Advanced Crime Mapping Topics

Results of the First Invitational Advanced Crime Mapping Topics Symposium

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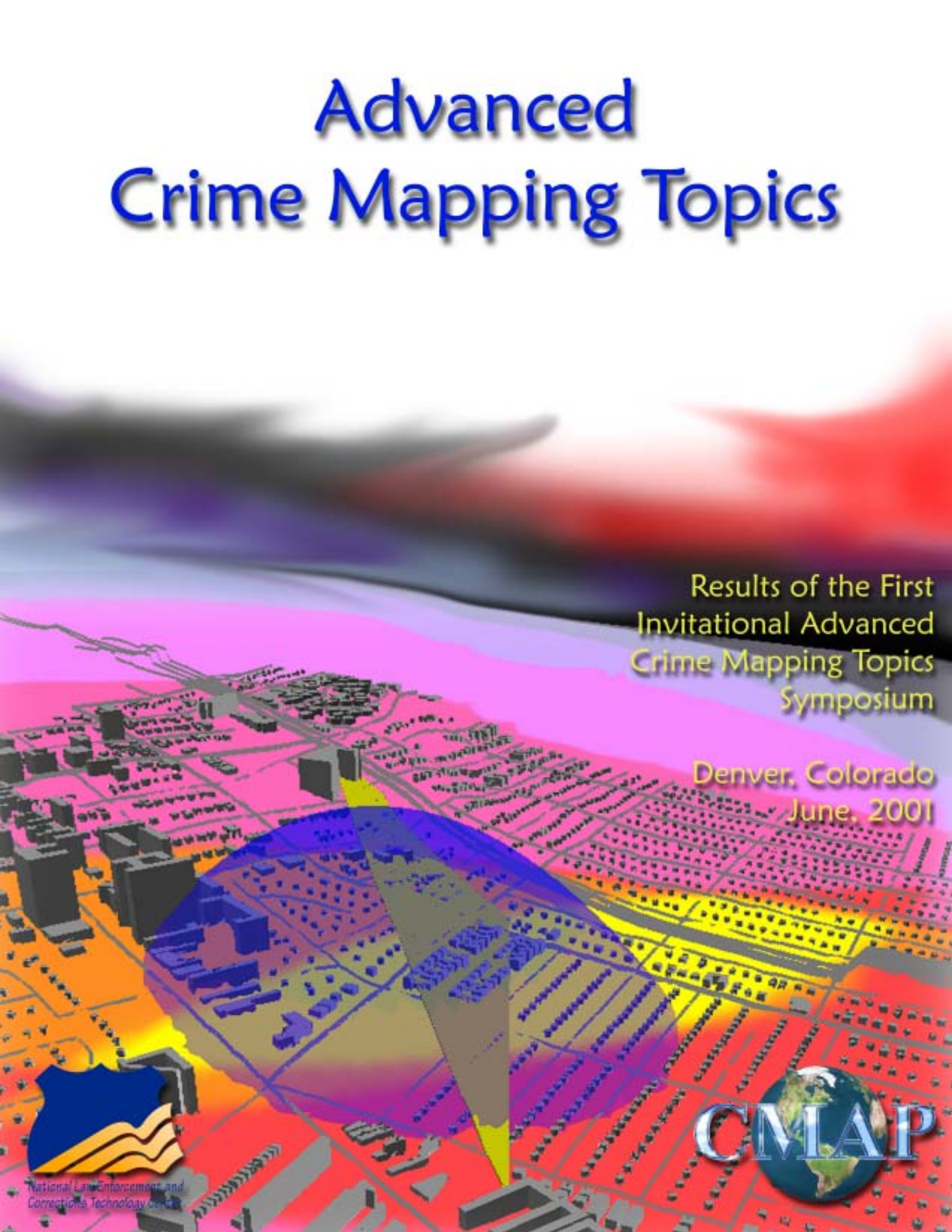

Credits

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The Growth of a Profession: A Research Means to a Public Safety End

Noah Fritz • Director • Crime Mapping & Analysis Program (NLECTC)

The profession of crime analysis has grown exponentially over the past 15 years. One of the most interesting questions regarding crime mapping and analysis remains: why has this current growth and interest in crime analysis occurred at this point in time? The modern popularity of Crime Analysis can be largely explained by five primary reasons (McEwen *et al*): (1) cost and popularity of computers have dramatically dropped and increased, respectively, both in society and within law enforcement since 1990; (2) the conceptualization of community and problem oriented policing and subsequent publications by academicians has legitimized the role of research and analysis in policing; (3) the federal government has financially backed this initiative with personnel and technology grants; (4) chiefs of police and sheriffs have embraced the concept and practice of community policing, culminating in the success of COMSTAT and ICAM and the claims associated with this effort have pointed to crime rate reductions within jurisdictions utilizing this new style of policing; finally, (5) professional standards have been identified and established within law enforcement; specifically, the Commission for the Accreditation of Law Enforcement Agencies (CALEA) has provided cursory support of crime analysis.

What seems to have occurred in tandem is an evolution in policing where progressive chiefs pervaded agencies across the country. These new chiefs and sheriffs embraced these new concepts and styles and incorporated them into daily practice and operations. These new leaders managed their agencies like businesses effectively basing decisions on data and applied research. This evolution of policing over the past decade or two has lent itself to organizations prepared to create staff position dedicated to research, planning and analysis.

As policing has evolved into a profession, it has relied more and more upon professional standards, demanded more proficient hiring standards, a more clearly defined skill set, a more diverse knowledge-base, and a pre-defined set of abilities. These skills, knowledge and abilities (SKAs) can be witnessed within many human resources or personnel departments at progressive city and county governments. While this is not the place to address the current state of the SKAs for the profession of crime analysis, it is the impetus for this manuscript and the symposium that made this publication possible.

We at the Crime Mapping and Analysis Program (CMAP) are attempting to move past the general concepts of crime analysis and focus on the action or process of this analysis. For our purposes here we break crime analysis into four functions: (1) crime series or investigative analysis, (2) operations research or resource allocation studies, (3) problem solving or applied research, and (4) discrete site analysis. These analytical functions are the foundation (and form the sections) of this publication.

Section one investigates some of the analytical techniques used by crime analysts in the study of crime series and patterns. The second section takes a look at the applied research questions pertinent to resource allocation and operations research. Section three probes the role of crime mapping and analysis in regard to problem-oriented policing, particularly problem solving techniques and applied research methodologies for community policing. The final section explores the use of Geographic Information Systems (GIS) and analysis in discrete sites (schools, parks, mall, etc.)

Our gratitude is extended to each author for their efforts and patience in getting this published work to press. While this was clearly a collaborative effort, each author is given complete credit for their submittal. Each contribution is the author's intellectual property and reflects their professional opinion. As such, it must be pointed out that these articles do not reflect the official opinion of the National Institute of Justice, the National Law Enforcement and Corrections Technology Center or the Crime Mapping and Analysis Program.

Like other emerging professions we must continue to write and publish our views and opinions, provide peer review of our techniques and approaches, strive for continuing education for our profession, and synthesize our findings and results. Most of all, we need to become collaborators, inventors, innovators, instructors, and dedicated students of our trade. We need to put the same rigorous analysis inward, about who we are, what we do and how we do it. Most certainly, we must begin to address how we might go about testing and improving our techniques. We hope this publication is a start in this direction.

Section-I: Investigative Analysis

Sean Bair • Program Manager • Crime Mapping & Analysis Program (NLECTC)

Background:

As part of the first Advanced Crime Mapping and Analysis Symposium, the Crime Mapping and Analysis Program (CMAP) assembled a group of six analysts from around the country who had achieved national recognition for their contributions to and achievements in the field of tactical crime analysis. The group discussed for two days the methods, process and discipline of tactical crime analysis. Symposium participants identified the sister discipline of "Investigative Analysis," to include elements of Tactical Crime Analysis and other widely accepted Crime Analysis disciples.

Each author will offer his or her own interpretation of Investigative Crime Analysis in the form of an article. Although each author's perspective may vary, the following definitions can be used as a baseline for this section:

> **Investigative Analysis**: *Investigative Analysis is the analysis of data for the purposes of identifying and eradicating a crime series.*
>
> **Crime Series**: *A crime series involves the analysis of criminal offenses that are thought to share the same causal factor (usually a single offender or group of offenders) given their descriptive, behavior, spatial, or temporal commonality.*

In order to develop a meaningful perspective on the subject of Investigative Analysis, participants began by identifying the intellectual distinction between a professional practice as an *art* and a *science*. Initially, our discussion focused on how investigative or tactical analysis, at present, is as much art as science. We can define an art as being a practice whose value is predicated on the nature of the practitioner; whereas we can define a science as a practice that is independent of the practitioner.

Although a work of art can be copied, the copy itself is not a work of art (*e.g.* one may take a photo of the Mona Lisa, thereby creating an exact copy, but the genius which was imparted into the original cannot be transferred into the copy.) A scientific process, on the other hand, is independent of the person performing it (e.g., it doesn't matter who calculates the area of a rectangle or even the size of the rectangle, the result will always be the same and verifiable by any analyst.)

Art can be copied but it much harder to repeat or impart on another the exact method or means by which you achieved your results. Science can be replicated by anyone as long as he or she has the methods and formula. Science will always yield the same results given an adherence to the methods and formula whereas art will not.

Tactical Analysis is *artistic* in how analysts use intuition, hunches or identify series based on unscientific methods, memory, or experience. Investigative Analysis is more scientific because it uses proven, verifiable methods for analyzing a series (Nearest Neighbor Analysis, Various Time Series Analyses etc.), which may be applied to any problem. The process of evolving to more scientific methods requires the development of models, standardized practices and use of the scientific method to identify and resolve crime series. Given

this, the articles in this section have attempted to provide verifiable and replicable methodologies for performing Investigative Analysis. These processes, models and formulae can be incorporated into a set of standardized practices any analyst might apply toward the eradication of serial crime.

Dan Helms contributes our first article in the series titled: "*The Tactical Checklist, A General Methodology For Analytical Investigation."* Mr. Helms lays the foundation underlying the fundamentals of Investigative Analysis. He offers a model that can be employed by analysts for use in identifying and resolving series. Using this set of standardized practices, an analyst can be assured to have employed all possible means of analyzing a series.

The second article in the series is from Chris Bruce and is titled: "*Killing Crime At Its Root: An Introduction To Cause Analysis.*" Mr. Bruce poses the question of why "why" is not more widely used in the study and analysis of crime series. He offers the answer of 'cause analysis' as a means to identify and resolve series as well as a mechanism to prevent future crimes.

The third article in this section, "*Tactical/Investigative Analysis of Targeted Crimes*," is a collaborative effort by Julie Cooper, Lt. Michael Ronczkowski, and Eric Nelson. They write on how various methods of Investigative Analysis can be employed as well as provide a theoretical and practical framework to follow. Case examples are provided and analytical techniques presented as to how to identify and eradicate series.

Tess Sherman presents the final article, "*The Role of Tactical Crime Analysis in a Serial Rape Investigation."* Ms. Sherman takes us through an example of how GIS was used to successfully analyze the relationships between a serial rapist and the mode of transportation he used to select and abduct his victims.

The Tactical Checklist: A General Methodology for Analytical Investigation

Dan Helms • Crime Analyst • Las Vegas Metropolitan Police Department (NV)

Introduction:

Emphasis within the field of crime analysis has clearly shifted toward tactical operations within recent years, with many agencies establishing tactical units or details within their analytical sections, and de-emphasizing formerly ascendant strategic and administrative practices. Successful case studies abound, demonstrating how effective tactical analysis can be at defeating specific criminal threats to public safety. Regrettably, although an increasing arsenal of specific techniques and methods are becoming generally available (e.g. "Sequencing,"[1] "Density Analysis," "Journey-to-Crime Estimation,"[2] and "Tempo Analysis"), most of these techniques, when applied, are practiced in a vacuum; a tactical analyst may apply a particular model or method against a given series, but lack a broader methodological context. This means that many techniques can be misused, misunderstood, or may not be deployed when appropriate because the process followed by the tactical analyst is not clearly defined or organized.

