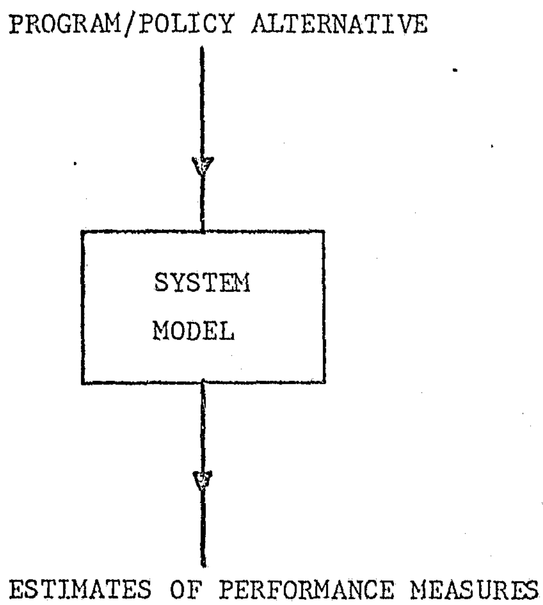

PROGRAM/POLICY ALTERNATIVE
SYSTEM
MODEL
ESTIMATES OF PERFORMANCE MEASURES

FIGURE 3

ALTERNATIVE/ATTRIBUTE MATRIX

ATTRIBUTE	ALTERNATIVE A_1	A_2	. . .	A_N
a_1	r_{11}	r_{12}	. . .	r_{1N}
a_2	r_{21}	r_{22}	. . .	r_{2N}
⋮	⋮	⋮		⋮
a_M	r_{M1}	r_{M2}	. . .	r_{MN}

Key: a_i = i th attribute, i=1,2,...,M

A_j = j th alternative, j=1,2,...,N

r_{ij}= estimated performance rating on i th attribute for j th alternative

R = MxN matrix of ratings r_{ij}

M = number of attributes or performance measures

N = number of program alternatives

FIGURE 4

in Fig. 5 a specific, albeit highly simplified illustration of how the alternative/attribute matrix of Fig. 4 might appear. Only point estimates are given for each alternative/attribute combination, and the attributes have not been disaggregated into the more detailed measures of performance presented in the earlier sections.

If we assume that the design problem corresponding to Fig. 5 entails reducing a community's burglary and robbery rates, for example, then the security effectiveness attribute might be measured by, say, the estimated weighted average percentage reduction in these crimes. Without going into a long digression on the validity of this measure, suffice it to say that the weights themselves might be chosen to reflect perhaps the Sellin-Wolfgang seriousness indices for these crime (cf., Fig. 6), or perhaps some local priorities vis a vis these crimes. On this measure, Fig. 5 shows that alternatives A_1 through A_4 have been scored 10, 15, 8, 18, respectively, and that A_4 is judged superior to the rest for this particular attribute. On the attribute cost, measured in $100,000, say, the relative desirability of the alternatives is judged A_3, A_1, A_2, A_4. For this attribute, A_4 now appears inferior. If we limit our analysis to just these two attributes, we see very graphically the ingredient that makes multi-objective or multi-attributive decisionmaking so difficult. When a particular goal and its associated attribute are examined, it is clear that some alternatives will be preferable, perhaps uniquely so, while other alternatives will become preferable when another attribute is considered. As the number of relevant attributes and proposed alternatives grows, the decisionmaking problem becomes increasingly less tractable for the decisionmaker: there are too many comparisons to make and the dimensions or attributes of comparison are incommensurable.

The illustration just given also points up several other aspects of the alternative/attribute matrix. The attributes needn't be expressible exclusively in quantitative terms, althought the needs for ultimately doing so through scaling techniques will be a requirement of some of the decision aids presented next. Thus, the implementability and compatibility attributes of Fig. 5 are measured by the three qualitative (categorical or nominal) ratings of high, medium, and low; there could have been more or fewer such categories of course. The initial performance estimates can also be rankings (i.e., ordinal rather than cardinal or nominal measures), as is the case for operability, where 1 might denote best on a scale of 1-to-4, etc. In short, all levels of measurement

ILLUSTRATIVE ALTERNATIVE/ATTRIBUTE MATRIX

CPTED DECISION PROBLEM

ATTRIBUTES		ALTERNATIVE PROGRAMS			
		A_1	A_2	A_3	A_4
a_1	Security-Effectiveness	10	15	8	18
a_2	Cost	5.3	8.5	1.2	10.1
a_3	Implementability	HI	MED	HI	LO
a_4	Compatibility	HI	HI	HI	MED
a_5	Operability	2	2	1	3

FIGURE 5

SELLIN-WOLFGANG CRIME SERIOUSNESS INDEX

SEVERITY VARIABLES	INCIDENT WEIGHTINGS*
Number of Victims of Bodily Harm	
Received Minor Injuries	1
Treated and Discharged	4
Hospitalized & Discharged	7
Killed	26
Number of Victims of Forcible Sex Intercourse	10
Number Intimidated by Weapon	4
Number Not Intimidated by Weapon	2
Number of Premises Forcibly Entered	1
Number of Motor Vehicles Stolen	2
Value of Property Stolen, Damaged, or Destroyed ($)	
Under 10	1
10 - 250	2
251 - 2000	3
2001 - 9000	4
9001 - 30,000	5
30,000 - 80,000	6
Over 80,000	7

*These are additive for each crime having any of these characteristics.

FIGURE 6

CONTINUED

4 OF 5

are admissible for the attributes, from qualitative (nominal-scale) to quantitative (ratio-scale), and ties in values among alternatives are also permitted. Were this not the case, there would be immediate conflict with the present state-of-the-art ; measurement of crime and environmental variables, as noted earlier.

4.3 Multiple-Attribute Decisionmaking Aids

The following approaches to multi-attributive decisionmaking draw from extant methods which can be conveniently characterized by the extent to which they reduce the dimensionality of the original decision problem. Referring to Fig. 4, what this means is that if M attributes have been enumerated as being important performance measures by which to judge a CPTED alternative (e.g., M = 5 in Fig. 5), then the original dimensionality of the decision problem is M. As elaborated previously, the complexity of the decisionmaking situation grows with M and the number of alternatives to be considered, N. As we shall see, some of the decision aids which we present deal directly with all M attributes, while others attempt to reduce the problem to some lesser dimensionality than M. Of course, since each attribute is important in its own right, it would be desirable to consider simultaneously and explicitly all M without imposing any assumptions to collapse them or without omitting any of them. Methods which do so however suffer from either not producing unique solutions to the decision problem (i.e., yield a single best alternative to implement), or from not sufficiently reducing the complexity of the original problem to the point where it becomes tractable (i.e., as measured by the number of attributes which remain to be considered). At the other end of the spectrum of methodologies, there are techniques which reduce the decision problem of M attributes to a single, composite dimension. These approaches either impose assumptions that permit the M dimensions (attributes) to be combined or mapped into a 1-dimensional space, or impose conditions that remove M-1 dimensions from consideration. Between these two ends of the spectrum, we find methodologies which reduce the original complexity to something less than M, but greater than 1. We shall present methods according to this typology and in order of their complexity reduction, highlighting the assumptions and informational requirements of each. A final section will provide a mathematical synopsis of each technique described.

4.3.1 Multi-Dimensional Methods

4.3.1.1 Dominance

One of the principal techniques for treating multi-attributive decision problems in their full dimensionality, M, is called "dominance." In this approach, as in all full dimensionality approaches, each attribute is sovereign or independent. That is, an alternative's performance estimate on each attribute must stand on its own, and an unfavorable value on one can't be traded-off against a more favorable rating on another. All attributes must be examined separately and independently.

The essential idea underlying the dominance approach is that if in comparing all alternatives one has higher attribute scores on all attributes, then that alternative is said to dominate the rest. Actually, we can relax this definition slightly by saying that an alternative dominates another if it is better on one or more attributes and at least as good on the others. We can illustrate this simple concept of dominance by changing some of the attribute scores of Fig. 5 to those in Fig. 7. If we recall that the most desirable operability score is 1 and that low cost is more favorable than high cost, then Fig. 7 shows that alternative 2 strictly dominates alternative 1 since it is better on all attributes.* Hence the decisionmaker can drop A_1 from further consideration. We also note that A_3 dominates A_2, although it is not "strictly" dominant since there is a tie on the attribute a_1, security-effectiveness. The second alternative can therefore also be dropped from the list. Finally, we note that A_4 does not dominate A_3 nor is it dominated by A_3. While A_4 is strictly better than A_3 on attributes a_1 and a_2 (security-effectiveness and cost), it is inferior on attribute a_3 (implementability) and merely tied on the rest. Hence, both A_3 and A_4 remain for additional consideration; a unique solution is not obtained.

This simple example illustrates the key advantage and principal defect of the dominance approach to decisionmaking. On the positive side, the concept is easily uderstood, applied, and accepted. The decisionmaker can proceed solely on the basis of one attribute value being preferable to another and doesn't require numerical information to establish this preference (e.g., "high" compatibility is better or preferred to "medium"). No trade-offs

*To simplify the interpretation of Fig. 7, either the signs of a_2 and a_5 could be made negative or the attributes could be redefined so that higher values are always preferable.

ILLUSTRATIVE CPTED DECISION PROBLEM

DOMINANCE & SATISFICING APPROACHES

ATTRIBUTES		ALTERNATIVE PROGRAMS			
		A_1	A_2	A_3	A_4
a_1	Security-Effectiveness	10	15	15	16
a_2	Cost	5.3	4.9	4.5	4.4
a_3	Implementability	MED	MED	HI	MED
a_4	Compatibility	LO	MED	HI	HI
a_5	Operability	3	2	1	1

FIGURE 7

are forced on the decisionmaker either, for each attribute is examined independently. On the negative side, we see that dominance will typically be of limited utility because there will be a number of alternatives remaining in the original set after the method has been applied. In our example, two remain from the initial set of 4 alternatives and, therefore, the decisionmaker is faced with having to make a final choice between these two. Moreover, in the course of applying the dominance procedure, we do not get any information regarding a decisionmaker's degree of preference for a particular attribute score (e.g., how much more is "high" implementability preferred to "medium," etc.). Nor do we explicitly factor in the relative importance of each attribute. Thus, we don't know how much high security is preferred to low cost, or how a difference in security ratings trades-off against a difference in cost, cost against implementability, and so on.