The following process model can guide the tactical crime analyst through the process of evaluating, analyzing, and eventually – we hope – defeating a tactical problem such as a crime series. This model has been developed by the author and implemented rigorously for the past five years. It is based on the **Scientific Method** – *Observe*, *Hypothesize*, *Experiment*, *Conclude* – which is often restated for crime analysts as the **SARA** model: *Scan*, *Analyze*, *Response*, and *Assess*. This methodology, however, will provide the tactical analyst with a practical checklist of steps to accomplish when approaching a new problem.

The Nature and Definition of Tactical Problems:

Tactical analysis is one of the four main divisions of the profession of crime analysis: **Tactical**, **Strategic, Operational**, and **Administrative**. Briefly, these can be described as follows:

Tactical Crime Analysis *is the comprehensive identification, evaluation, analysis, and resolution of specific criminal activity problems*. These problems are typically categorized as being *Incidents*, *Patterns*, *Trends*, or *Series*. Tactical problems are characterized as being distinct from mainstream criminal activity due to the presence of recognizable identifiers which distinguish them as belonging to an identifiable category. Incidents are unique crime events which are not related to other events, but which are distinguishable from mainstream criminal activity due to their significantly unique properties, and which demand directed attention (i.e., a school-room spree-killing). Trends are criminal activity that is generally related by location, time, date, *modus operandi*, or other characteristics, but which does not share the same causality. Patterns are criminal activity that is related by any number of characteristics (e.g. location, modus operandi, time, day, etc), but doesn't have sufficient suspect information to confirm or refute the causality behind the related incidents.[3] Series are criminal activity that is believed to share the same causality. By causality, we mean that the same offender, group of offenders, criminal organization, gang, or enterprise is responsible for planning or perpetrating the involved crimes. Previous definitions of Tactical Crime Analysis include, "Tactical analysis provides information to assist operations personnel (patrol and investigative officers) in the identification of *specific* and *immediate* crime problems and the arrest of criminal offenders. Analysis data is used to promote a quick response to field situations."[4] The aim of the Tactical Crime Analyst is to

resolve each individual problem as quickly and decisively as possible for the immediate benefit of the public safety.

Strategic Crime Analysis *is the comprehensive identification, evaluation, analysis, and resolution of non-specific criminal activity problems*. These problems are characterized as being descriptive of mainstream criminal activity; the Strategic Crime Analyst therefore deals with those problems making up the vast majority of threats to the public safety. The aim of the Strategic Crime Analyst is to increase public safety by reducing the level of crime throughout his or her jurisdiction.

Operational Crime Analysis *is the comprehensive identification, evaluation, analysis, and resolution of specific police activity problems*. These problems are characterized as being distinct from mainstream police activity due to the unusual and atypical nature of each problem. Police activity problems involve activity initiated and performed by the police, law enforcement, and public safety authorities (e.g., patrol operations, traffic stops, surveillances, warrant services, etc.), as opposed to criminal activity, which are crimes perpetrated by offenders. The goal of the Operational Crime Analyst is to resolve each individual problem as quickly and decisively as possible for the improvement of the public safety through the successful police operation.

Administrative Crime Analysis *is the comprehensive identification, evaluation, analysis, and resolution of both non-specific police activity problems*. These problems are characterized as being descriptive of mainstream police activity problems; the Administrative Crime Analyst therefore deals with those problems making up the vast majority of problems relating to police activity. The aim of the Administrative Crime Analyst is to increase public safety by increasing the efficiency of police activity.

Primary Attributes of Tactical Problems:

We first begin our evaluation of any new problem by breaking it down into its descriptive elements, and then subjecting each element to the appropriate analytical regime. We can define most tactical problems faced by crime analysts using five primary attributes: **Time**, **Space**, **Behavior**, **Target**, and **Offender**. Let's briefly explain what we mean by these attributes.

Time describes the temporal nature of the events that constitute our problem; we attack these factors using various temporal analysis methods.

Space describes the spatial nature of the events in our problem; spatial analysis is our approach to defeating these factors.

Behavior describes the *modus operandi* (MO) and signature of the offender(s), and tells us how a crime is committed. It also describes the behavior of victims and others associated with the crimes we are studying – an essential element not to be skipped!

Target describes the object of the crime. This is often an individual victim or group of victims, but can also relate to a type of business, or a type of property which could be, for example, stolen or damaged as the objective of the crime. Most types of crime involve a multitude of targets (e.g., a sexual assault's target is predominantly the person of the victim; however, the victim's house, her purse or wallet, might also be considered targets for the purpose of tactical analysis. In recent years this science of "victimology" has gained widening acceptability both in the United States and abroad.

Offender consists of the physical descriptions of the actual criminal offenders, as well as their vehicles, clothing, property, weapons, and anything else which can be used to evaluate them. We classify physical evidence as falling within this elemental block.

In order to perform a thorough analysis of a tactical problem, therefore, the analyst must consider and evaluate each of these elemental attributes in order to understand the nature of the problem. Each element can be attacked using a variety of analytical techniques, any of which might result in a breakthrough, or at least an increased understanding of the problem.

However, when we attempt to analyze these elements, we quickly find that they, too, can be readily broken down into component attributes. Let's compile a short list of four subattributes for each major factor, which will describe in sufficient detail the nature of any tactical problem.

Elements of Time:

There are four basic elements that describe the **Temporal** element of a tactical problem: **Distribution (Cyclical)**, **Distribution (Linear)**, **Temporal Environment**, and **Schedule**.

The *Cyclical Distribution* of a crime series or other tactical problem describes how events repeat themselves in temporal cycles, such as by hour of the day, day of the week, day of the month, and month of the year.

The *Linear Distribution* describes how cases relate to one another in a linear arrangement – their basic distribution pattern (i.e., Clustered, Random, or Uniform), tempo (i.e., Accelerating, Stable or Decelerating), and their timeline.

The *Temporal Environment* correlates the temporal element of a problem with other temporal factors. The most obvious of these is probably the diurnal dichotomy – do the crimes take place by day or by night? This is an obvious way in which the temporal part of the external environment can influence crime. Other obvious environmental correlations relating to timing include irregular events such as holidays, anniversaries of important dates, etc.; watershed events such as when a "copycat" attack follows a publicized event, such as a terrorist attack or a school shooting; and of course common, often cyclical events such as paydays, lunch hours, rush hours, rent payments, etc.

The *Schedule* of a problem can tell us about the Temporal Activity Space of the perpetrators – as well as of the targets. We can, for example, extrapolate such factors as the offender's hours of sleep, hours of work (if any), days available to commit crimes, and so forth in many instances. In some cases, we can even be very precise, and perhaps actually outline how the offender likely spends most of his time, with obvious tactical applications.

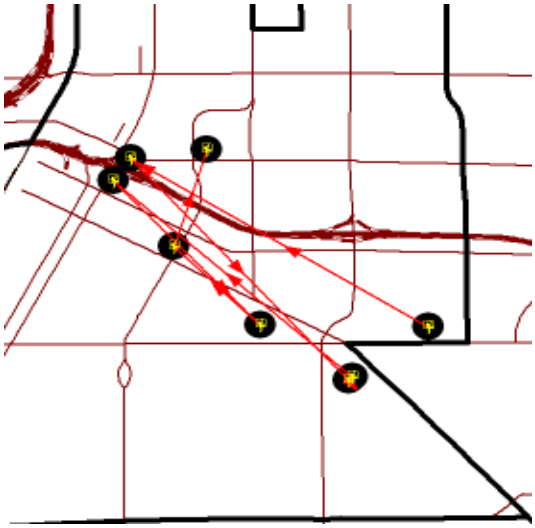
Elements of Space:

The **Spatial** element of any tactical problem can also be defined with four subattributes: **Distribution**, **Environment**, **Movement**, and **Action Space**.

The spatial *Distribution* of a crime problem describes how the locations of crime events relate to one another. This includes point distribution patterns (e.g., Clustered, Random, or Uniform), densities, progression, axes, etc. This attribute should reflect not only spatial distributions of crime scenes themselves,

but also of evidence recovery sites, victim encounter sites, “lairs,” victim homes and workplaces, and any other spatial locations with a bearing on the problem.

The spatial *Environment*, like the temporal environment, describes the correlation between significant locations and other spatial phenomena. For example, if all crimes in a series occur at bus stops, it seems likely that the location of bus stops could be used as part of a predictive model. If crimes occur near schools, perhaps the school locations exert some influence on the spatial behavior of the offender? The most obvious type of correlation is, for most of us, proximity – that is, following Distance Decay rules, we assume that two spatial events mutual influence increases as distance decreases; so, when looking for significant environmental factors, we usually begin by looking at what is closest to our crime scenes. However, negative correlations are also potentially important – for example, if all of our crimes occur in desert or undeveloped areas, we might posit that the presence of roads or buildings might have a negative influence on the criminal’s behavior; something which would be useful when attempting to model and predict future behavior.



Movement describes the dynamics of the spatial element of our problem. For example, does the series of crimes move from east to west? Does it spiral outward from some central point? Are there distinct areas in which the offender attacks in some revolving sequence? Are crimes getting closer together, or farther apart as the series progresses? Does the direction between cases change?

The *Activity Space* of a crime series is usually derived by a density or distance calculation from known crime scenes, and describes the areas in which the offender moves. As with the temporal Schedule factor, we can sometimes extrapolate the criminal’s spatial environment based on the evidence available to us. We might be able to guess what roads he travels, what type of neighborhoods he frequents, estimate his home or work neighborhoods, where he shops, eats, his method of transportation, and so forth.

Behavioral Elements:

The **Behavior** displayed in a tactical problem can be, like every other basic attribute of the problem, described with four subattributes: **Category**, **Signature**, **Evolution**, and **Mission Creep.**

The *Category* of a crime problem is comprised of the main factors which make it behaviorally distinctive. These include type of crime (e.g., Rape, Robbery, Burglary, etc.), as well as MO factors such as Premise/ Location Type, Method of Entry, Weapon Use, etc. These elements describe how the criminal act is perpetrated, and are integral considerations for every crime analyst.

Signature[5] is a sometimes confusing concept which describes the specific methods by which the criminal commits his acts – his unique perspective on how best to accomplish his criminal tasks. Signature elements can include the use of a distinctive weapon, key words or phrases, a trademark disguise, or other distinctive behavior that distinguishes the offender from other offenders in the same Category (i.e., there may be many Apartment Rapists, but only one wears a “Batman” costume and forces the victim to lay on the kitchen table). Signature elements include both the style in which MO is performed, as well as non-MO behavior –

that is, behavior which is not germane to the criminal act itself, such as a burglar who defecates on the victim's floor, or the serial killer who cuts a particular symbol into the corpses of his victims.

Evolution describes how the Signature of crime changes over time, expressing the dynamics of the criminal behavior of our tactical problems. For example, an offender may begin his residential sexual assault career by using improvised disguises such as a pillowcase. However, as the series progresses, he may bring his own disguise in the form of a ski mask. Another example might involve the use of weapons – an offender may begin as a strongarm robber, but after running into a physically defiant victim, may change his methods to display a knife or firearm, thus avoiding a previously identified weakness in his system. This process of "criminal natural selection" is rational, but not always reasonable.

Mission Creep is the term which describes how the Category of crime changes over time, and is a very distinct (although related) concept to behavioral Evolution. Criminal Evolution describes how the criminal alters the way in which he commits crimes; Mission Creep describes how the criminal alters the crimes which he commits. For example, a given offender may begin his career as a street robber. After some period goes by, he may encounter a sexually attractive victim and append an opportunistic sexual assault to his crime. Afterward, he may intentionally begin seeking out attractive female victims, and change from a serial robber to a serial rapist. Mission Creep usually involves adding new crimes to a criminal repertoire, but can also involve discarding some: Junior gang-members, for example, are likely to be involved in fights, petit larcenies, auto thefts, and burglaries when they begin their gangland careers, but over time will likely stop performing petit larcenies, residential burglaries, and chaotic brawling in favor of more "advanced" criminal activity, such as organized homicides, high-profile robberies, commercial burglaries, etc.

Target Elements:

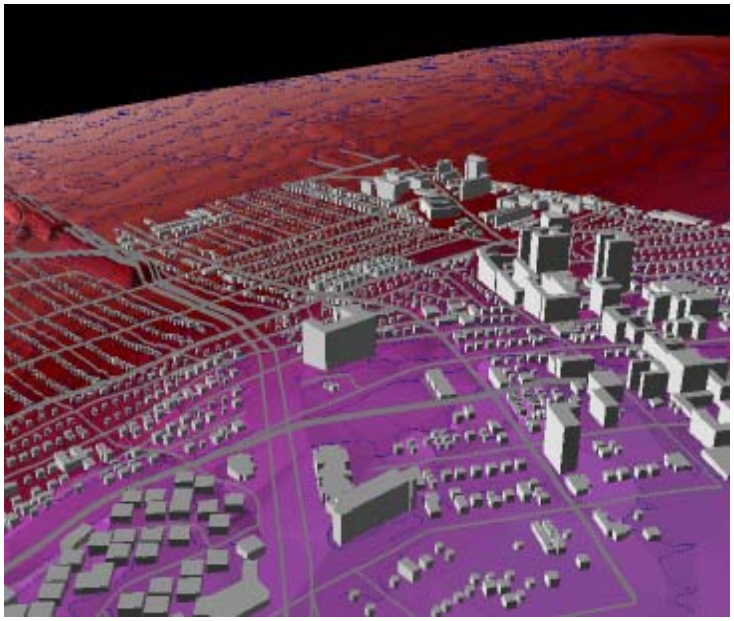
Understanding the **Targets** of criminal activity is essential to understanding the activity itself. Targets are invariably selected for a reason; the reasons involved may be opportunistic, rational, carefully planned, or subconscious, but they always exist and can often be extrapolated by the resourceful analyst. There are four essential subattributes to each Target: **Description**, **Actions**, **Motivation**, and **Movement**.

The *Description* of a Target consists of its physical appearance – and also of its non-physical appearance. The fact that the victim of a sexual assault was blonde, blue-eyed, tall, and well-dressed reflects obvious physical factors of the victim's Description. However, the fact that the victim was also the mayor, or an off-duty policewoman, or a schoolteacher, exemplifies the less-obvious, but equally significant non-physical

appearance of the victim. Descriptions are important because they inform us as to how the offender sees his target; this may involve more than eyesight!

The *Actions* of the Target are a lamentably overlooked factor in most tactical analyses. Quite often, an analyst might fail to recognize that the calm, solicitous, soft-spoken robber from one case could be identical to the loud, brutal, vicious robber in another case. The difference? In the first case, the victim cooperated, but in the second he resisted. Victim actions invariably influence offender reactions, and vice versa. Also, actions are critical influences in target selection by most offenders: A woman walking alertly and directly to her car in a parking lot presents a very different opportunity from a woman walking distractedly, rummaging around her purse looking for her keys, paying no attention to her situation. Actions also describe the behavior of non-human targets, such as commercial businesses. States such as "Open for business" and "Closed for the night" are reflected in this factor, as well as such efforts as posting security guards, implementing surveillance cameras, etc.

The *Motivation* factor for Targets describes why they have been targeted – what is the motivation to attack this target? Does the victim have lots of money? Is he or she unusually susceptible to attack? Is there some obvious weakness to exploit? Does the victim represent something to the offender, such as a political enemy or an old nemesis, making them a target for aggression? Is the target affiliated with, for example, a rival gang?



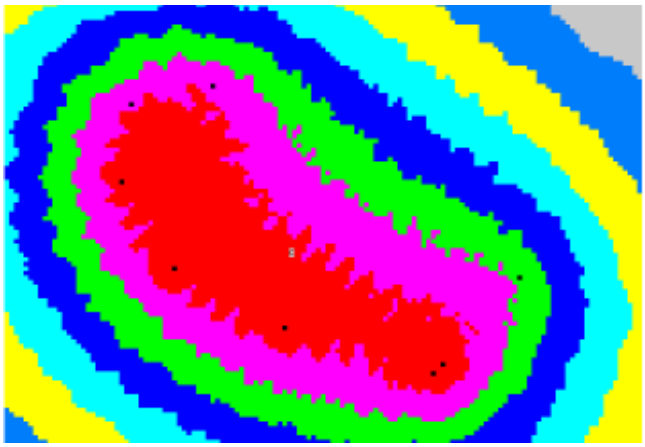
The *Movement* of a Target describes how the target changes in space, time, and behavior. Thus, a commercial business "moves" from being open to being closed when it shuts down for the night. Obviously, the physical movements of a victim are also considered here – how a person may travel to and from work, or the route taken by an armored car, for example.

Offender Elements:

The final primary attribute of our tactical problems, the **Offender**, is divided into four categories in the same way as other elements. Like Target subattributes, these are: **Description**, **Actions**, **Motivation**, and **Movement**. These factors closely mirror their namesakes that comprise the Target attribute; however, they pertain to the offender rather than to his targets and are clearly distinct.

Description covers the physical description of the Offender, as well as his vehicles, property, garb, weaponry, etc. It also includes the physical evidence he leaves behind of himself, such as DNA, footprints, fingerprints, etc.

Actions tell us what the Offender does during his crimes, and possibly at other times as well.



The *Motivation* for an Offender is critical to understanding our analyses of his behavior, timing, environment, and target selection – it tells us his underlying reason for being a criminal. Some criminals are compelled by the need for money and the inability or perceived difficulty of earning it legitimately. Others may be motivated by peer pressure. Some may see criminal activity as utterly normal. Sexual predators can be compelled to commit acts from time to time which, at other times, they find abhorrent and repulsive, and for which they may honestly loathe themselves and yet be unable to stop. In some cases, the analyst can hypothesize as to the Motivation of an Offender based on the nature of the tactical problem itself – the Motivations for a serial rapist and a commercial burglar are likely to be very different. It may be possible to make some very precise guesses, or at least attempt to do so; but at other times this may be highly misleading. It's important to realize that a single Offender may have complex and overlapping Motivations for committing different crimes within a single series.

The *Movement* of the Offender describes how he changes his behavior, his spatial environment, his timing, and his target selection as he progresses in his criminal career.

Recursion:

Clearly, the attributes and subattributes outlined above overlap and encroach upon one another to a high degree. The Target's Actions and Movements are certain to influence the Temporal Distribution of crimes, the Offender's Actions in making his attacks, etc. In fact, every factor influences, to some degree, every other factor in our list. Therefore, our analyses of each particular subattribute should cause us to change the way we look at every other factor in our problem. This means the analyst must constantly re-evaluate every part of the analytical process, returning again and again to areas already explored to see how new discoveries in other areas may result in new perspectives and open up new avenues to understanding the problem as a whole.

The Tactical Process Matrix:

The following matrix displays the five primary attributes and twenty subattributes which describe any tactical problem:

The Tactical Process Checklist

Temporal	Spatial	Behavioral	Target	Offender
Cyclical Distribution	Spatial Distribution	Category	Description	Description
Linear Distribution	Spatial Environment	Signature	Actions	Actions
Temporal Environment	Movement	Evolution	Motivation	Motivation
Activity Schedule	Activity Space	Mission Creep	Movement	Movement

The Process Checklist Method:

There is a simple process for evaluating, analyzing, and hopefully resolving our tactical problems by using the *Tactical Process Matrix* as a checklist. This straightforward process requires three simple steps:

1) ***Analysis****: Attack each factor with any available analytical methods, tools, and techniques*
2) ***Evaluation****: Note how your results influence all other factors*
3) ***Recursion****: Re-evaluate every factor taking into account all new analytical findings.*

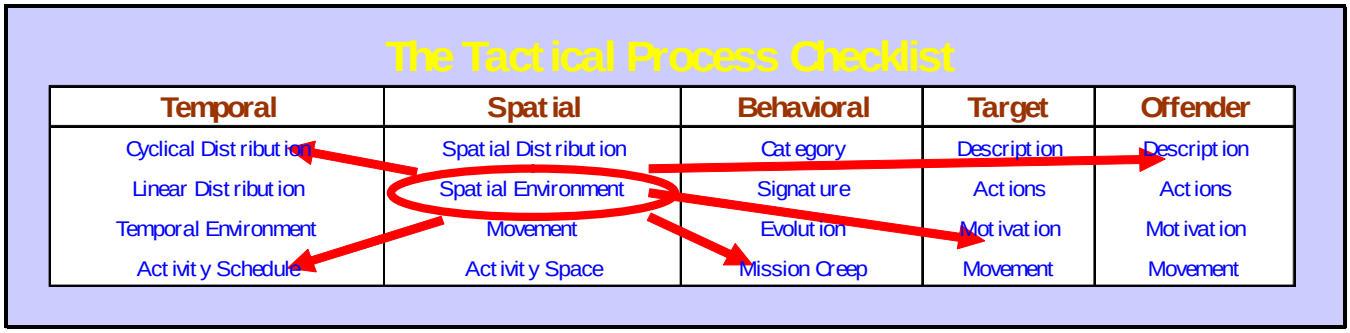
Repeat this process – *endlessly*.

Questions:

The six questions every crime analyst should pose against each element of his analytical matrix are, naturally, "**Who, What, When, Where, Why,** and **How**?"

Consider each of these questions in relation to each cell in our matrix, and answer each as best you are able to satisfy your analytical needs. Some questions may seem obvious, and depending on the resources and time available to the analyst, may be skipped. Those questions that cannot be clearly answered require analysis, and this is how we should shape our approach to each element of the problem.

For example, asking "Who?" of the Linear Temporal Distribution attribute may seem strange, but on careful consideration we can see that this is a very valid question to pose against this topic. For example, it may be possible to interpolate how many offenders are involved in a crime series by the timeline of events. In this case, we should use analytical attacks such as Spectral Density Analysis to search for multiple cyclic patterns, Timeline Convolution to separate and extract those patterns so we can examine them separately, and Correlation Analysis to associate particular events with particular offenders. Then, once we have made a determination that the series may have been committed by, for sake of example, one to three offenders working alone or in rotating teams, this will have obvious implications for the way in which we study the Signatures involved in each crime, the Spatial Distribution of crimes, the Victimology associated with each event, and so forth.



We begin with the first cell in our matrix, and attack it with whatever tools are available to us. In the example matrix we use here, the first factor to analyze is Cyclical Distribution. We would use methods such as Weighted Hourly Analysis, Clock-Face Diagrams, Spectral Density Analysis, Day-of-Week Counts, and Virtual Temporal Topologies to analyze this factor. We then visit every other cell in the matrix and note how our Cyclic Distribution conclusions will influence each factor (e.g., if our Cyclic Temporal Analysis

indicates that the offender prefers to attack on Saturday nights between midnight and 3 AM, we would note under Offender Actions that perhaps our perpetrator is busy at other days and times, is active weekend nights, etc.; under Behavioral Categories we note that he is a "Night" and "Weekend" offender; under "Signature" we might expect nocturnal elements such as the use of a flashlight; under Target Actions we might note to look out for victims whose lifestyle might be significantly similar at those times; under Spatial Environment we would want to check to see whether or not nearby businesses were open or closed at those times and what transportation is available then, etc., etc.). We complete this process for every cell in the matrix and evaluate changes for every other cell. We can physically tick checkmarks off on a computer or paper matrix to record our progress and ensure we haven't accidentally skipped a step. Once we have tested each cell, and for each tested cell have noted its influence on every other cell, we recommence the process from the beginning and proceed all over again.

This process does not have a clear-cut end in most cases. The tactical analyst may terminate the process due to insufficient information, lack of time, or a successful resolution.

Resolution:

Effective tactical crime analysis does not end with analysis; far from it. Even if we have analyzed a tactical problem so thoroughly that we understand everything about it correctly, we still have to do something about it or else our efforts are worthless. There are five ways in which a crime analyst can contribute to a tactical resolution: **Deterrence**, **Denial**, **Intelligence**, **Investigation**, and **Interception**.