4.3.1.2 Satisficing

This approach also preserves the full dimensionality of the decision problem in that M attributes are separately and independently considered. As with dominance, the method has strong intuitive appeal and centers on a simple idea. The decisionmaker states the smallest attribute scores that will be acceptable on each attribute -- in effect, supplying the minimum goals or performance values corresponding to his program objectives.*

As a concrete example, suppose the decisionmaker supplies the following M acceptability thresholds: security-effectiveness, at least 15; cost, no more than 4.75 (x $100,000); implementability, at least MED; compatibility, at least MED; operability, not to exceed 3 (i.e., not below third in rank). Referring again to Fig. 7, we see that the first alternative can be dismissed either for failing to meet the security-effectiveness, cost, or compatibility criterion. Similarly, the second alternative can be dropped since it fails the second criterion, i.e., it's too expensive. The last two alternatives are both feasibile, however, in that both meet all the criteria. Consequently, the decisionmaker must consider these two further.

Again, this simple example allows us to distill some general features of this "satisficing" (or "sufficing") approach. It shares with dominance the

*As before, if the attributes are not defined so that "bigger is better," either such attribute's scores can be negated (multiplied by -1), the attributes redefined, or simply a ceiling rather than floor type threshold on performance can be stated (e.g., largest or worst value tolerable for program cost).

possibility of being left with more than one alternative at the conclusion of its application. In contrast to dominance, however, the remaining set of feasible alternatives can be reduced to one alternative by successively increasing the acceptability thresholds. This process of more restrictive filtering will eventually culminate in one feasible alternative, viz., the one to be implemented. Alternatively, if the initial set of thresholds is too restrictive so that there are no feasible alternatives remaining, the acceptability criteria can be selectively lowered until one alternative just meets them all. It's this iterative flexibility which makes satisficing a more powerful decision aid than dominance.

Satisficing has a number of advantages and drawbacks. On the positive side, we appreciate its strong intuitive appeal, as with dominance. It also enables us to consider each attribute on its own merits, to allow attributes to be expressed in non-numerical form, to only need to know which values of an attribute are preferred (not necessarily the degree of preference), to not need information on the relative preference of the attributes themselves, and to be able to relate the scores to specific acceptability criteria. The latter quality, however, dictates higher informational needs for satisficing than for dominance, i.e., the M performance threholds. On the debit side, we also note, in addition to the need for more data, that none of the alternatives gets credited for especially good attribute scores since only minimum values (thresholds) are invoked in inspecting each attribute. Thus, in the example given, the third alternative appears "slightly" inferior on the security and cost dimensions but isn't credited (in its comparison with alternative four, say) for its high score on implementability relative to the threshold placed on this attribute. While this conveys the basic idea of non-crediting, we hasten to add that except for cost, which is directly quantified at the highest level of measurement (ratio-scale), we don't really know what the true "distance" is between "high" and "medium" on implementability, nor perhaps between 15 and 16 on the security-effectiveness scale (i.e., these may be only rank or ordinal-level measurements). As we shall see, the ensuing procedures help to overcome this defect by attempting to credit alternatives which have some exemplary scores.

It should be recognized that both dominance and satisficing are probably both used, at least implicitly, during the design stage as well as in the final decisionmaking. That is, in the course of synthesizing alternatives, the astute designer will undoubtedly mull over numerous tentative designs, discarding obviously inferior ones and attempting to enhance those designs that appear weak on some attribute he considers salient. However, the designer will be imputing his own subjective scores to these designs; he may not be dealing with the decisionmaker's attribute set, the decisionmaker's operational definitions of the attributes, and his performance standards may not be congruent with the thresholds which the decisionmaker eventually specifies. Of course, were the designer advised of all these at the outset, and if his attribute scorings were to be adopted without inputs from other experts, then the design and decisionmaking functions could be combined. Typically, such a designer might proceed sequentially, stopping with the first design which just met or exceeded the imposed performance criteria --i.e., he would have found a "solution" to a particular CPTED problem. Practically, of course, the decisionmaker might be reluctant to place all this authority in the designer's hands or to forego seeing and choosing from an explicit array of program options.

4.3.2 Uni-Dimensional Methods

Dominance and satisficing are the main procedures available for treating and preserving the full dimensionality of multi-attributive decision situations. Their chief advantage stems from reducing the number of alternatives to be finally considered, since their application needn't end with one feasible alternative. Dominance, as we've seen, uses an alternative-alternative comparative approach, while satisficing employes an alternative-goal threshold approach. Although they are both weak in reducing the original set of alternatives to a unique choice, at least satisficing can be applied iteratively to mitigate this defect. The two approaches can be strengthened when used in concert with the uni-dimensional techniques which we shall now define.

The essential feature of all the uni-dimensional methods which we shall describe is that the M attributes characterizing any alternative is collapsed to a single dimension. The methods which do this can be further dichotomized. The first three approaches accomplish the uni-dimensionalization by preserving one of the M attributes as the one final dimension. The remaining methods work by mapping the original M-dimensional attribute information into a single numerical scale.

4.3.2.1 Maximin

The maximin approach has its conceptual roots in the "weakest link" metaphor;i.e., in selecting a chain we might proceed by identifying the weakest link in each alternative chain and then pick the one which possessed the strongest weakest link. In the present context, the decisionmaker would examine each alternative's attribute values, identify the lowest (worst) score for each alternative, and then choose the alternative with the highest score in its worst attribute. Even this so-called "maximin" value and its associated alternative could be rejected, of course, if it didn't exceed some performance threshold. The designers would then be banished to the drawing boards in the hope of improving the maximin alternative, or coming up with some even better new ones.

As we shall illustrate momentarily, the maximin procedure has as its principal disadvantage the need for a high degree of comparability within and across attribute values. This is because the procedure calls for not only comparing attribute values within an alternative, but also comparing the worst attributes across alternatives. Since these worst attributes need not all pertain to the same attribute, as is usually the case, it is not clear how the best of the worst values is to be ascertained. Thus, maximin requires all attributes to be measured on a common, though not necessarily numerical, scale.

We can easily illustrate this need by again referring to Fig. 7. Although it is hard to decide without the benefit of some common, explicit scale -- the very point we're trying to make -- it appears that the first alternative's worst attribute score is on the fourth attribute, compatibility, while for the second alternative, the worst appears to be associated with the last attribute, operability. Since the third alternative has maximum scores on its last three attributes, its weakest score must lie among the first two, let's say the first one, security-effectiveness. Similarly, the last alternative appears to have its weakest rating in the third attribute, implementability. Even if we accept these easily contestable conclusions, how are we to decide which is the best of these worst scores? How does the "low" score for A_1 on a_4 compare to the score of 2 for A_2 on a_5, to the score of 15 for A_3 on a_1, and the score of "medium" for A_4 on a_3 -- i.e., which of these is best and therefore which alternative should be finally selected?

To illustrate a successful application of maximin vis a vis Fig. 7, we shall assume that the four attributes have been scaled from 0 (i.e., no security-effectiveness, maximum cost, poorest implementability, compatibility, and operability) to 100 (i.e., maximum security, zero cost, highest implementability, etc.). Without digressing into the fundamentals and intricacies of scaling for the moment, our scaling exercise might result in the values shown in Fig. 8. For the first alternative, A_1, it is now clear that a_4 is the worst attribute since it has the lowest value among all the comparably scaled attributes. A_2's worst attribute is a_5 with a score of 45. A_3's worst score is 55, on a_2, and A_4's worst rating is on a_3, with value 50. In effect, at this stage, we have replaced each alternative and its M attributes by a single attribute value; i.e., we have uni-dimensionalized each alternative. Finally, from this set of N poorest attribute or performance scores, we pick the one with the highest value, viz., 55. Since this is associated with the third alternative, the decisionmaker concludes that this is the program option to implement.

This example also highlights another deficiency of the maximin procedure, beyond the requirement of comparability. The method doesn't take advantage of all the available performance data in arriving at a final choice. As we observed, one attribute becomes the proxy for each alternative, all M-1 other attribute values having been discarded in the course of searching for the worst score. Ties, of course, have no effect in this regard, since only one such worst value gets recorded for the final run off. Consequently, even if an alternative is exemplary in all but one attribute, another alternative which is only mediocre on all attributes would be chosen over it as long as its poorest value was better than the former's. The chain analogy is thus seen to be rather crude, for in the decisionmaking context, the attributes (links) are not really homogeneous in measure, they are not interchangeable in regard to their performance description roles, nor do they pertain to simultaneously acting program features.

4.3.2.2 Maximax

The maximax procedure is the reverse of the maximin method and shares all of its benefits and drawbacks as a decision tool. If maximin can be regarded as pessimistic or conservative in its selection approach, then maximax might be characterized as optimistic or liberal. The reason for this is that the procedure calls for identifying the best attribute value for each alternative

ILLUSTRATIVE CPTED DECISION PROBLEM

MAXIMIN & MAXIMAX APPROACHES

ATTRIBUTES		ALTERNATIVE PROGRAMS			
		A_1	A_2	A_3	A_4
a_1	Security-Effectiveness	50	75	75	80
a_2	Cost	47	51	55	56
a_3	Implementability	50	50	90	50
a_4	Compatibility	10	50	90	90
a_5	Operability	30	45	90	90

FIGURE 8

and then selecting the alternative which has the highest of these best scores.

Returning to the scaled version of Fig. 7 given in Fig. 8, we observe that A_1's best attribute value is 50 (on both attributes a_1 and a_3). Similarly, A_2, A_3, and A_4's best scores are 75, 90, and 90, respectively. The best of this set of N (i.e., 4) highest scores is 90, a value shared by A_3 and A_4. Hence, either alternative could be implemented, which is consistent with the maximax criterion, or the tie could be broken by a reassessment of the attributes on which A_3 and A_4 scored the 90.

The comparability assumptions and the informational inefficiency which inhere in the maximax and the maximin methods restrict their utility as decision aids. The comparability assumptions and selection criteria also imply equal weighting of attributes and therefore uniform priorities vis a vis the goals which they reflect. Such indifference isn't the usual state of affairs in CPTED, nor in many other decisionmaking contexts. This defect is addressed by some of the methods which follow.

4.3.2.3 Lexicography

The lexicographical procedure, unlike those described so far, assumes that the attributes by which the alternatives are to be judged are not necessarily of equal importance and can be ranked accordingly. It belongs to the class of uni-dimensional techniques in the sense that one attribute (dimension) is considered at a time, starting with the attribute which is predominant in importance. If one alternative has a higher attribute value on this most salient dimension, it is selected and the decision process terminates. If there are several alternatives which are tied on this maximal value, then the non-maximal alternatives are discarded and the procedure continues by considering the next most salient attribute. Again, either a uniquely maximal value is found or the tied alternatives are retained and the remainder dropped in yet another iteration of the procedure. The screening process is repeated in this way until either a unique alternative is obtained or the least salient attribute has been examined. As necessary, any ties at this last stage can be broken by appending additional attributes of decreasing saliency to the original set.

Figure 8 offers a simple illustration of this straightforward technique. We assume that the M attributes have already been ranked in relative importance and that the rows of the alternative/attribute matrix reflect this ranking so that the first row attribute a_1 (security-effectiveness) is most important, the second row a_2 (cost) is next most important, ... ,and the last row a_M (operability) is least important. According to the lexicographical procedure then, a_1 is to be considered first. This leads to the maximal attribute value of 80, possessed only by A_4. Therefore the procedure ends here and the fourth alternative is selected for implementation.

Through Fig. 9, a slight variation on Fig. 8, we can illustrate the potentially iterative nature of lexicography. In Fig. 9, the maximal value on a_1 is still 80, but now A_2, A_3, and A_4 are tied on this predominant attribute. A_1 is discarded therefore, and we now consider attribute a_2. On this next most important attribute, a maximal value of 55 is shared by alternatives A_3 and A_4. Iterating once more, we delete A_2 from further consideration and move on to the third attribute. On a_3 the maximal value is 90. Since this value is uniquely possessed by A_3, the procedure terminates and the third alternative is finally selected.

Lexicography, like the other uni-dimensional techniques, does not require numerical information and has basically modest informational requirements. Although it requires ranking of the M attributes, these rankings needn't be numerically expressed (i.e., qualitative inputs such as the following suffice: most important, next most, ... , least). Moreover, lexicography does not necessitate the comparability and numerical scaling across attributes that maximin and maximax do. These features, coupled with the intuitive appeal and simplicity of the technique, make lexicography particularly useful as a decision aid. Its major weakness, as we saw in regard to Figs. 8 and 9, is that it too does not take advantage of all the information in the alternative/attribute matrix. The following techniques attempt to overcome this inefficiency.

4.3.2.4 Conjoint Analysis

Conjoint analysis is a uni-dimensional decision scheme in the sense that a single numerical performance index or figure of merit is derived for each alternative. It has the advantage over lexicography in that all attributes are weighed in during the computation of an alternative's performance index. In order to do this, it is assumed that the decisionmaker can do more than merely rank the attributes in importance, as in lexicography. If the

ILLUSTRATIVE CPTED DECISION PROBLEM

LEXICOGRAPHICAL APPROACH

ATTRIBUTES		ALTERNATIVE PROGRAMS			
		A_1	A_2	A_3	A_4
a_1	Security-Effectiveness	50	80	80	80
a_2	Cost	47	51	55	55
a_3	Implementability	50	50	90	50
a_4	Compatibility	10	50	90	90
a_5	Operability	30	45	90	90

FIGURE 9

decisionmaker can actually attach a numerical measure of importance to each attribute, i.e., supply a set of saliency weights, then he can apply these weights to each alternative's attribute values. The alternative which obtains the highest weighted average for its performance score is then selected for implementation. Usually this best score will be unique.

Before we examine the assumptions underlying conjoint analysis and their practical implications, we shall illustrate the method using the data of Fig. 10. This figure is identical to Fig. 9 in the alternatives' attribute scores, but now we have appended a set of M weights, w_i, to the attributes which reflect their importance vis a vis the context of CPTED application. For convenience in deriving each alternative's overall performance index and in seeing directly the relative importance of the attributes implied by the w_i, a set of relative weights, w_i', is also displayed. These w_i' are simply obtained by dividing w_i by the sum of all the w_i (i.e., 100 for the illustration). Thus, the absolute importance of security-effectiveness and cost is 35 and 30, while their relative importance is 35% and 30%, respectively. For any set of weights we compute the performance index of an alternative as either the sum of the products of the attribute weights and attribute values divided by the sum of the weights, or more simply, as the sum of the products of the relative attribute weights and the corresponding attribute scores. Both yield the same result. Thus, for the first alternative in Fig. 10, we obtain the overall performance measure of (35x50 + 30x47 + 20x50 + 10x10 + 5x30)/(35+30+20+10+5) = 44.10, or alternatively, (.35x50 + .30x47 + .20x50 + .10x10 + .05x30) = 44.10. By repeating this procedure for all N alternatives, we find that in this case the third alternative has the highest overall performance rating, 76, and therefore should be selected for implementation.

As we have just seen, the conjoint method does not disregard any of the attributes since all M attribute values are utilized to form each alternative's performance index. This is a key point of departure from the methods described so far. Because the index computations involve the arithmetic operations of multiplication and addition, the attribute values must be both numerical (ratio-scale) and comparable -- the same restrictive conditions which prevailed in the maxi procedures. Thus, if cost were directly valued in dollars, e.g., $530,000 for alternative 1, $850,000 for A_2 , as given earlier, the weighted values for cost would completely swamp the weighted values contributed by the other attributes unless high scores on each of them had approximately the same numerical value (e.g., as in Fig. 10). Moreover, the weights themselves require

ILLUSTRATIVE CPTED DECISION PROBLEM

CONJOINT ANALYSIS

ATTRIBUTES		WEIGHTS		RELATIVE WEIGHTS		ALTERNATIVE PROGRAMS			
						A_1	A_2	A_3	A_4
a_1	Security-Effectiveness	w_1	35	w_1'	.35	50	80	80	80
a_2	Cost	w_2	30	w_2	.30	47	51	55	55
a_3	Implementability	w_3	20	w_3'	.20	50	50	90	50
a_4	Compatibility	w_4	10	w_4'	.10	10	50	90	90
a_5	Operability	w_5	5	w_5'	.05	30	45	90	90
TOTAL WEIGHTS		W	100	W'	1.00				
OVERALL PERFORMANCE INDEX						44.1	60.6	76.0	68.0

FIGURE 10

both a high level of measurement (ratio-scale, not just rankings) and a reasonable basis for their formulation. In the context of our example, the weights imply that cost is 1½ times as important as implementability, and that cost is as important as implementability and compatibility combined. Although there are techniques for eliciting such weightings, the meaningfulness and confidence of such judgments may remain quite dubious.

Even after satisfactory weights have been established and the attribute values made numerical and comparable, other unpalatable implications may also remain. In our example, the relative weights for cost and operability are .3 and .05, respectively. A score of 15 on cost and 90 on operability would therefore contribute the same amount, 4.5, to the total performance index for any alternative having these attribute values. Yet 15 may be considered a very poor cost rating, while 90 may be an exemplary operability score (we recall that all attributes are scaled so that "bigger is better"). This implies that such poor and high scores may offset one another. But do poor cost features and exceptional operability actually trade-off;in fact, can such judgments be made? In general then, we see that one of the defects in conjoint analysis is that unacceptably low performance on one or more attributes may be masked by high weighted-attribute scores on others. Conversely, high weighted-attribute scores may be severely diluted by several poor weighted-attribute scores. This defect can be mitigated somewhat by first applying the satisficing procedure, thereby eliminating any alternative which doesn't meet minimum performance thresholds on each attribute.

Related to the trade-off and masking problem is the assumption that weighted attribute scores have independent, additive effects on total performance. Thus, conjoint analysis does not allow for any interaction effects or complementarities (either positive or negative) among attributes, since only a simple additive model is employed. For example, an alternative may be excellent with respect to security and cost scores, yet be of little value unless its implementability rating is at least average and its compatibility and operability scores aren't too low. An alternative with less exemplary security and cost ratings may become a much more valuable candidate because its other attribute scores are all at average levels, thereby making the overall package considerably more meaningful. Of course, to the extent that attributes can be identified which behave essentially independently and which jointly reflect all the important qualities of a program alternative, then the additive weighting approach can be a powerful multi-attributive decision-making tool, much as linear programming is in the world of mathematical optimization.

4.3.2.5 Performance Indices

The conjoint method just described entails an additive model for obtaining an overall numerical performance index for each alternative. This need not be the functional form of the index, however, and shouldn't be if there are significant interaction effects. Figures 11 - 13 suggest a number of other indices which combine attribute scores according to mathematical formulas more complex than the additive model. All of them require the same measurement and comparability of attribute scores as in the additive scheme described previously.