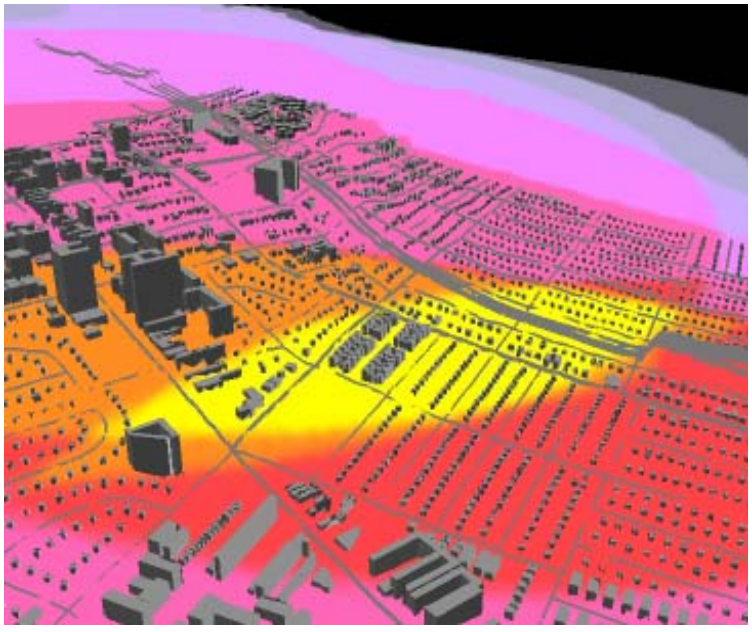
Deterrence is the reduction or elimination of the tactical threat by causing the offender to refrain from further attacks. This can be accomplished by means such as high-visibility patrols, area saturation, directed activities, media campaigns, public awareness posters, etc. The crime analyst can drastically improve the success of these measures by directing them to best effect. Wanted posters, "snitch" campaigns, directed patrol activities, and so forth can be targeted through strong spatial and temporal identification of the offender's hunting grounds and activity space. His friends and family might be avenues of approach as well, if the analyst can make the right people suspicious and distrustful of the offender through skilled media interaction and public contacts. The advantages of deterrence are that it can be attempted with very little information to go on, and requires comparatively slight effort to accomplish. The drawbacks are that it is difficult to measure its success, and that it can result in displacement – the offender continues to commit his crimes, just in a different area or using different methods; while this outcome may satisfy our particular agency, it fails to serve the greater goal of public safety.

Denial is the reduction of elimination of the tactical threat by denying the offender any targets. This can be accomplished through "target hardening" measures – more public awareness, Crime Prevention Through Environmental Design (CPTED), and other means can be brought to bear to reduce the number, attractiveness, and vulnerability of the offender's victim pool. If the offender targets unattended, unlocked cars left "only for a second" at gas stations or post offices, a public awareness campaign combined with the implementation of fines for persons who leave an unsecured vehicle unattended in certain public places could force the offender to change his methods, move elsewhere, or even abandon them. If, through deterrence and/or denial, the police can make criminal activity less attractive than a legal lifestyle, some criminals may even make a permanent change. The advantages of denial countermeasures are that it capitalizes on the ability of citizens to avoid crime and protect themselves, reducing law enforcement involvement and freeing up valuable resources, and that it is also easy to implement with little information. The drawbacks are that, like deterrence, it is difficult to measure, may result in displacement, and depends on individual potential

targets to take necessary actions, a matter which is outside police control and therefore uncertain. Denial is distinguishable from deterrence in that it *denies* the offender access to a target; deterrence, on the other hand, deters the offender from striking even when victims are abundant.

Intelligence parallels Investigation as a countermeasure which eliminated a threat by identifying and targeting the offender. Unlike investigative methods, however, which rely on evidence recovered from the crimes – such as physical evidence, witness accounts, suspect testimony, etc. – the Intelligence effort begins from outside the scope of the tactical problem and works its way inward. Successful police intelligence involves gathering information of sufficient quality and quantity to generate investigative leads. The process of elimination is used to pare down a list of possible threats and offenders, allowing the police to prioritize their efforts and concentrate them. Tactical crime analysis can work hand-in-glove with intelligence units by providing greater access to information and improved analytical measures. The advantages to intelligence countermeasures include the fact that they are difficult for the offender to circumvent and that there is almost invariably enough information available to the police for effective intelligence efforts. Disadvantages include that it can be very resource-intensive and time-consuming. Intelligence efforts are also sometimes difficult to direct – that is, information is likely to fall into the hands of the police, but the police have little control over what information they get.

Investigation is another avenue to victory. This involves the elimination of the threat by identifying and targeting the offender. Most detectives do this by interviewing victims and witnesses, examining crime scene evidence, and then through a process of elimination identifying the offender and obtaining an arrest. Crime analysts can drastically increase the successfulness of these measures by prioritizing leads for investigating detectives, by generating "profiles" of likely offenders, by targeting neighborhoods where the offender is likely to live and work, by identifying the kind of work he does, or the school he attends. Because they often have access to vastly superior research tools and data than most detectives, crime analysts can occasionally perform routine investigation work superior to that of sworn detectives. Investigation is the countermeasure which today most often results in successful resolution. Its advantages



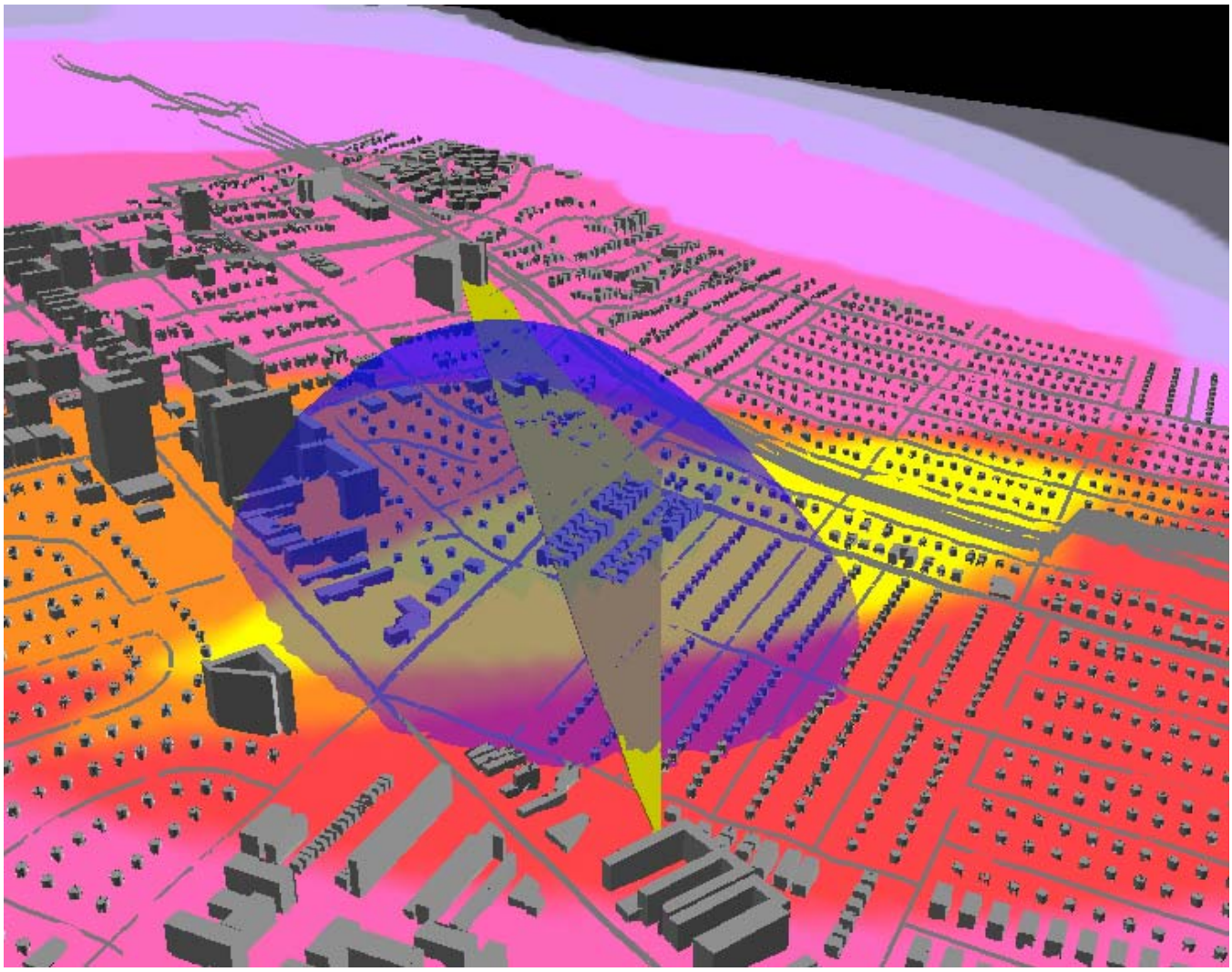
include the fact that police operations are already mostly designed to implement investigative methods well and quickly; that almost all tactical problems include sufficient physical evidence, witness accounts, and other fodder for the investigator to ensure success; and, finally, that investigative methods are accomplished on the timeline set by the police, and using the resources allocated by the police, allowing law enforcement to retain the initiative in deciding which tactical problems should receive focused attention. Disadvantages include the fact that investigation depends upon the offender to err by either leaving evidence, allowing him- or herself to be recognized or described, etc., which forfeits initiative. These methods can be very time-consuming and manpower-intensive, sometimes prohibitively so.

Interception is for most tactical analysts the Holy Grail of their profession. It is the eradication of the tactical problem by intercepting the offender in a criminal act. Tactical analysts are pivotal to this process. The resourceful analyst can prioritize a short list of probable targets for future events based on analysis of past activity; he or she can improve the police ability to successfully perform a bait, decoy, or sting operation by unraveling criminal methodologies, allowing law enforcement to finely tune their countermeasures. He or she can guide investigators and responders to commanding positions and allow them to rationally predict the timing of future events. He can recommend surveillance equipment locations and listening posts. The advantages to interception include that conviction rates and surety are far higher then through other means because the attacker is caught in the act; also, this countermeasure uses the offender's own methods against him, exploiting patterns and predictabilities probably unknown to the offender himself. Disadvantages, however, include the fact that interception relies upon accurate forecasting, a tricky and difficult proposition. Moreover, even if a pattern is correctly identified and a perfectly valid forecast is made, the offender may behave unpredictably due to imponderable factors such as illness, car trouble, overtime, or almost anything else one can imagine. Failed forecasts can degrade the credibility of the forecaster. Perhaps the greatest problem with interception is that it requires the commission of another crime in order to succeed – if the crime involved is a homicide or a sexual assault, one more cases, even the threat of one more case, may be completely unacceptable.

The Shotgun Approach:

The analyst should not be bound by limited options when confronting any tactical problem. Rather than restrict themselves to a small set of tools, techniques, and methods, tactical analysts should use the "shotgun approach" – ***Use Every Available Tool Against Every Distinct Part of Every Tactical Problem.***

This means that specific methods should be applied across the board to every factor of our series. For example, "cluster-finding" methods such as nearest-neighbor tests, Ripley's K statistic, Moran's I statistic, and others are well-known ways to identify spatial distributions of events; however, they can also be applied to temporal factors, allowing the analyst to look at temporal distributions using the same visualization techniques as have been so effectively applied to spatial analysis. Using methods such as Multi-dimensional Scaling (MDS) and Smallest Space Analysis (SSA), these same cluster-finding models can be used to perform behavioral modeling against the MO, Signature, and Categorical considerations.



Even when the analyst is satisfied that he or she has unraveled the mysteries of the problem and is in position to frame a suitable response plan, rather than limit oneself to a single "optimum" response countermeasure, multiple measures should be implemented whenever practical. Thus, instead of simply making a forecast and attempting an interception of an active series, the analyst should also prepare a deterrence plan. Intel and investigation methods should be followed up. Why stick to a single approach if you can try them all? If you can't try them all in a meaningful way, due to a lack of reliable analytical findings, lack of resources, or (all too often) a lack of authority, prioritize your countermeasures to get the best possible benefit with the means available to you.

Summary:

The tactical methodology outlined here can provide a clear and coherent guideline for tactical crime analysts when attacking a tactical problem. By following the steps outlined here, the analyst can bring to bear all available tools and techniques on every aspect of a tactical problem such as a crime trend, pattern, or series, ensuring that no critical factor has been left unaccounted for. By following this process, we can streamline our tactical methods and even, where possible, divide effort intelligently among units and personnel. The depth and intensity of analysis can be maximized without sacrificing that all-important consideration weighing down on every tactical analyst – time.