The first of these figures, Fig. 11, illustrates a nonlinear model which appends to an additive component a nonlinear component involving interaction terms. In this case, the interaction terms simply consist of all distinct pairs of attribute scores (without regard to order) for an alternative and an associated set of weights u_{ik} or u'_{ik} in analogy to the weights w_i and w'_i for the linear component. The subscripts i and k in the weight u_{ik} pertain to the corresponding ith and kth attribute pair. A weight of zero implies no interaction between the associated attribute pair. In this formulation, therefore, the decisionmaker must supply both sets of weights w_i and u_{ik} for the additive and nonlinear components of the performance index P. When this is done, as illustrated in Fig. 11, we see that calculation of P_j for each alternative A_j results in alternative 3 having the highest overall performance index (based on the same ratings of attributes r_{ij} and weightings w_i used earlier in Fig. 10).

Figure 12 demonstrates the effects on final choice of a completely nonlinear model, the model being multiplicative with respect to the M attribute scores rather than additive. Here the normalized weights, w'_i , enter the model as exponents. Applying this performance model to the ratings and weights given in Fig. 10, we see that alternative 3 obtains the best overall index.

The mathematical forms that can be devised are limitless. A final example will illustrate another dimension of this variety. In the two previous indexes, the weights w_i were made explicit. This is not a general requirement

ILLUSTRATIVE CPTED DECISION PROBLEM

NONLINEAR PERFORMANCE INDICES

MODEL:

$$P_j = w'_1 r_{1j} + w'_2 r_{2j} + \dots + w'_M r_{Mj} + u'_{12} r_{1j} r_{2j} + u'_{13} r_{1j} r_{3j} + \dots + u'_{1M} r_{1j} r_{Mj}$$

$$+ u'_{23} r_{2j} r_{3j} + u'_{24} r_{2j} r_{4j} + \dots + u'_{2M} r_{2j} r_{Mj}$$

$$+ \dots + u'_{M-1,M} r_{M-1,j} r_{Mj} \qquad j=1,2,\dots,N$$

$$= \sum_{i=1}^{M} w'_i + \sum_{i>k=1}^{M} u'_{ik} r_{ij} r_{kj} \qquad w'_i = w_i \Big/ \sum_{i=1}^{M} w_i \qquad u'_{ik} = u_{ik} \Big/ \sum_{i>k=1}^{M} u_{ik}$$

ATTRIBUTES		RELATIVE WEIGHTS LINEAR COMPONENT	RELATIVE WEIGHTS: NONLINEAR COMPONENT a_1	a_2	a_3	a_4	a_5
a_1	Security Effectiveness	$w'_1=.35$					
a_2	Cost	$w'_2=.30$	$u'_{12}=.2$				
a_3	Implementability	$w'_3=.20$	$u'_{13}=0$	$u'_{23}=0$			
a_4	Compatibility	$w'_4=.10$	$u'_{14}=.1$	$u'_{24}=0$	$u'_{34}=.1$		
a_5	Operability	$w'_5=.05$	$u'_{15}=.3$	$u'_{25}=.2$	$u'_{35}=0$	$u'_{45}=.1$	

OVERALL PERFORMANCE INDEX	ALTERNATIVE
$P_1 = 1376.1$	A_1
$P_2 = 3290.6$	A_2
$P_3 = 6446.0$	A_3
$P_4 = 6078.0$	A_4

FIGURE 11

ILLUSTRATIVE CPTED DECISION PROBLEM

NONLINEAR PERFORMANCE INDICES

MODEL: $P_j = (r_{1j})^{w'_1}(r_{2j})^{w'_2}\ldots(r_{Mj})^{w'_M} = \prod_{i=1}^{M} r_{ij}^{w'_{ij}}$ $j=1,2,\ldots,N$

ATTRIBUTES	RELATIVE WEIGHTS	ALTERNATIVE PROGRAMS A_1	A_2	A_3	A_4
a_1 Security Effectiveness	$w'_1=.35$	50	80	80	80
a_2 Cost	$w'_2=.30$	47	51	55	55
a_3 Implementability	$w'_3=.20$	50	50	90	50
a_4 Compatibility	$w'_4=.10$	10	50	90	90
a_5 Operability	$w'_5=.05$	30	45	90	90
OVERALL PERFORMANCE INDEX P_j		40.73	58.98	74.50	66.24

FIGURE 12

ILLUSTRATIVE CPTED DECISION PROBLEM

NONLINEAR PERFORMANCE INDICES

MODEL: $P_j = \sqrt{2\, r_{1j}\, r_{5j}} \left[1 - e^{-r_{2j}/100} \right] r_{3j}^{.2}\; r_{4j}^{.1} \left(r_{5j} + 5 \right)^{.05}$

ATTRIBUTES		ALTERNATIVE PROGRAMS A_1	A_2	A_3	A_4
a_1	Security Effectiveness	50	80	80	80
a_2	Cost	47	51	55	55
a_3	Implementability	50	50	90	50
a_4	Compatibility	10	50	90	90
a_5	Operability	30	45	90	90
OVERALL PERFORMANCE INDEX P_j		67.5	133.3	245.9	218.6

FIGURE 13

however. Figure 13 shows an index in which the attribute weightings are implicit. Here the functional form and its associated parameters serve the same role as the formerly explicit weights. Applying this index to the ratings of Fig. 10, we observe that the third alternative again obtains the highest index score.

All of these index schemes share the same attribute measurement and comparability assumptions as the conjoint method. While the more general index models illustrated here have the potential for embodying the interactions or complementarities (both positive and negative) of the attributes, the problem becomes one of identifying an appropriate mathematical formulation to reflect these interdependencies (the so-called "identification" or "specification" problem of systems theory). Of course, where logical relations between attributes are known or can be deduced, as in systems or operations analysis studies, the functional form of the performance index no longer remains arbitrary. Since this is rarely the case in social systems, the structure of the index will usually be subject to much judgment. Among such structures, decisionmakers will probably prefer additive weighting to nonlinear models because of its easy comprehensibility, albeit a simplistic representation.

In concluding our discussion of numerical performance indices, it is important to note that cost/benefit and cost/effectiveness measures are subsumed by such indices. That is, if cost is identified as an attribute of importance and if either benefit or effectiveness (themselves attributes) can be measured in terms of levels of other attributes, then numerical performance indices can be defined such as the ratio of cost to effectiveness, the difference between benefits and cost, and so on.*

4.3.2.6 Utility Measures (Worth Assessment)

Utility theory or worth assessment is a decision methodology which represents a significant departure from the attribute-oriented approaches discussed so far. Instead of focusing on attributes per se, worth assessment examines the distribution or scope of possible outcomes for each alternative. The multidimensional nature of the decision problem stems from the multiple real-world events which can affect the level of an alternative's

*A fuller discussion of cost/benefit and cost/effectiveness measures is provided elsewhere in the Program Manual.

performance, or outcome, rather than the alternative's multiple attributes. Thus, the outcome for an alternative may change radically with the rate of criminal adaptation (e.g., in tactics, target, time, place, etc.), unemployment levels, the introduction of new patrol policy, drug abuse levels, etc., which ensue after program implementation. The essential feature of the utility approach is that it captures the probabilistic aspect of these so-called "states-of-nature," and explicitly recognizes that the worth or utility of an outcome need not relate linearly to the level of the outcome.

In analogy to the attribute-oriented schema of Fig. 4, Fig. 14 shows the informational requirements for the utility approach. As before, the A_j represent the candidate alternatives, and the decision problem is to identify and implement the one which is best in some sense. The s_i represent various states of nature, i.e., descriptive statements about real-world events or conditions which may prevail. Important events which may impinge on the effectiveness of an alternative may include, for example, criminal adaptation rate (fast, or less than one year; slow, or at least one year), unemployment level (under 5%, 5-8%, over 8%), institution (or not) of a new patrol policy (e.g., 1-man patrol cars, 50% plainclothes patrol, etc.). Thus, if these were the only state-of-nature of major importance in regard to an alternative's outcome, there would then be 2x3x2 or 12 mutually exclusive and exhaustive states s_i to be considered, along with subjective assessments of each of their probabilities or likelihoods p_i .

Figure 15 illustrates how these states and their associated probabilities can be derived from a list of the random variables and their uncertain outcomes (events). The only constraints in estimating or attaching probabilities to the levels of each random variable is that each probability be a number from 0 to 1 and that the probabilities sum to 1 over all levels of a particular random variable. Figure 16 illustrates the computation of the final joint probabilities corresponding to each state s_i (a mutually exclusive and exhaustive set of outcomes for the random variables) under the assumption that all the events are independent and that all the p_i are to be derived from subjective probabilities estimated for all the simple events such as fast adaptation, slow adaptation, etc. Of course, the p_i can be assigned subjective probabilities directly, as long as the decisionmaker obeys the same rules regarding the limits and sum of the p_i as for the more elementary events. Because of the large number of constellations of conditions making up the set of s_i, it is

UTILITY ASSESSMENT SCHEMA

UTILITY MATRIX

STATES OF NATURE	PROBABILITIES	ALTERNATIVES					
s_i	p_i	A_1	A_2	$\cdots$	A_j	$\cdots$	A_N
s_1	p_1	u_{11}	u_{12}	$\cdots$	u_{1j}	$\cdots$	u_{1N}
s_2	p_2	u_{21}	u_{22}	$\cdots$	u_{2j}	$\cdots$	u_{2N}
$\vdots$	$\vdots$	$\vdots$	$\vdots$		$\vdots$		$\vdots$
s_i	p_i	u_{i1}	u_{i2}	$\cdots$	u_{ij}	$\cdots$	u_{iN}
$\vdots$	$\vdots$	$\vdots$	$\vdots$		$\vdots$		$\vdots$
s_M	p_M	u_{Mi}	u_{M2}	$\cdots$	u_{Mj}	$\cdots$	u_{MN}
EXPECTED UTILITY U_j		U_1	U_2	$\cdots$	U_j	$\cdots$	U_N

U_j = Expected Utility of jth Alternative = $\sum_{i=1}^{M} p_i u_{ij}$, $j=1,2,\ldots,N$

s_i = ith State of Nature, $i=1,2,\ldots,M$

p_i = Probability that s_i Occurs

A_j = jth Alternative, $j=1,2,\ldots,N$

u_{ij} = Utility (Worth) of jth Alternative in State s_i

FIGURE 14

ILLUSTRATIVE CPTED DECISION PROBLEM

UTILITY ASSESSMENT

RANDOM VARIABLE	OUTCOMES/EVENTS	PROBABILITIES
Criminal Adaptation Level	E_1 : Fast (< 1 yr.)	$P(E_1) = .25$
	E_2 : Slow ($\geq$ 1 yr.)	$P(E_2) = .75$
Unemployment Level	E_3 : High (>8%)	$P(E_3) = .1$
	E_4 : Medium (5%-8%)	$P(E_4) = .7$
	E_5 : Low (<5%)	$P(E_5) = .2$
Adoption of New Patrol Policy	E_6 : Yes	$P(E_6) = .4$
	E_7 : No	$P(E_7) = .6$

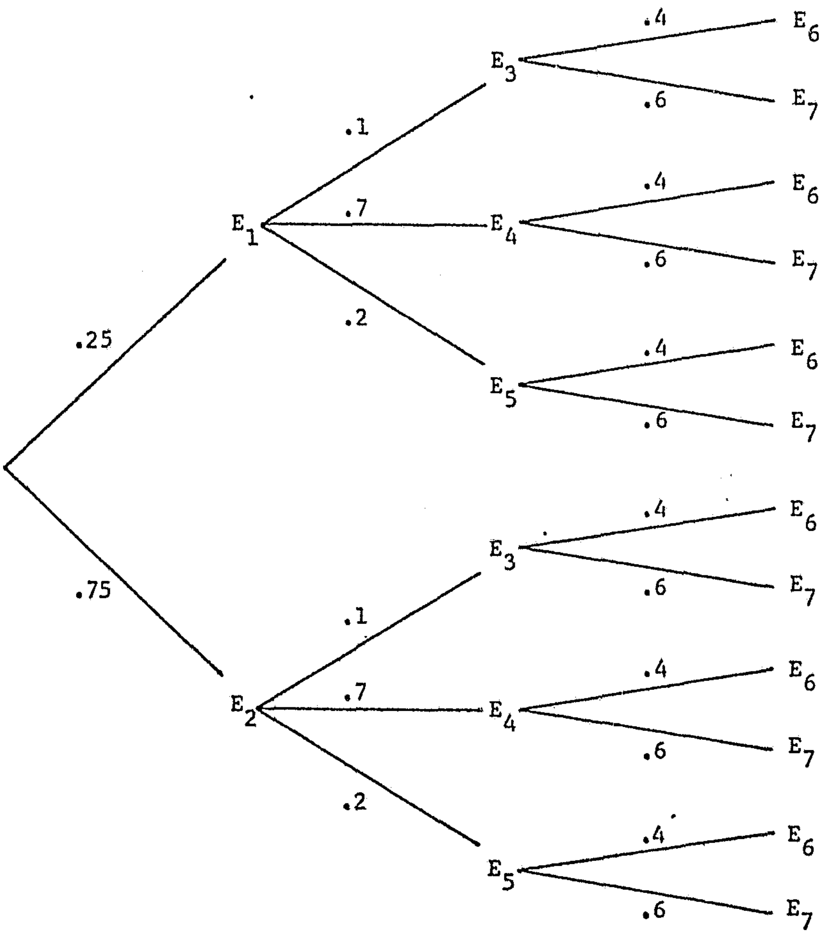
FIGURE 15

ILLUSTRATIVE CPTED DECISION PROBLEM

UTILITY ASSESSMENT

ELEMENTARY EVENTS & PROBABILITIES

STATES OF NATURE & PROBABILITIES*



s_i	p_i
s_1	p_1 =.01
s_2	p_2 =.015
s_3	p_3 =.07
s_4	p_4 =.105
s_5	p_5 =.02
s_6	p_6 =.03
s_7	p_7 =.03
s_8	p_8 =.045
s_9	p_9 =.21
s_{10}	p_{10}=.315
s_{11}	p_{11}=.06
s_{12}	p_{12}=.09
	Σp_i=1

*E_i Statistically Independent

FIGURE 16

much easier to assign the subjective probabilities at the level of the individual random variables themselves and then derive the p_i for the states, as we have done in Fig. 16 (this is especially easy when the events are independent, as we have assumed).

The next step in the procedure involves using implicitly or explicitly the design criteria or attributes to estimate the overall level of effectiveness (not necessarily numerical) of each alternative for each state-of-nature. That is, we consider the effect of each possible real-world event, should it occur, on the alternative as a whole. Assuming a utility function has been constructed which maps these quantitative or qualitative outcomes into a numerical (interval-level) utility or worth score, we can then assign a set of utilities u_{ij} to an alternative A_j operating under each assumed state-of-nature s_j.*

The final step involves a uni-dimensional scaling of the alternatives. A common measure used to accomplish this is to compute the "expected" utility corresponding to each alternative; i.e., to calculate the average worth associated with each alternative considering all the real-world contingencies and their likelihoods. Figure 17 illustrates these computations. As we see, this culminates in the choice of alternative 4 , since it yields the highest expected utility.

As we have just seen, the utility approach requires multi-dimensional information different from the other methods. This stems from treating the decision problem according to a different perspective; i.e., viewing impacts of alternatives as being dependent on uncertain real-world contingencies with known likelihoods. Thus, the chief virtue of the method is its ability to explicitly account for and to directly cope with uncertainty in states of nature when the performance levels of the alternatives are otherwise reasonably certain and not too difficult to obtain. Toward this end, the decisionmaker must identify the states-of-nature, estimate their likelihoods, and derive a utility function (or functions) which maps the performance levels of alternatives operating under these states into degrees of utility or worth on an

*A number of systematic procedures are available for constructing utility functions (usually an S-shaped curve starting from the origin). Since the details and mathematical underpinnings are beyond the scope of this presentation, a rich set of references has been provided.

ILLUSTRATIVE CPTED DECISION PROBLEM

UTILITY ASSESSMENT

STATE OF NATURE s_i	PROBABILITY p_i	ALTERNATIVES & UTILITIES A_1	A_2	A_3	A_4
s_1	.01	50	30	40	60
s_2	.015	40	50	60	40
s_3	.07	60	70	70	90
s_4	.105	30	45	65	70
s_5	.02	90	60	70	85
s_6	.03	55	55	75	65
s_7	.03	70	60	80	90
s_8	.045	30	55	65	85
s_9	.21	80	75	90	95
s_{10}	.315	45	90	65	90
s_{11}	.06	65	70	85	80
s_{12}	.09	75	45	95	25
EXPECTED UTILITY U_j		56.98	70.15	75.02	80.38
$U_j = \sum_i p_i u_{ij}$		U_1	U_2	U_3	U_4

FIGURE 17

interval scale. Eliciting such probabilities and utility functions from decisionmakers is not an easy exercise. When the performance levels themselves are dependent on many factors or attributes, the method provides the decisionmaker with no direct assistance in dealing with this multi-dimensional form of complexity since the method itself is not attribute-oriented. The decisionmaker is left to his own devices in sorting out this information. Thus, the major contrast between the utility approach and the attribute-oriented methods is that utility puts applications context or contingencies in the foreground and program features or attributes in the background, while attribute schemes do just the opposite.

4.3.3 Intermediate Dimensionality

As we have seen, dominance and satisficing treat a decision problem in its full dimensionality while the other schemes presented thus far attempt by various means to compress the basically multi-attributive nature of the decision problem into one dimension, the final composite measure of an alternative's performance. Between these two extremes lies the possibility for methodologies which represent an alternative's performance in a number of dimensions, k, greater than 1 and less than M, the original number of relevant attributes. One might consider, for example, a scheme which retained and treated separately the first three most salient attributes, ignoring the remaining M-3. The dimensionality, k, of such an approach would therefore be 3. In general, any such procedure would have to address two sub-tasks: (1) Selection of the k dimensions or attributes to be considered; and (2) Determination of the best alternative based on these k dimensions.

4.3.3.1 Non-Metric Multidimensional Scaling

Multidimensional, non-metric scaling is an apporach to intermediate-dimensionality decisionmaking in the sense just described. While there are several variants of the method, we shall describe a particular scheme which displays most of the features of the other multi-dimensional scaling methods. The basic theme in all of them is to derive the dimensionality of a set of complex alternatives, locate each alternative in that space, and compare each alternative to an ideal alternative located in the same space. If there is an alternative which is closest to the ideal on all dimensions, then it is selected as best. Since such simultaneity rarely occurs, the decisionmaker employs a composite measure which reflects the distance of each alternative from the ideal and then selects the one which is closest to the ideal according to the measure. As we shall see, while the level of measurement and computation necessary to accomplish this is relatively modest, the total number of inputs that the decisionmaker must supply can become unwieldy. The procedure which we shall examine takes non-metric input information (i.e., ordinal preferences for pairs of alternatives over all distinct pairs) and yields metric results (i.e., interval or ratio-scaled information on the proximities of a set of proposed alternatives to an ideal).

In order to deduce the k key dimensions underlying a set of alternatives, the procedure begins by having the decisionmaker or a panel of experts prepare list of the principal attributes used in the decision problem and to indicate a range of values or to simply specify typical high, average, and low values for each attribute. From such lists, M attributes are selected on the basis of their highest frequency of mention as well as their relative independence. Although the final list must not omit any attribute considered crucial to the decision problem, there are no other assumptions regarding the relative importance or actual interdependence of the M attributes on the list.