Illustrations:

Accompanying illustrations show the progressive investigative forecast of a ten-case crime series consisting of home-invasion rapes, robberies, and murders. Three different spatial prediction methods (Movement pattern extrapolation, Kernel Density, and Journey-to-Crime) are all superimposed on the facing page to show how one particular apartment complex is highlighted by all three methods. Detectives using this data identified the suspect - previously unidentified - by canvassing the complex in under an hour. The suspect has been apprehended and is awaiting trial at the time of this publication.

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Killing Crime at Its Root: An Introduction to Cause Analysis

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Aspiring journalists learn that every story must answer six basic questions: who, what, when, where, how, and why. A story that lacks the answers to one of these questions is not complete. Crime analysts act as journalists when they analyze crime patterns and trends, and report the results of their analysis to their officers, their superiors, and the community. A crime analyst approaching a new crime problem asks many of the same questions that a reporter covering the story would ask, and most of them roll up into one of the "five Ws and one H."

In crime analysis, great attention has been given to the question of where (in the form of geographic analysis and environmental analysis), the question of when (in the form of temporal analysis), the question of who (in the form of offender and target profiling), and the question of how (in the form of classification and *modus operandi* analysis). Yet very little attention has been paid to the crucial question of *why*—the root of a crime problem that, when cut, kills the weed; the cornerstone of a pattern that, when pulled, makes the structure collapse.

The question of "why" is asked not only of the pattern itself, but also of each of the commonalities involved in the pattern:

- *Why* is this particular offender committing this type of crime?
- *Why* does he choose this particular type of target or victim?
- *Why* does he strike in this geographic area, or during this time frame?
- *Why* does he use this type of weapon, or enter his targets through this method?
- *Why* does he steal this type of property?
- *Why* does he flee in this direction?

The factor or factors that have instigated the pattern may range from the obvious to the unidentifiable. The number of factors may range from one to dozens, but they are often identifiable if the analyst takes the time to ask the right questions.

Why does *why* receive so little attention? Of the six factors listed above, it is the only one that does not regularly appear in crime reports. It is the only factor that cannot be analyzed with readily available data. Of the six factors, *why* requires the most careful and creative application of the analyst's intelligence and experience. Even when done sincerely and correctly, cause analysis often results in no satisfactory answer. The reasoning behind some patterns and some criminals will always remain inscrutable, even when the offender is apprehended and questioned.

But when cause analysis *does* result in an answer, this information can be more powerful than any other product of analysis. The cause of a crime problem, if known, almost always dictates its solution. Any other forecasting attempts or patrol and investigations based tactics can usually be eliminated in favor of a strategy specifically designed to remove the pattern's root cause.

Furthermore, cause analysis goes hand-in-hand with problem-oriented policing, which emphasizes that the root cause of crime, and not the crime itself, should receive the bulk of attention. In the eyes of problem-oriented policing, addressing a crime pattern is better than addressing individual incidents, but addressing the *cause* of the pattern is better still[1]. Suppressing or displacing a pattern, or arresting an offender, may prevent dozens of future crimes, but killing the root of the pattern—eliminating its cause—may prevent hundreds or thousands. Cause analysis thus provides crime analysts a means to put problem-oriented policing to practice.

Assumptions:

Literature on the craft of cause analysis among crime analysts is scant. Much of what follows is based on my own practice and experience and those of other analysts to whom I have spoken.

My approach to cause analysis makes the **following series of assumptions** about crime and criminals:

1. **Single crimes usually do not have an identifiable cause**, other than the traditional "motivated offender," "suitable target," and "absence of capable guardianship"—identified by Cohen and Felson in their Routine Activities Theory—converging at a particular time and place. We may call these "crimes of opportunity."

2. **A jurisdiction is at an equilibrium state** when it experiences only "crimes of opportunity." At this state, crimes are random, unpredictable incidents that occur because of a coincidental convergence of offender, target, time, and place.

3. **A crime pattern disrupts this equilibrium** by introducing a series, hot spot, or trend that is *not* random—that is composed of "crimes of design" rather than "crimes of opportunity."

4. Since there is now something (a crime pattern) where there was nothing but equilibrium before, *something has instigated this change*. This "something"—one or more factors—is the *cause* of the crime pattern—the object of the analyst's question of "why."

Motivated offenders, suitable targets, and absence of guardianship remain factors even in pattern crimes, of course, but pattern crimes feature either:

- An *intensified* traditional factor, such as a *continually* motivated offender, a *continual* supply of suitable victims, or a *continual* absence of capable guardianship;

- An *additional* factor, related to place, time, crime, or *modus operandi*.

Finding the Cause:

The commonalities observed in a pattern are usually the keys to its causes. The cause of an auto theft pattern in which only Honda Accords are stolen can usually be found within those Accords—perhaps the thieves have a "master key," or perhaps a local "chop shop" has been flooded with orders for Accord parts. The motivation of a serial robber who always strikes between 2:00 p.m. and 4:00 p.m. may center on this time range—perhaps this is when the robber or his victims get out of school, or work.

Often, of course, there is a plurality of commonalities, and thus of causes. An analyst studying a pattern of burglaries into lakeside bungalows in which only antique statuary is stolen must puzzle over the burglar's preferences for both lakeside bungalows and antique statuary.

By way of example, assume that an analyst has discovered a pattern of robberies in his city, occurring between 19:00 and 21:00, in a large park known as Cotter Field. Suspect descriptions vary from case to case—as does *modus operandi*—but almost all of the victims have been men and women between the ages of 18 and 21, walking alone, either to or from a local subway station.

Even with this small amount of information, the analyst has enough to put out a crime bulletin or community alert, warning the department and the community about this robbery pattern. The police agency might reasonably assign extra officers to Cotter Field between these hours in the hope to deter future robberies. But neither the analysis nor the solution has addressed the cause of the pattern, and therefore we have no guarantee that we won't see a resurgence of the pattern once the extra patrol presence is lifted.

To find the cause, the analyst focuses on the two points of commonality: the victims, who were overwhelmingly between the ages of 18 and 21, and who were walking to or from the subway; and the times of the incidents, which almost always fall between 19:00 and 21:00.

The subway stop in question is called "University" for a reason, as it serves Winchester University, a large institution in the middle of the city. Already the analyst suspects that the victims, given their ages, are students at Winchester. The reporting officers didn't note this on their reports, but the analyst follows up with the Investigations Unit and discovers that his suspicions are correct.

The analyst uses his GIS system to plot the robberies, the subway station, the park, and the buildings that comprise Winchester University, and discovers that the students' route through Cotter Field would take them to an outlying building known as Wagner Hall. The analyst visits Cotter Field and learns that while the walking path is busy with activity during the day, in the evening it is lightly trafficked, poorly lit, and surrounded by dense vegetation.[2]

So far, the analyst has discovered a great deal, but he has yet to find the inciting incident that accounts for the *sudden* emergence of this pattern in this opportune area.

A call to Winchester University reveals that the school used to hold its evening classes in Mayer Hall, which required students to walk on a brightly lit, heavily-trafficked street between class and the subway station. Only within the past few months has the college held classes in Wagner Hall.

The analyst's intuition, knowledge of his jurisdiction, intelligence, initiative, and proper application of POP and CPTED principles has now produced a probable *cause* for this pattern:

> *A change in class location has shifted these students' daily routes from a safe path to a dangerous one.*

The police agency can now focus on a solution meant to kill the root of this problem.

Finding the Solution:

The remedy typically prescribed for a crime pattern—patrol overtime—is rarely the best one, though an analyst retards the agency's ability to pursue more profitable strategies if he fails to answer the question of *why*. When only the who, what, when, where, and how are known, what option does the agency have but to place more officers *where* and *when* the crimes are most likely to occur, in an effort to convince the *who* to take his *what* and *how* someplace else?

When the cause is known, however—or even suspected—it almost always offers a more intelligent approach to strategy development, allowing the agency *and* the community to craft a solution that deals with the root causes of a specific problem. Solutions that produce results in one scenario may not have the same effect in another, and only by investigating the cause can we be sure that our strategy makes sense for the problem at hand.

Continuing the robbery example given above, the department might take any of the following "traditional" steps:

1. Put more officers in Cotter Field, suppressing the pattern for a short time. But extra patrol doesn't usually last forever, and once it's removed, new activity could be expected.

2. Permanently address the problem through redistricting by creating a new patrol route devoted entirely to Cotter Field. This would probably be a waste of resources, however, as the pattern is only active between 19:00 and 21:00, and restructuring patrol routes to deal with a single problem is rarely a good idea.

3. Detectives could send decoys through the path, intent on catching the robbers, but you could probably never hope to catch *all* of them, and where victims and opportunity await, criminals will come.

4. Students could be warned to walk in pairs or to take an alternate route, but some wouldn't hear the warning, and others wouldn't heed it.

Having a good idea of the pattern's root causes, however, gives the police agency the following additional options, which would probably be more effective in the long-term:

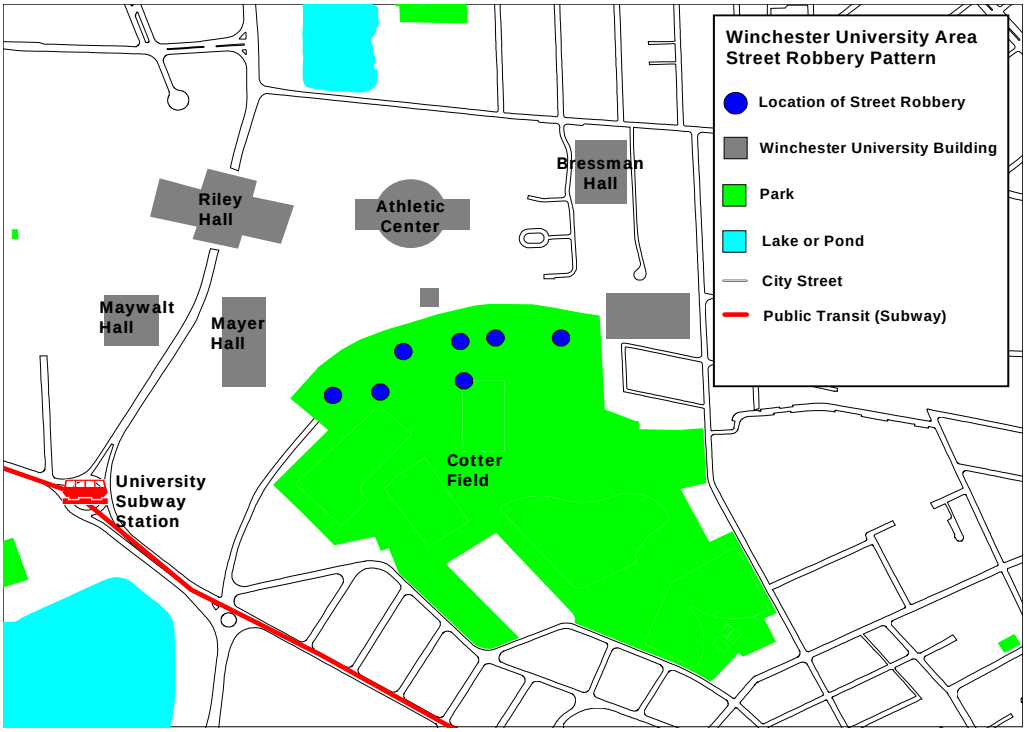
1. Explain the pattern to the administrators at Winchester University and convince them to change the location of its evening classes back to its original location. Given contemporary concerns about campus safety, this would probably be a fairly easy "sell."

2. Engage the city's Public Works and Parks & Recreation departments to increase lighting and visibility along the path in question. This has the advantage of potentially preventing other crimes, in addition to the ones related to this rerouting of students.

Either of these alternate options, dictated by the dynamic of this specific pattern, has the potential of immediately eradicating it. Furthermore, both involve a much less substantial dedication of the police agency's valuable time and resources.

Crime Mapping in the Cause Analysis Process:

So far, I've written little about the specific uses of crime mapping for cause analysis. I have argued in the past that crime mapping receives too much emphasis as a stand-alone panacea, and too little emphasis as an integrated part of the crime analysis toolbox. I think that the cause analysis process, however, illustrates how crime mapping works hand-in-hand with the analyst's talents and technique—to extraordinary effect.