From the enumeration of attributes and values, the procedure goes on to fabricate a set of simulated or fictitious alternatives by systematically varying each attribute through all its values (e.g., generating 3M fictitious alternatives if each attribute is scored at typical low, average, and high levels only). Next, the decisionmaker is asked to judge the similarities of all distinct pairs of alternatives which can be drawn from the fabricated set (i.e., the N(N-1)/2 pairs A_1A_2, A_1A_3, ..., A_1A_N; A_2A_3, A_2A_4,...,A_2A_N;...$A_{N-1}A_N$ wherein no alternative is paired with itself, nor is any pair such as A_1A_2 considered different from A_2A_1). The decisionmaker must therefore rank from highest to lowest similarity all such pairs, asking himself whether A_1A_2 is more alike than A_1A_3 and so on. To reduce ordering biases, the pairs themselves are presented randomly to the decisionmaker. To assist in ranking the typically large number of distinct pairs, the random pairs may be first assigned by the decisionmaker or panel to say 1 of 8 different clusters, the first group containing pairs judged most similar, the second group, next most similar, etc. The final pass at ranking then involves ranking pairs within each cluster. As appropriate, some shifting of pairs between clusters is made so that the last pair in the first cluster is in fact judged more similar than the first pair in the second cluster, and so on. If a panel rather than a single judge is used, their judgements can be combined by averaging the ranks ascribed to each alternative pair. The degree of the judges' consistency in rankings can also be assessed using an appropriate correlational measure such as the Kendall coefficient of concordance.

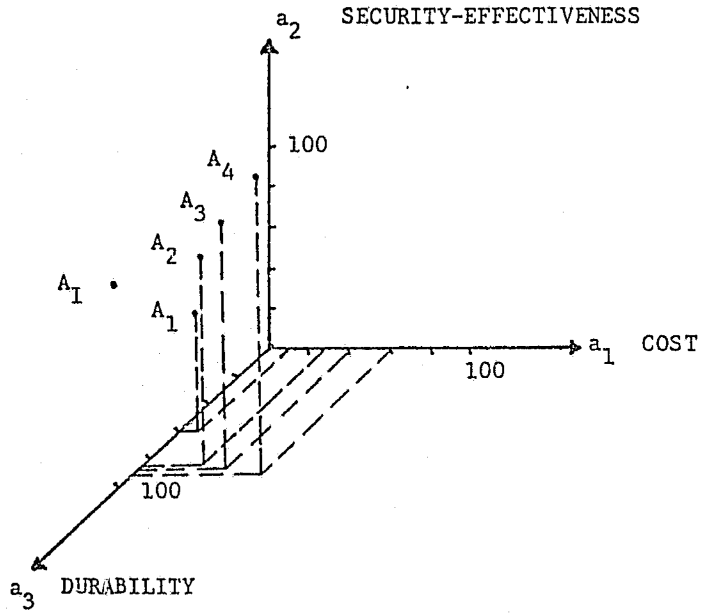
The result of these initial steps is a measure or ranking of the perceived similarity of each fictitious alternative with respect to all others, a total of N(N-1)/2 rankings for N such alternatives. In effect, as in the earlier attribute-oriented schemes, we can picture each alternative as a point in an M-dimensional attribute space, with one coordinate axis for each attribute, and with one point on an axis for each level of that attribute. The more similar any two alternatives are, the closer they will lie in this space. In terms of the similarity rankings obtained for the N alternatives, it can be shown that the set of N(N-1)/2 rankings for any N alternatives can always be preserved in terms of the inverse inter-point distances in a space of N-1 dimensions. That is, using N-1 coordinate axes, a configuration of interpoint distances for all alternative pairs can be found which correlates perfectly with the similarity rankings (i.e., the closer in similarity of two alternatives, the more proximate the locations of the alternative pair in space, with all such spacings being consistent with all the rankings). If the dimensionality N-1 of this space is sequentially reduced in unit steps to some value k less than N-1, then departures will occur from such a perfect fit between the similarity rankings and the corresponding inter-point distances. Using a goodness-of-fit or "stress" measure, we can construct such new spaces with fewer dimensions -- the aim of multidimensional scaling -- and measure their goodness-of-fit with respect to the original rankings. A stress of 0 indicates a perfect fit, while .05 is considered an excellent fit, and 1 corresponds to a complete mismatch. To the extent that the stress measure for these new configurations is not too high (e.g., above .10), we have then determined a less complex underlying set of dimensions which reflect the perceived similarities of the alternatives. As often happens, however, the coordinate axes corresponding to these lower dimensionality representations are not identical to the original M attributes and usually require familiarity with the problem or expert judgment to interpret their meanings.

The aforementioned steps answer the question of how many dimensions effectively underlie a decisionmaker's perceptions about the similarity of a set of complex alternatives. If this spatial representation adequately characterizes each alternative, then it can also be employed to identify which of N real proposed alternatives the decisionmaker most prefers. This final question is resolved in three steps. The first entails locating each of the N candidate alternatives in the previously derived space of k dimensions. Next, an ideal alternative is postulated and also located in this space; i.e., one whose attributes are all at the most desirable levels. The final step involves finding the "distance," according to some acceptable metric, between the location of this ideal alternative in k-space and each of the N real candidate alternatives. This distance measure might be based on the so-called "city-block" metric (the sum of absolute displacements between candidate and ideal on each attribute), the "Euclidean" metric (the square root of the sum of squares of differences between candidate and ideal on each attribute), or some other such distance measure (e.g., other special cases of the so-called Minkowski p-metric). Once chosen, the distance metric is computed for all N alternatives. The decision problem is then finally resolved by selecting the alternative which is closest to the ideal according to the distance measure used.

While it is beyond the scope of this presentation to describe the mathematical details or computer routines involved in finding the k dimensional configurations and their stresses, we can illustrate the basic idea and show how a distance measure can be applied to solve a complex decision situation. Figure 18 depicts the possible outcome for the aforementioned multidimensional scaling procedure. As in the earlier examples, we again assume that four hypothetical alternatives have been proposed. Since we can portray at most 3 dimensions, we also assume that the multidimensional scaling resulted in k=3 as the minimum number of relevant dimensions with reasonably good stress level (below .10). As Fig. 18 indicates, the first two coordinate axes have

ILLUSTRATIVE CPTED DECISION PROBLEM

MULTIDIMENSIONAL SCALING



ALTERNATIVE		COORDINATES	DISTANCE FROM IDEAL	
	A_j	(a_1, a_2, a_3)	CITY-BLOCK METRIC	EUCLIDEAN METRIC
	A_1	(10,50,60)	100	64.81
	A_2	(25,70,85)	70	41.83 *
	A_3	(40,85,87)	68 *	44.65
	A_4	(60,90,90)	80	61.64
IDEAL	A_I	(0,100,100)	--	--

FIGURE 18

been interpreted to correspond to security-effectiveness and cost, both original attributes that haven't been transformed in any way by the multidimensional scaling. From the constellation of alternatives, it is inferred that the third axis appears to measure an alternative's "durability," presumably a composite attribute reflecting what we earlier called implementability, compatibility, and operability. Having located an ideal alternative, A_I, as shown in Fig. 18, we can now calculate the four distances between it and each of the proposed alternatives. Using a city-block metric, we conclude that alternative A_3 is closest to ideal. Under the Euclidean metric, however, we conclude that A_2 is closest. Clearly, had we chosen to use the original M attributes or some subset of them, we could have employed the same distance measure to find the best alternative relative to an ideal without going through the initial steps of the multidimensional scaling procedure; however, we would not have determined the possibly smaller set of attributes on which the decisionmaker's perception of best was founded.

While illustrating the essential steps and concepts involved in the multidimensional scaling approach, this simple example glosses over several practical and conceptual difficulties. First, there is the need to identify a meaningful set of attributes and levels out of which to compose a simulated set of alternatives. These must be comprehensive or representative of the possibilities without becoming so unwieldy as to require a laborious number of paired comparisons. Second, in order to distill the underlying dimensionality of the decision problem, the decisionmaker must judge the similarity of N(N-1)/2 pairs drawn from the set of N simulated alternatives, a number of comparisons which grows exponentially (e.g., if N is only 15, there are 105 similarity judgments to be made). N itself can grow quickly. If, for example, there are thought to be M attributes with, say, only 5 levels each, then N = 5M. If M were only 5, as in our earlier examples, this would result in 25(25 - 1)/2 or 300 paired comparisons.

Apart from the gross magnitude of such an effort, the fact that the decisionmaker must rank the pairs for similarity calls for considerable discriminatory power and consistency in terms of the set of attributes he is really applying. We still know relatively little about the way or functions used by individuals in combining differences in pairs of objects over several dimensions so as to render overall similarity judgments. Moreover their models for doing so may change as the stimuli become more complex or greater in number (e.g., some dimensions may eventually get ignored as conflicting criteria or shear tedium set in). There is also the assumption that the utility of an object or its preference is inversely proportional to its distance from an ideal and that the components that make up the distance metric can be simply added. The validity of averaging the rankings perceived by a set of judges may also be called into question. The distance measures discussed clearly imply that the underlying dimensions for the combined or average judge are independent or non-interactive. On the positive side, the procedure does allow the attribute information to be qualitative, rather than numeric, and it needn't be comparably scaled across attributes as in most of the other uni-dimensional techniques. This is because the multidimensional scaling procedure itself yields comparable, numeric scales on each of the k final dimensions. The computation involved, however, is usually not amenable to hand calculation as in the other approaches. Moreover, as in multiple factor analysis, these final k dimensions do not necessarily correspond to the M attributes originally used to construct the simulated alternatives. As illustrated, they may not therefore admit of easy interpretation or have any direct intuitive appeal.

4.4 Treatment of Uncertainty

In the preceding illustrations of the decision algorithms, we have assumed that each alternative was given a single attribute score on each attribute. As elaborated in Section IV.A, the decisionmaker or experts who assign such scores are usually uncertain as to exact values. There are a number of ways to reflect this uncertainty in the attribute ratings. Depending on the approach adopted, some modifications may be necessary in applying the preceding decision schemes. As we shall discover, although the methods themselves don't change in any fundamental way, two problems emerge. First, the amount of computation involved, usually in the number of comparisons to be made, may increase. Second, and more importantly, the likelihood of being left with only one alternative at the conclusion of the modified procedures increases significantly.