Crime mapping greatly assisted in the analysis of the student street robbery pattern in the following ways:

- **Initial Identification**. By plotting crimes on a regular basis and looking for clusters, the analyst may have first spotted the street robbery pattern through the use of crime mapping tools.
- **Route Mapping**. Knowing that the students were walking from a local subway station, the analyst mapped the route from the station to the park, facilitating further analysis of the problem. Bringing up a map layer that included Winchester University's buildings, the analyst was able to discern the students' probable destination.
- **Presentation**. This neat, clearly labeled map helped the analyst describe the problem to departmental personnel, but it was of greater assistance when the analyst was asked to give a presentation to the administrators of Winchester University, explaining why they should move the night classes back to Mayer Hall.
- **Environmental Design**. A complete GIS, with city light poles and city trees, allows the analyst to diagram the needed changes to the Public Works and Parks & Recreation departments.

The greatest benefit of crime mapping in cause analysis involves its ability to *compare multiple geographic factors*, in order to find geographic correlations and thereby explain crime patterns. The analyst in this example was able to visually compare the locations of criminal incidents with the locations of university buildings, parks, and subway stations to hypothesize the pattern's causes. In other examples, it may be beneficial to map assaults against the locations of liquor stores, or to compare auto theft locations with a map of major avenues away from the city. There are thousands of examples in which the comparison of crimes to other geographic factors might help determine the crimes' causes, and crime mapping makes this type of analysis possible.[3]

Conclusions:

Simple crime analysis often seems like a routine repackaging of data using fancy tools. Cause analysis, however, calls upon the analysts' intelligence, innovation, experience, knowledge and skills, requires them to put valuable theory to practice, and engages them in an exciting, dynamic process that can have an astounding effect on crime in their jurisdictions. We would like to see our profession give greater emphasis to this process and the techniques involved in cause analysis.

We have presented here an admittedly ideal example (though based on a real pattern) of how cause analysis works—in truth, many patterns exhibit either obvious causes, making the process less ingenious, or indecipherable causes, making the process impossible.

Further investigation into the applications of cause analysis should begin with the collection of case studies from various agencies and, more importantly, their publication in crime analysis books and their presentation at crime analysis symposiums. Too many case studies—in both publication and presentation—end with the initial identification, analysis, and description of the crime problem. A disjointed form of strategy development follows and is only occasionally successful. Analysts have seldom demonstrated how the analyst has followed the pattern *past* the descriptive analysis process, and through the cause analysis process. Such demonstrations, we think, make our profession seem more interesting, more important, and more influential—and they show how crime analysis can truly accomplish its mission of reducing crime.

End Notes:

[1] For a full discussion of Problem-Oriented Policing and problem solving, see Herman Goldstein, *Problem Oriented Policing* (McGraw-Hill, 1990).

[2] The analysts is here applying some principles of Crime Prevention Through Environmental Design (CPTED), which can be used by analysts to puzzle through many causes. The International CPTED Association is a resource for those who want more information: http://www.cpted.net/.

[3] In this instance, the analyst's comparison has been entirely visual. In a more complex situation, with more incidents to consider, the analyst may wish to employ distance measurements and statistical techniques to establish a precise mathematical correlation.

Tactical/Investigative Analysis of Targeted Crimes

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Michael Ronczkowski • Lieutenant • Miami-Dade County Police Department (FL)

Introduction:

Modern day law enforcement agencies are continually striving to meet the immediate needs of their customers, both internally and externally. With increased media scrutiny and a rising demand for public information, as well as the continued evolution of crime and the increasing complexity of career criminals and their motives, those agencies responsible for public safety have been tasked with a new mission. In an environment where the "good guys" have resources which are exhaustible, while the sheer number of "the bad guys" is unknown and can grow exponentially with merely opportunity as an incentive, modern law enforcement has found itself in a position where it must "work smarter" to deal with the developing criminal element. In part due to technology, society as a whole has grown to be more aware of their everyday surroundings and often seeks instant gratification and response to any perceived deficiency or lack of service. Advances in technology have provided the tools by which crime fighting will evolve (e.g., computer information databases, wireless communications, national and international intelligence networking, etc.). It will be the human components of this changing landscape, however, that will be responsible for the implementation and use of the skills and techniques necessary to harness this technology for the purpose of increased information and detection resources. To accomplish their common goal, police forces around the world have turned to crime and intelligence analysts to fill this role.

The analysis of crime has been something that police agencies have done since their earliest inception. To facilitate functions as simple and defined as a constable knowing when and where to walk his area of the city to find troublemakers, or a town Sheriff knowing how many deputies he would need patrolling the streets to deter robbers or bandits from striking, law enforcers have sought to know and understand the criminal activity in their jurisdiction in order to deal with it. In today's world, however, with the increasing complexity of both crime and the environment in which it resides, the need for detailed and comprehensive analysis has dictated the invention of the professional law enforcement analyst as a separate and distinct occupation within a police organization.

It is incumbent upon law enforcement agencies to clearly define their role/mission, not only for patrol purposes, but also for their analytical personnel in order to rapidly address criminal activity. There are numerous variables involved in identifying and addressing targeted crimes that are often opportunistic in nature, e.g., *modus operandi (MO), temporal, and spatial*. It is a mix of technology, resourcefulness, awareness, and standardized practices that enable analysts to effectively respond and assist a particular crime problem. However, just like any good formula you need a foundation on which to build. Once the foundation's principal features have been identified and defined, to ensure that everyone is on the same playing field, the tactical/investigative analytical process can be put into place. One notable observation for many tactical/investigative crime analysts is that the process that they invoke is not a global one, but rather one that stays within the lines and ends upon completion of a specific user defined work product such as a bulletin or map, therefore lacking follow-through. It should be noted that the *Tactical/Investigative Crime Analysis Process* referred to herein is often the 24-72 hour window immediately following the commission of a crime. This window tends to yield the greatest number of leads due to the ability of victims and

witnesses to provide "fresh recollection" of incidents. However, it should be noted that a definitive timetable cannot be placed on every investigation due to the continual development of investigative information. Thus, analysts should continually strive to provide an array of timely analytical products to meet investigative case needs. Outlined below is a working definition of tactical/investigative crime analysis process.

> *Tactical/Investigative Crime Analysis Process:* A continual operational support process involving the review and analysis of current and historical crime data, in conjunction with applicable supplementary data from multiple ancillary sources for the purpose of identifying recent, immediate and/or specific-ongoing crime trends, patterns, series and hotspots, locating suspicious persons, developing investigative leads, and assisting operational personnel with crime prevention, case clearance and successful prosecutorial support.

Certainly for operational personnel, (e.g., patrol officers, detectives, crime prevention officers, and undercover enforcement officers), fast, accurate tactical/investigative crime analysis is a vital resource and essential as an operational support function.

Beyond a working definition, it is incumbent upon analytical practitioners to define the tactical/investigative analytical process at every step to ensure, not assume, that all participants in their respective agency or region are utilizing like terms, and processes.

Goal:

Although each law enforcement agency has its own unique culture and systems, they share the common goal of immediately identifying and addressing criminal activity. Therefore, the goal of tactical/investigative crime analysis that can be shared among agencies is an effective law enforcement response to a crime series or pattern. This can be achieved through the following four practices discussed and agreed upon by several practicing Tactical/Investigative Analysts at the recent CMAP symposium on Crime Analysis & Crime Mapping:

1. *Deterrence*
2. *Interception*
3. *Subject identification/arrest of offender*
4. *Target Hardening*

In order to maximize effectiveness and to ensure goal attainment is expedited and lasting, tactical/investigative crime analysts should avoid the pitfalls of merely relying on historical data analysis and strive for "real-time" analysis. To achieve a true "real-time" analysis process, law enforcement agencies should seek to automate the entire analytical process. It is possible to perform "real-time" analysis with limited automation, but depending on the volume of crimes analyzed, there is a likelihood that valuable information could be overlooked. By automating the analytical process, agencies will be increasing their likelihood that a series, pattern, or trend will be identified in a timely manner. Quite often analysts find themselves faced with doing the tedious tasks of data updating and correcting, and on relying upon their own brain as the computer for the thousands of cases that cross their desks.

Data Collection:

Although a common term in today's society, "data" is an often misused and misrepresented term. "Data" has become synonymous with computers and electronic databases, however, for an analyst, "data" may be construed as any pieces of information that crosses his/her desk. In this era of robust databases, law enforcement agencies should strive to avoid relying on strictly manually reviewing their "data". This in and of itself is not necessarily a taboo practice. In fact, the effective analyst will understand that the principles of the analytic process are the same whether done by hand or aided by technology. Automation is merely a means of expediting the analytical process by giving analysts the ability to process large volumes of information in a rapid manner, and enabling the ability to process complex data formulas. All too often, analysts are tasked with data entry into multiple databases. Their time is spent doing mundane data entry and their products are analytically bankrupt. Computer technology should be viewed as a tool in effective tactical/investigative crime analysis.

The data collection process is an ongoing function of tactical/investigative crime analysis, and one that should be continuous and have a set of standardized practices. Ideally, the collection of internal crime data would be initiated once a victim, witness or officer makes a call that assigns a case number to an incident location. The simple fact that analysts work in an office and not on the street with sworn officers limits an analyst's ability to gather information immediately and visually depict a crime scene. However, the advantage to this separation of work environment, of course, is that the analyst is able to pull in a non-bias view of the "big picture," accessing far more information than a reporting officer would be capable of in the same period of time. However, to compensate for the delay in information access, the analyst must be proactive in the data collection process. Written incident reports tend to be the initiating factor for most tactical/ investigative crime analysis. To increase the timeliness and effectiveness of the analytic product, the analyst must use the police officers themselves as a part of the data collection process. Officer's Notes, Attempt To Locates (ATLs), or Be On the Lookouts (BOLOs) made by the responding officers/dispatchers are all vital forms of documentation that can expand and quicken the analyst's data collection. Also crucial in rapid information gathering are officer contacts and conversations.

Many analysts find themselves relying on Calls for Service (CFS) data to identify trends, patterns, or series. Unless updated and reconciled regularly, the use of raw CFS data will be misleading and inaccurate. While the data itself should not be discounted, it should never be used exclusively in either pattern or hotspot analysis. Effective analysis takes into account as many different forms and sources of information as possible. To avoid being a one-dimensional analyst it is imperative that you "know your data", as well as what is available to you. There are numerous data resources available to analysts in most jurisdictions beyond their own agency's crime analysis system, such as:

1. *Dispatch Data*
2. *Field Interview Cards/Reports*
3. *Pawn Shop Databases*
4. *County and State Department of Corrections Databases*
5. *Parole and Probation Records*
6. *Utility Records*
7. *Jail Booking Records*
8. *Impounded/Seized Property & Evidence*
9. *Public Records Resources, e.g., Tax Records, Civil Cases, Property*
10. *Vehicle Records*

11. *Other agencies; e.g., School Board and Transit Police Departments*
12. *Business Licensing*
13. *Historical Events, Data, and Tactical Operations*
14. *Geographic Information*

While not an all-inclusive listing, the aforementioned resources will aid any analyst in qualifying investigative leads and other crimes in virtually any identified pattern or series. It is important to remember that just mere access to a resource alone does not substantiate a verified source. That is why it is important to "know your data" beyond what is visually depicted such as "meta data" when dealing with geographic information. An analyst at a minimum should know the source of the information and how often it is updated (validated) and verified, and by whom. Also, analysts should have full, unrestricted, access to data and databases. Restrictions only hinder and delay the tactical/investigative crime analysis process.

Process:

The nature of tactical/investigative crime analysis requires that many variables are to be considered and weighted in a rapid manner. The key to being an analyst is to be proactive, not reactive, by being involved at all levels of an investigation. Being proactive starts by "talking" to all parties involved in a case and using multiple investigative resources in order to avoid continually using a singular analytical approach to every case.

Outlined below are steps to a process known as the "loop effect"[1]. For purposes of this article we also refer to this as the macro-micro-macro continuum. By implementing and utilizing this process, analysts will be able to conduct a thorough and proactive approach to virtually any tactical/investigative analytical assignment. In addition, an often-overlooked step, "follow-through", will be realized. By initiating and following this process virtually all aspects of an assigned case will be readily available for real-time analysis. In addition, analysts will remain involved in a case through its prosecution (follow-through) and be kept abreast of daily case changes that in turn can lead to the reconciliation of data.