Perhaps the simplest way of factoring in uncertainty in the attribute scores without changing the procedures at all is to let the actual score be some representative or central value in the underlying distribution. That is, the score actually assigned may be a measure of centrality such as the mode (most likely value), the median (the value which balances the series of possible values in the sense that the probability of an actual score being higher or below the median is 1/2), or the mean (a balance point in the sense that the sum of squares of deviations in scores above the mean equals the sum of squared deviations below). Other so-called point estimates are also possible of course. Another possibility is to use an interval estimate, or range of scores, for each of the ratings. That is, we could state for each alternative and attribute a minimum and maximum score. Preferably, some probability statement would accompany these lower and upper bounds, thereby providing a "confidence interval estimate" for the attribute. Similarly, we could state a so-called 10-90 percentile range, such that scores falling below or above this range are each only 10% likely. Another common choice is the interquartile range. Here the bottom of the range is that value below which 25% of the scores would be expected to fall on the average, and the top range is that value such that there is a 25% chance of its being exceeded. Many other confidence interval estimates can be constructed along similar lines.

The dominance procedure is amenable to such range specifications. The extension is straightforward and may be carried out in several ways. In a stronger formulation of dominance, we could consider an alternative dominated if its upper range estimate on all attributes is exceeded by the lower range estimate for the corresponding attributes of some other alternative. A weaker form of dominance would entail pairwise comparisons of the corresponding maximum and minimum range values for each alternative. An alternative would be dominated if its extremal range scores were never better, but actually worse for at least one attribute vis a vis those of another alternative, again considering respective attribute pairs and all attributes. Clearly, the result of using range estimates would tend to exacerbate the problem of the dominance procedure's not providing a unique alternative at its conclusion.

The satisficing approach is also readily adaptable to range estimates. Here, we could consider an alternative unsatisfactory if one or more of its upper range attribute ratings were lower than a prescribed threshold. While other definitions of satisficing are possible, the problem in using a criterion like this one is that, again, too many alternatives may remain at the conclusion of the procedure. This is because a best or optimistic (upper range) score is being employed to pass each attribute test, rather than a single most likely or some other typical attribute value.

The modification of the maximin and maximax procedures, while also straightforward, leads to somewhat more computational effort due to the larger number of necessary comparisons. Since each attribute is now given two extremal values, a new dimension is added to both the maximin and maximax approaches which results in several optional schemes for carrying them out. A conservative approach, for example, could entail using the lower or minimum range estimate for each attribute. This results in a "maximinimin" in the following sense. As in the ordinary maximin, we characterize or summarize each alternative by its minimum attribute score and then select the alternative which has the largest of these. In so doing, there is the extra step now of first minimizing across attribute scores for each attribute (i.e., assigning the lowest range estimate) and then minimizing across attributes within each alternative as before. In analogy to this, we could also develop a maximinimax, a maximaximin, or a maximaximax procedure. Clearly, just as the aforementioned maximinimin is much more pessimistic or conservative than the ordinary maximin, the maximaximax would be much more optimistic than the regular maximax.

The modification for the lexicographical scheme follows closely that for dominance. As before, after identifying the most salient attribute, we now simply reject any alternative whose upper attribute rating is exceeded by the lower range score for some other alternative. For this reduced set of alternatives, we repeat this procedure for the next most important attribute, and so on, until only one alternative is left or the last attribute has been considered. Here too, the use of extremal values rather than most likely values or other representative scores will probably lead us to examine more attributes in rank order than before and also heightens the chance of a non-unique alternative being left at the procedure's conclusion.

The conjoint and nonlinear index methods that we have described are not as amendable to handling uncertainty as the above techniques unless the scores used are simple point estimates (e.g., most likely values). The reason for this is the shear computational effort involved on the one hand, and the profusion of indices which result on the other. That is, if each of M attributes is considered at each of its 2 extremal values, we would obtain 2^M overall index scores instead of one for each alternative. Moreover, if the weights themselves are uncertain, as will likely be the case, then they would also be assigned range estimates. Thus, the total number of performance indices for all N alternatives would jump to $Nx2^Mx2^M$ or $N2^{2M}$ (e.g., for N=4 and M=5, as in our modest illustrations, we'd have 4096 indices, or 1024 for each alternative). Apart from the need to generate all these, a process which could be expedited by a computer, we'd still be left with deciding which of the 2^{2M} index scores should represent each alternative. This underscores the virtues of the simpler decision schemes when uncertainty in attribute ratings is a feature of the decision context.

While the utility approach is designed to cope directly with uncertainty and needn't be addressed further here, it should be recalled that the uncertainty is with respect to a set of contextual or real-world contingencies and not directly in terms of the alternatives' attributes. We shall also not consider further the multidimensional scaling approach as it too becomes extremely cumbersome when uncertainty is introduced.

4.5 Aggregation of Group Judgments

As we have seen, application of the preceding methodologies is not a purely mechanistic affair, nor is it likely to ever become so. It calls for considerable informed, responsible judgment with respect to identification of attributes, their operationalization, their ranking and scoring, the expression of uncertainty, explication of assumptions and limitations, and the corresponding selection of an appropriate decision aid. Failing such a careful, systematic approach to the choice and execution of a particular methodology, the results deserve a vote of no-confidence. This is to be distinquished, however, from a healthy skepticism which stems from challenges of either the assumptions which have been made explicit, or the rationales which have been provided for the ratings and uncertainties ascribed to alternatives' attributes.

While beyond the scope of the present treatment, the decisionmaker is advised that the formidable task of identifying superior alternatives in contexts as complex as social programming needn't be a lonely one, nor is he bereft of complementary methodologies such as the Delphi method for eliciting and refining the judgments of assisting experts. Toward this end, numerous references have been provided here, in addition to others which probe more deeply the decision aids which we have presented.

5. Mathematical Synopsis of Decision Aids

5.1 Introduction and Definitions

The purpose of this section is to recapitulate the multi-attributive decision aids presented earlier, but with formal definitions and mathematical notation which will provide clarity, rigor, and conciseness beyond that given in the verbal descriptions. To further aid in the assessment of their relevance and practicality, assumptions will be restated along with informational needs and bounds on computational complexity. The reader who is unacquainted with the mathematics involved or doesn't find the formalities helpful can skip this section with no loss in conceptual understanding.

5.2 Preliminary Definitions

With respect to the alternative/attribute matrix of Fig. 4, let us define alternatives, attributes, and attribute scores as follows:

A_j = jth alternative, $j=1,2,\ldots,N>1$

a_i = ith attribute, $i=1,2,\ldots,M\geq 2$

r_{ij} = Estimated performance rating on ith attribute for jth alternative

R_j = Vector of performance ratings r_{ij} for alternative A_j

R = MxN matrix of performance ratings r_{ij}

M = Number of attributes (features, qualities, performance measures, etc.)

N = Number of proposed program alternatives (decision options)

V_i = Set of values which the ith attribute can assume

The set U of all possible alternatives which can be synthesized is then given by the Cartesian product of the V_i:

$$U = \{ \prod V_i = V_1 \times V_2 \times \ldots \times V_M \}$$

A particular set A of N alternatives A_j is thus a subset of U:

$$A \subset U$$

In turn, any particular alternative A_j is an element of A:

$$A_j \in A$$

5.3 Dominance

Consider the maximum number of pairwise comparisons $\binom{N}{2}$ or $\frac{1}{2}N(N-1)$ of alternatives A_j, A_k, $j \neq k$, without regard to order. For any pair A_j, A_k if $r_{ij} \geq r_{ik}$ $\forall$ i and there is some $i = i'$ such that $r_{i'j} > r_{i'k}$, then A_j

dominates A_k and A_k is dropped from the original set A. Let S be the set of dominant A_j ; A_{j*} , remaining after at most $M\binom{N}{2}$ such comparisons of alternatives and attributes, i.e.,

$$S = \{ A_{j*} \}$$

If n(S)=1, then the decision problem is resolved by selecting the corresponding unique A_{j*}. If $n(S) \neq 1$, some other procedure must be applied to the set S to determine a final choice. The r_{ij} need not be of measurement level higher than nominal (categorical or qualitative) as long as the relative preference of the categories is known for each attribute.

5.4 Satisficing (Sufficing)

Let $L = (l_1, l_2, \ldots, l_m)$ be a vector of minimal attribute values (lower bounds) imposed on the set of attributes $\{a_i\}$ vis a vis their least acceptable values from among the sets V_i. We assume all attributes have been redefined so that larger r_{ij} are preferred to lower r_{ij}. A satisfactory alternative is then one for which $r_{ij} \geq l_i \ \forall\ i$. An unsatisfactory alternative is one for which there exists some i' such that $r_{i'j} < l_{i'}$. All such alternatives are dropped from the original set A. Let S^1 be the set of satisfactory A_j, A_{j*} , at the completion of the maximum MN comparisons, $R_j \geq L \ \forall\ j$:

$$S^1 = \{ A_{j*} \}$$

(1) If $n(S^1) = 0$, i.e., S^1 is empty, either design new alternatives or modify the threshold vector L to L^1 such that for some j, j* , $R_{j*} \geq L^1$ and $n(S^1) = 1$.

(2) If $n(S^1) = 1$, then the decision problem is resolved by choosing the unique corresponding alternative A_{j*}. At most, MN comparisons will be needed to complete this case.