The Loop Effect:

Case Initiation: For an analyst, just like a detective, case initiation begins with the initial call requesting assistance. This is an often-overlooked analytical step. Most analysts begin their process by reviewing reports. However, by incorporating or reviewing dispatch logs, ATL's/BOLO's issued through dispatch by responding officers and the originating caller, and multi-jurisdictional data, where available, analysts can glean information that may have been overlooked and not be incorporated into the original offense report. Additionally, talking with sworn officers and listening to the radio/scanner can also initiate the analysis of a case or pattern. While often these communications are informal meetings with one or a couple of officers, this process too can be standardized. Regularly scheduled information-sharing meetings between analysts and investigators, and routine attendance by analysts at patrol briefings and beat/district meetings will provide a proactive tactical/investigative crime analyst with both the means to access more immediate information regarding crime activity, as well as the opportunity to disseminate information back to the line officer after it has gone through the analytical process (See Target/Investigative Awareness step for more on analytical product dissemination).

Initial Analysis: Although listed as the second step in the process, it needs to be noted that this step is continuous and lasts throughout the course of the analysis, whether it be pattern-specific, case-specific, location-specific, or subject-specific. Although many analysts may rely solely on computerized databases it should be noted that not all information might be captured or updated in a database. Based on this observation, analysts should strive to read all reports relevant to their assignment. However, an analyst should not become pigeon holed looking at just one crime type and discounting all others. For instance, when performing pattern/series analysis of armed robberies, the analyst should additionally factor assault reports with similar MO and suspect description, as well as looking at auto thefts or burglaries in the same area that could help facilitate the robbery activity and could be linked through a reasonable time line. Similarly, when seeking to identify an active criminal area within a neighborhood experiencing significant residential burglary activity, the analyst must also factor criminal damage (vandalism/graffiti) and trespass reports, as well as vehicle-related larcenies to get the "full-picture" of ancillary crimes in order to avoid mere displacement of one particular crime. Effective initial analysis cannot begin, and certainly can never be complete until the analyst has all related case information necessary to draw the picture of criminal activity occurring. Countless crimes are either directly or indirectly related, e.g., robbery and auto theft, and "specializing" in one crime will certainly lead to information being omitted or overlooked thus adversely affecting the final analytical product. By reading reports, the best tool possessed by any analyst, themselves and their brain, are put into play to subjectively analyze raw data. This is something that is not possible by relying strictly on automation. This step can best be described a micro style analytical methodology due to the analyst assessing each report/case individually (micro) versus comparing all crimes/cases against all others (macro).

The 5 W's and Real-Time Analysis: Real-time analysis is the preliminary review and validation process of criminal information via an array of automated resources in support of the identification of patterns, series or trends, suspicious persons, investigative leads, and hotspots. This step is accomplished within 24 to 72 hours of the "trigger" case being generated. The trigger case would be that case, or group of cases that the analyst selects to initiate the process. Unlike step two, this step is macro in nature and is designed to quantify and qualify the identification of a criminal pattern. It is crucial for the analyst to take a proactive stance at this step and begin asking the 5 W's (who, what, where, when, and why) when querying against databases and resources for salient features. However, an analyst should not overlook a deductive approach and must often include "how" in their analytical review. Do not assume that someone else has "probably" asked these questions and that the role of an analyst is to merely support what the detective wants. Real-time analysis is comprehensive and exhaustive. Analysts should be looking toward an end product at this step by identifying what decisions are going to be made with the results. Preparing a matrix or tabular data set will typically aid in the identification of a pattern by categorizing and sorting information by similar characteristics. The method should again start by taking all available data and beginning the elimination or exclusion of unrelated cases based on differences in the strongest commonalities, (e.g., Modus Operandi, suspect description) taper to the more subjective elements of the case, (e.g., victimology, targeted environment), and consistently search for patterns in the most frequently available, but often most misrepresented variables (e.g., time and location). This elimination of unrelated cases (qualification) is the next step in a graduated process that goes from a macro to a micro methodology approach.

Pattern/Trend Identification: Effective pattern and trend identification is dependant upon the data being validated, reconciled, and most importantly, the analyst's ability to analyze the data which is incumbent upon them "knowing" their data and what is available or how to get it. In the analysis of any pattern/series crimes, the macro-to-micro-to-macro continuum will greatly aid an analyst in case linking and trend identification. An analyst should always start their search as broadly as possible, narrowing the criteria by the most descriptive and least subjective elements first, then continuing to include or exclude cases based on the more subjective variables, until a clear picture of a pattern of behavior or activity emerges. Most practicing analysts find organizing their data (the cases and all of the available characteristics) into matrix-style tables for easy organization and comparison to be the most efficient way of performing this analysis. Analysts with the resources to invest in computer programs that allow for queries and searches on the agencies crime data, or even ancillary data, note this capability as a great tool for this level of analysis. These analysts find this technology is extremely helpful in the pattern identification process, especially those programs that allow for "wild card" (e.g., "*") searches on specific text within a police report or various fields in a records management system or database. Of particular value is the ability to cross-reference characteristics between cases spatially, or by "like" physical traits that may seem dissimilar when viewing only tabular data. Such as the example of an armed robbery suspect who is later warned for trespassing at a car dealership where a vehicle is later reported stolen – thus generating three different incident reports, all with surface variables that may not point to a pattern, without in-depth report and subjective review capability. Initial pattern identification should not be taken for face value. It should be weighted and/or measured against several variables relevant to the activity at hand, and continually documented.

Modus Operandi (MO) is perhaps the variable given the most weight by law enforcement personnel when seeking to identify trends, patterns and series. However, MO's should be categorized and defined for use by all personnel within an agency. Even though a crime may have several apparent MO features the analyst needs to identify the primary underlying theme, e.g., a robbery subject who follows home a victim from a store robs them of their Rolex watch in their driveway. This example might be classified as a driveway or

follow home robbery, but when in reality the primary intention of the offender was the Rolex watch, thus, a predefined MO of Rolex robbery would be appropriate. With MO's categorized and defined, an analyst will have a baseline from which to query for salient features. By weighting or measuring against numerous variables an analyst is undertaking an exclusionary approach to refining their searches. Outlined below are some of the variables, beyond MO, that should be reviewed when seeking to quantify an identified crime trend, series or pattern.

- Subject Analysis: Description(s) of subjects tend to be the principal focus, but analysts should include a subjects actions (before, during and after) the incident, timing, and mode of transportation or movement.
- Victim Analysis: Much like subject analysis, victims should be reviewed to seek identifiable traits that may have brought attention to them being targeted by subjects such as a visitor in a rental vehicle looking for directions in a high crime area. In addition, commercial establishments maybe targets not only at their building but taxi and pizza delivery businesses may experience their employees targeted at remote locations with the underlying reason being a specific business.
- Spatial Analysis: Various components of an investigation are viewed against geographical variables in an attempt to identify not only a subject's location or environment of operation, but to locate avenues of movement.
- Temporal Analysis: Law enforcement personnel will often use a day of the week or time as a guide to aid in deployment of personnel to address a specific problem. Through temporal analysis, analytical personnel strive to identify cyclic behaviors as well as development of timelines that can aid in finding a tempo to the pattern.

Enhanced Analysis: Enhanced analysis can be the continuation of pattern identification, or can be case or subject-specific. It is at this step that tabular and text based information is incorporated for further analysis in a geographic information system (GIS) against spatial variables such as land parcels, parks, and landmarks. Analysts should regularly factor in multiple variables, geographic layers, and additional crimes when visually representing data in support of their theory or identified pattern. Be cautious not to just map chronological data, but strive to visually depict relationships that are not readily apparent. The mere placement of dots on a baseline map, in and of itself, is not analysis. As an analyst you are seeking to visually depict variables in support of an identified pattern, trend or series, and to use the map as another tool in quantifying your analysis.

Various forms of analysis are easily incorporated into the process at this step. The following types of analysis should be considered, or regularly used, at this stage of the process: Offender/Victim Movement Analysis, Temporal Analysis, Environmental Surveys, Tempo/Interval Analysis, Property Analysis, Link Analysis (criminal relationships), Victim/Target Characteristic Analysis, Causal Analysis, and Motivational/ Offender Psychology Analysis (frequently referred to as profiling). The final goal of this step is to develop analytical leads by which operational personnel may create or solidify strategies by which to combat the activity. These leads can take the form of suspicious persons generated by police field contacts or known offenders, a more precise description of an unknown suspect that includes their possible travel patterns, motivations, and "comfort zones," or a knowledge of similar targets/victims, their locations, and the times and days they are most vulnerable to attack. Obviously, not every crime pattern or case analysis will produce all of these leads. Indeed, there will be occasions that an analyst is hard-pressed to find even one type of enhanced analytical results. At this time, the analyst may even consider whether or not they are seeing a true pattern, or perhaps several different patterns intersecting, yet giving the appearance of a single pattern, thus making any type of predictive analysis difficult, overbroad, or inaccurate. At this juncture, it is not

enough for the analyst to say that the work they have done is "enough to put out a bulletin/work product." It is at this step that an analyst must be exhaustive in their research, pulling as many different variables into the equation as possible until a complete understanding of the activity/pattern is possible. It is more harmful at this juncture to generate inaccurate analysis than taking a little more time to produce complete results. At the same time, one should consider that they are striving for real-time analysis. If an informational bulletin is necessary to alert officers to a hotspot of activity or detectives to a potential lead, it should be generated quickly and thoroughly using all available information, with the added disclaimer that the analysis is ongoing and that further identification of pattern activity is forthcoming. Through the use of disclaimers analysts are notifying the end-user that their product is continually being reconciled. An analyst should neither withhold information to "wait" for an ideal pattern to take shape (as this can sometimes be a long wait), nor should they be rushed to "guess" under the time constraints of operational personnel. The skilled analyst must find a balance between these two extremes that is both timely and thorough. At the culmination of this step, an analyst will have gone from a micro methodology back out to a macro methodology in order to have ensured a global approach.

Target/Investigative Awareness: Once identified and verified, appropriate documentation, e.g., bulletins, flyers and maps, are prepared for immediate dissemination. These documents should be updated regularly and noted (dated), as they are prepared. The information contained on these documents should be direct and to the point, and designed to address the needs of the user, not the individual who prepares them. Analysts should avoid the use of predefined layouts for each and every document. By changing layouts or formats the end user will be forced to review the document instead of assuming that what they are looking at is the same thing they read last time. Documents should be sent out to all levels of the organization simultaneously, as well as everyone in the department, unless otherwise restricted, via electronic means (Internet or e-mail) and hardcopy distribution. In addition, a standardized system of contact with those applicable user groups (patrol, investigations, crime prevention, surveillance squads, etc.) should be made and enforced with the dissemination of each work product, whether requested or generated proactively. The onus will be on the analyst to create and foster these relationships, as the contact the analyst has with sworn personnel is part of the tactical/investigative crime analysis process. Remember, sworn officers can function without analysts (though as mentioned earlier, not as well as they do with them), but an analyst has no job/function without operational personnel. You need them, and it is your job to make them see that they need you.

Continued Support/Monitoring: The aforementioned step is often where the role of the analyst stops in many agencies. The officer/detectives have their initial information, bulletin, alert, etc., and are ready to move on to another phase of the investigation. However, in order to ensure follow-through it is important for the analyst to stay active in a case by continually monitoring and analyzing relevant data as it is received. Analysts should strive to ensure that information/leads are documented, updated and reconciled on a regular basis. Ensure that supplemental reports and arrest documents are also reviewed, as they are prepared. Regular contact with the case detectives/beat officers is necessary until a final resolution is achieved (Deterrence, Interception, Arrest/ID, and/or Target Hardening).

Prosecutorial Support: As the role and expertise of an analyst is increased, the ability to play a vital role in support of a prosecution will be enhanced. Through the various forms of analysis discussed in the Enhanced Analysis step, an analyst will often be able to paint a vivid picture for a prosecutor that will enable a jury to visually depict events. As the analyst has tracked the activity throughout the course of the pattern/trend/series, frequently they have the best understanding of the "whole picture," and are thus able to relate this information best to others. The picture can be painted via an array of tools such as; spatial, link analysis

programs, matrixes, and tabular data. The insight gleaned by this information can demonstrate various relationships that can aid prosecutors in court on various levels such as in Williams Ruling Hearing. Involvement in this level of the investigation will also prove to be a valuable resource of information to the analyst. By establishing a follow-through to the prosecutorial stage in a case, the analyst will have access to a record of resolution (e.g., conviction, acquittal, sentence, future probation status, etc.).