(3) If $n(S^1) > 1$, then 2 or more A_{j*} have R_j which satisfy L. Let J^1 be the set of indices j* corresponding to the A_{j*} in S^1. Then if r_{ij*} corresponds to the ith attribute rating of A_{j*}, $j* \in J^1$, determine the set I^1 of attribute indices such that

$$I^1 = \{\min_i{}' \{ \min_{j* \in J^1} r_{ij*} \}\}$$

where min denotes minimization with respect to the domain of r_{ij*} values themselves and min' pertains to the members of the index set corresponding to the min r_{ij*} . This step requires at most $n(J^1)M(M-1)/2$ comparisons. Now increase the threshold of the attribute(s) with this index(es) so that

$$l_i > \min_i \min_{j*} (r_{ij*}) \quad , i \in I^1,\ j* \in J^1$$

Denote this new threshold vector L^2 and let the reduced set of alternatives A_{j*} which now satisfies L^2 be denoted S^2 and their subscript set, J^2 . This requires $Mn(J^2)$ comparisons. If $n(S^2) = 1$, the decision problem is resolved. If $n(S^2) > 1$, determine the index set of attributes such that

$$I^2 = \{ \min_i{}' \{ \min_{j* \in J^2} \ r_{ij*} \}\}$$

and increase L^2 to L^3 so that

$$l_i > \min_i \min_{j*} (r_{ij*}) \ , \quad i \in I^2,\ j \in J^2$$

This procedure is repeated a maximum of M times. The informational requirements and level of measurement are the same as for dominance, plus the set of M thresholds comprising L.

5.5 Maximin

The maximin procedure assumes that the ratings r_{ij} derive from a scale common to all the attributes, although not necessarily numeric. The best alternative(s) then corresponds to the set S of A_{j*} given by

$$S = \{A_{j*} \mid j* = \max_j{}' \{ \min_i \ r_{ij} \}\}$$

where max' pertains to the members of the index set corresponding to the maximum value(s) in the domain of maximization: That is, j* corresponds to the unique index, or to any one of the possible indices, for which $\max_j \min_i (r_{ij})$ is tied (max here used in the usual sense of the values r_{ij} themselves). If $n(S)=1$, then the corresponding unique A_{j*} in S is selected. If $n(S) \neq 1$, any of the tied A_{j*} may be selected. The sorting required to establish $\min_i r_{ij}$ need not require more than $NM(M-1)/2$ comparisons (i.e., using the transposition method). The sorting to establish $\max_j{}'$ need not require more than $N(N-1)/2$ comparisons. Hence, A_{j*} can be found through no more than $N(M^2-M-N-2)/2$ comparisons.

5.6 Maximax

All the data requirements, definitions, and computational bounds of maximin apply here. The best alternative(s) then corresponds to the set S of A_{j*} given by

$$S = \{A_{j*} \mid j* = \max_j{}' \{\max_i r_{ij}\}\}$$

5.7 Lexicography

Let the attributes be ordered in strictly decreasing importance so that $a_1 > a_2 > \ldots > a_M$, there the symbol > denotes "more important than." Let J^1 be the original set of alternative subscripts $J^1 = \{1,2,\ldots,N\}$. Let S^1 be the subset of $A = \{A_j\}$ given by

$$S^1 = \{ A_{j*} \mid j* = \max_{j \in J^1}{}' \; r_{1j} \}$$

(1) If $n(S^1) = 1$, the corresponding unique A_{j*} is selected. This requires $N(N-1)/2$ comparisons at most. Otherwise, denote the subscripts of the tied A_{j*} by J^2 and obtain S^2 as

$$S^2 = \{ A_{j*} \mid j* = \max_{j \in J^2}{}' \; r_{2j} \} \subset S^1 \qquad , J^2 \subset J^1$$

(2) If $n(S^2) = 1$, the corresponding unique A_{j*} is selected. This requires $n(J^2)[n(J^2) - 1]/2$ comparisons at most. Otherwise, denote the subscripts of the tied A_{j*} by J^3 and obtain S^3 as

$$S^3 = \{ A_{j*} \mid j* = \max_{j \in J^3}{}' \; r_{3j} \} \subset S^2 \qquad , J^3 \subset J^2$$

(3) If $n(S^3) = 1$, the corresponding unique A_{j*} is selected. This requires $n(J^3)[n(J^3) - 1]/2$ comparisons at most. If $n(S^3) \neq 1$, then iterate as above, continuing for at most M iterations.

5.8 Conjoint Analysis

Suppose we have a function which maps the set of M attributes $\{a_i\}$ into the corresponding set of real numbers or weights $\{w_i\}$. Then if the ratings r_{ij} derive from scales at the ratio-scale level of measurement and if these are scaled for comparability, then the most preferred alternative(s), A_{j*}, is any member of the set given by

$$S = \{ A_{j*} \mid j^* = \max_j{}' \{ \sum_{i=1}^{M} w_i' r_{ij} \} \} \quad \text{where} \quad w_i' = w_i \,/ \sum_{i=1}^{M} w_i$$

If $n(S) = 1$, then the decision problem is resolved through the unique choice A_{j*} . If $n(S) > 1$, any one of the corresponding tied A_{j*} can be selected. The set of weights w_i may also be reconsidered in the context of the application to help derive a unique alternative A_{j*} .

The conjoint method requires 2M-1 arithmetic operations and N(N-1)/2 comparisons to determine the set S.

5.9 Performance Indices

Let the overall performance, P, be characterized by some function of the attributes a_i which are measured on a ratio-scale level and let the function's range be the real half-line $(0,\infty)$, i.e.,

$$P = f(a_1, a_2, \ldots, a_M) \quad , \; P \geq 0 \, .$$

For the jth alternative and set of attribute ratings $\{a_i = r_{ij}\}$, let A_j's performance be denoted as P_j where

$$P_j = f(r_{1j}, r_{2j}, \ldots, r_{Mj}) \qquad j=1,2,\ldots,N$$

Compute P_j $\forall j$. Then the best alternative A_{j*} is a member (usually unique) of the set S given by

$$S = \{ A_{j*} \mid j^* = \max_j{}' P_j \}$$

Conjoint analysis is a special case in which the function f is linear in terms of the a_i. The amount of computation involved in finding A_{j*} depends on the specific structure chosen for f.

5.10 Utility Measures

Consider M designated states of nature or real-world contingencies s_i , $i = 1,2,\ldots,M$ and N proposed alternatives A_j , $j=1,2,\ldots,N$. Let p_i be a set of probability measures over the s_i such that

$$\sum_{i=1}^{M} p_i = 1 \quad , \; p_i \geq 0 \quad \forall i \, .$$

Let u_{ij} be the worth or utility of implementing alternative A_j given that s_i actually occurs, where u_{ij} is some function of the attribute ratings r_{ij}, the ratings themselves possibly being subject to uncertainty and characterized by their own probability density functions or discrete distributions, i.e.,

$$p_{ij}(r) = f(\, r \mid A_j \,,\, s_i \,) \qquad i=1,2,\ldots,M \quad j=1,2,\ldots,N$$

Then the alternative to be selected as best is any member (usually unique) of the set S given by

$$S = \{ A_{j*} \mid j* = \max_j{}' \sum_{i=1}^{M} p_i \, u_{ij} \} \, .$$

5.11 Multidimensional Scaling

Let N' simulated alternatives be constructed by allowing each of the M original attributes (elicited from experts) to range over a set of specified typical values $S_i = \{ v_i \}$, $i=1,2,\ldots,M$ with $m_i = n(S_i)$ being the number of such values selected for the ith attribute. Thus,

$$N' = \sum_{i=1}^{M} m_i$$

Next, form all distinct pairs without regard to order from the set of N' alternatives, i.e., determine the set S of N'(N'-1)/2 pairs given by

$$S = \{ (A_j, A_k)_{j>k} \}$$

Let this set of pairs be ranked in similarity from 1 (the most similar pair A_j, A_k) to N'(N'-1)/2 (the least similar pair) by a single judge or a panel of P judges. Let r^i_{jk} be the rank given the j-kth pair by the ith judge. Form the average ranking of the j-kth pair, $\bar{r}_{jk}$, as

$$\bar{r}_{jk} = \frac{1}{P} \sum_{i=1}^{P} r^i_{jk}$$

and list the pairs (A_j, A_k) in order of their mean rankings $\bar{r}_{jk}$. Define the distance (i.e., Minkowski q-metric) between each such pair of alternatives as d_{jk} where

$$d_{jk} = \Big[\sum_{s=1}^{K} | a_{js} - a_{ks} |^q \Big]^{1/q} \qquad q \geq 1$$

in which a_{js} or a_{ks} is the attribute rating of the jth alternative, etc., with respect to the s th attribute (in the former procedures, these were referred to as the r_{si}) and where K is the dimensionality of the attribute space and q is any real number not less than 1 (e.g., when q=1, d_{jk} becomes the city-block metric; when q=2, d_{jk} becomes the commonly used Euclidean metric).

Next, we find the value of K such that the rank orders of the d_{jk} are congruent, or nearly so, to the rank orders of the (A_j, A_k) similarities (i.e., so that the goodness-of-fit or "stress" lies between 0 and .1).*

Now consider N real, proposed alternatives A_j and a postulated ideal alternative A_I positioned in this K-space. The coordinates of A_I will correspond to the K most desirable levels of the attributes on which this K-space is dimensioned (typically, the K axes are transformed versions of the original M attributes out of which the N' fictitious alternatives were fabricated). For the chosen value of q and corresponding distance metric, compute the distances d_{jI} between each of the N proposed alternatives A_j and the ideal A_I according to

$$d_{jI} = \left[\sum_{s=1}^{K} \left| a_{Is} - a_{js} \right|^{q} \right]^{1/q} \qquad j=1,2,\ldots,N$$

Then the best alternative A_{j*} is any member (usually unique) of the set S given by

$$S = \{ A_{j*} \mid j* = \min_{j}{}' \, d_{jI} \}.$$

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* See Kruskal, J.B., "Multidimensional Scaling by Optimizing Goodness of Fit to a Non-Metric Hypothesis," Psychometrika, Vol. 29 (1964), pp. 1-27, for a definition of "stress," or Shepard, R.N., "The Analysis of Proximities: Multidimensional Scaling with an Unknown Distance Function," Psychometrika, Vol. 27 (1962), pp.125-140, for a development of a correlational measure for the $\overline{r}_{jk}$ and the d_{jk}.

END