Inmate Notification/Monitoring: Many county and state correctional agencies have robust offender databases that are often overlooked by analysts. By tracking and monitoring inmate releases to a particular jurisdiction an analyst will be able to immediately identify potential suspect information should a pattern develop whether based on a MO or spatial relationships. Probation and Parole agencies are also resources that have enormous amounts of suspect information that can be incorporated into many forms of analysis.

The steps in this process complete what is referred to as an analytical "loop effect". By approaching each tactical/investigative crime analysis assignment in the prescribed format, investigative follow-through is sure to be achieved. Employing the "loop effect" will help in ensuring that all aspects and investigative leads are reviewed in total against all available variables.

Example of Loop Effect Process:

"Smash & Grab Commercial Burglary Pattern"

Step 1 - Case Initiation: Officers in Anytown, U.S.A. respond to the call of a burglary in progress at an address in the industrial park located in the northeast quadrant of the city. At the time of arrival, the reporting officer notes that the now-departed suspect has forced entry to a commercial business by throwing a large river rock through the front glass door. The suspect has removed various small, easy-to-carry items from the business. No prints are found, and no other physical evidence or witnesses are located. The reporting officer documents the incident, and submits a report. On the following shift, the tactical/investigative analyst, while reviewing the most recent calls and reports, notes the case report and marks it for pattern analysis.

Step 2 – Initial Analysis: The tactical/investigative crime analyst begins by accessing the agency's records data on possibly related incidents. In addition to searching for commercial burglaries, the analyst also includes reports of criminal trespass or criminal damage to commercial businesses (possibly attempted burglaries that were interrupted). Also, the analyst searches for any other reported crimes occurring at or around commercial businesses and the industrial park to develop a better understanding of the environment and activity in the area.

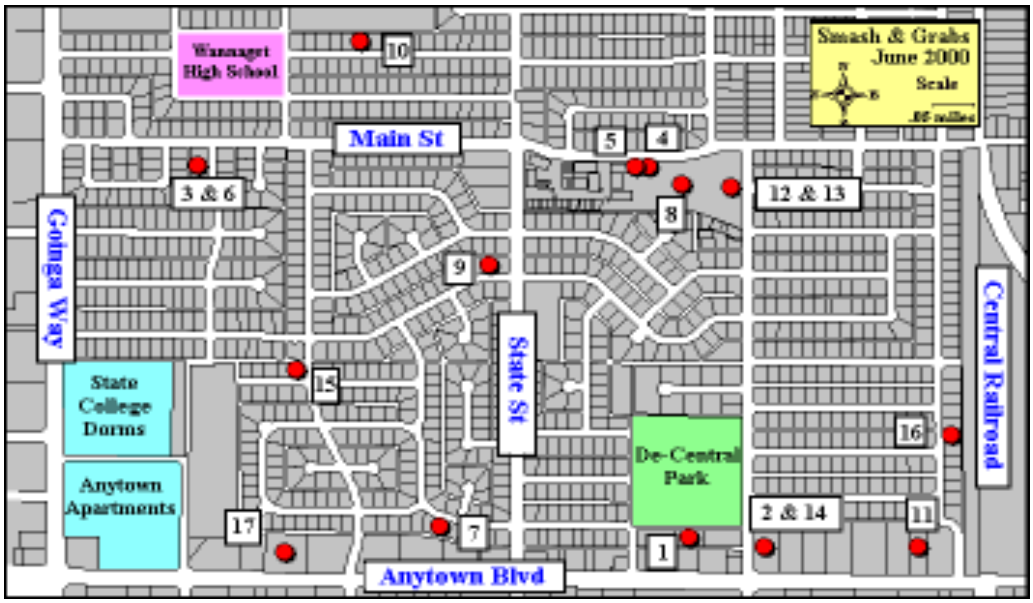
Step 3 – The 5 W's & Real-Time Analysis: Using the "trigger" case (the incident which originally alerted the responding officer to the activity), the analyst begins to study the elements of the selected cases, looking for both similarities and differences in as many separate variables as possible. To facilitate this, the analyst uses a matrix table to outline and view the case information.

Step 4 – Pattern/Trend Identification: At this juncture, the analyst begins to sort and include/exclude cases according to the similarities or differences in the elements of the crime. Finding a high number of "smash & grab"-style hits in and around this industrial area, the analyst assigns this as the principal MO on which to base the search. However, the analyst does not discount other break-ins with different modes of entry, if they have other similar elements to the cases that are smash & grabs. With no suspect information in any of the incidents, the analyst assigns the greatest importance to the variables of MO, time, date, day of week, business type, property type, physical environment of the scene, and location. The analyst weighs each of the possibly linked variables against each other. The more specific and similar the variables are to the other cases, the more likely they are to be considered part of the pattern. The analyst finds a pattern of similarly located break-ins involving a near-identical MO.

CRIME TYPE	DATE-1ST	DATE-2ND	TIME-1ST	TIME 2ND	LOCATION TYPE	POINT OF ENTRY	METHOD OF ENTRY	DAY-1ST	DAY-2ND
BURGLARY COMMERCIAL	06/15/2000	06/15/2000	0000	0530	OFFICE BUILDING	WINDOW	BREAK	THU	THU
BURGLARY COMMERCIAL	06/15/2000	06/15/2000	2320	2320	OFFICE BUILDING	DOOR: WINDOW	BREAK	THU	THU
BURGLARY COMMERCIAL	06/16/2000	06/16/2000	0025	0025	LIQUOR STORE	DOOR: WINDOW	BREAK	FRI	FRI
BURGLARY COMMERCIAL	06/16/2000	06/17/2000	1800	0900	CLOTHING/RETAIL	DOOR: WINDOW	BREAK	FRI	SAT
CRIMINAL TRESPASS	06/16/2000	06/17/2000	1700	1030	OFFICE BUILDING	WINDOW	BREAK	FRI	SAT
BURGLARY COMMERCIAL	06/18/2000	06/19/2000	2000	0720	CLOTHING/RETAIL	DOOR: WINDOW	BREAK	SUN	MON
BURGLARY COMMERCIAL	06/19/2000	06/20/2000	1700	0259	OFFICE BUILDING	WINDOW	BREAK	MON	TUE
BURGLARY COMMERCIAL	06/19/2000	06/20/2000	2300	0600	OFFICE BUILDING	DOOR: WINDOW	BREAK	MON	TUE
BURGLARY COMMERCIAL	06/20/2000	06/20/2000	0030	0735	CLOTHING/RETAIL	DOOR: WINDOW	BREAK	TUE	TUE
BURGLARY COMMERCIAL	06/21/2000	06/21/2000	0020	0020	CLOTHING/RETAIL	DOOR: WINDOW	BREAK	WED	WED
BURGLARY COMMERCIAL	06/21/2000	06/21/2000	0200	0208	OFFICE BUILDING	WINDOW	BREAK	WED	WED
BURGLARY COMMERCIAL	06/21/2000	06/21/2000	0414	0414	OFFICE BUILDING	WINDOW	BREAK	WED	WED
BURGLARY COMMERCIAL	06/20/2000	06/21/2000	1700	0630	OFFICE BUILDING	WINDOW	BREAK	TUE	WED
BURGLARY COMMERCIAL	06/20/2000	06/21/2000	1800	0655	CLOTHING/RETAIL	DOOR: WINDOW	BREAK	TUE	WED
BURGLARY COMMERCIAL	06/20/2000	06/21/2000	2000	0730	OFFICE BUILDING	DOOR: WINDOW	BREAK	TUE	WED
BURGLARY COMMERCIAL	06/20/2000	06/21/2000	1900	0745	OFFICE BUILDING	WINDOW	BREAK	TUE	WED
BURGLARY COMMERCIAL	06/20/2000	06/21/2000	1900	0800	OFFICE BUILDING	WINDOW	BREAK	TUE	WED

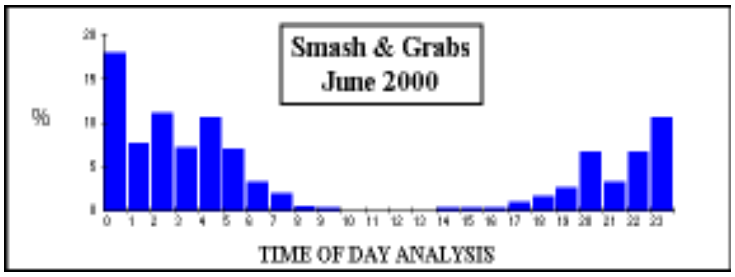
CRIME TYPE	DATE-1ST	DATE-2ND	TIME-1ST	TIME 2ND	LOCATION TYPE	POINT OF ENTRY	METHOD OF ENTRY	DAY-1ST	DAY-2ND
CRIMINAL TRESPASS	06/28/2000	06/29/2000	1200	0030	APARTMENT	WINDOW	BREAK	WED	THU
BURGLARY COMMERCIAL	06/19/2000	06/20/2000	1700	0259	OFFICE BUILDING	WINDOW	BREAK	MON	TUE
BURGLARY COMMERCIAL	06/30/2000	06/30/2000	0340	0340	BAR	WINDOW	BREAK	FRI	FRI
BURGLARY COMMERCIAL	06/21/2000	06/21/2000	0200	0208	OFFICE BUILDING	WINDOW	BREAK	WED	WED
BURGLARY COMMERCIAL	06/21/2000	06/21/2000	0020	0020	CLOTHING/RETAIL	DOOR: WINDOW	BREAK	WED	WED
BURGLARY RESIDENTIAL	06/17/2000	06/18/2000	1700	0600	RESTAURANT	DOOR: WINDOW	BREAK	SAT	SUN
BURGLARY COMMERCIAL	06/20/2000	06/20/2000	0030	0735	CLOTHING/RETAIL	DOOR: WINDOW	BREAK	TUE	TUE
BURGLARY COMMERCIAL	06/18/2000	06/19/2000	2000	0720	CLOTHING/RETAIL	DOOR: WINDOW	BREAK	SUN	MON
BURGLARY COMMERCIAL	06/19/2000	06/19/2000	2000	2007	AUTO PARTS/REP	DOOR: GARAGE	BREAK	MON	MON
BURGLARY COMMERCIAL	06/15/2000	06/15/2000	0000	0530	OFFICE BUILDING	WINDOW	BREAK	THU	THU
BURGLARY COMMERCIAL	06/16/2000	06/16/2000	0025	0025	LIQUOR STORE	DOOR: WINDOW	BREAK	FRI	FRI
BURGLARY COMMERCIAL	06/16/2000	06/17/2000	1800	0900	CLOTHING/RETAIL	DOOR: WINDOW	BREAK	FRI	SAT
CRIMINAL TRESPASS	06/18/2000	06/18/2000	1248	1253	CLOTHING/RETAIL	WINDOW	ROCK	SUN	SUN
BURGLARY COMMERCIAL	06/15/2000	06/15/2000	2320	2320	OFFICE BUILDING	DOOR: WINDOW	BREAK	THU	THU
BURGLARY COMMERCIAL	06/15/2000	06/16/2000	1900	0545	OFFICE BUILDING	DOOR: REAR	OTHER	THU	FRI
CRIMINAL TRESPASS	06/17/2000	06/17/2000	0200	0200	OFFICE BUILDING	DOOR: FRONT	FOOT IMPA	SAT	SAT
CRIMINAL TRESPASS	06/17/2000	06/17/2000	0200	0200	OFFICE BUILDING	DOOR: FRONT	FOOT IMPA	SAT	SAT
BURGLARY COMMERCIAL	06/27/2000	06/27/2000	0245	0300	AUTO PARTS/REP	WINDOW	BREAK	TUE	TUE
BURGLARY COMMERCIAL	06/26/2000	06/27/2000	1900	0423	BEAUTY SALON	DOOR: WINDOW	BREAK	MON	TUE
BURGLARY COMMERCIAL	06/20/2000	06/21/2000	1800	0600	AUTO PARTS/REP	DOOR: WINDOW	BREAK	TUE	WED
BURGLARY RESIDENTIAL	06/22/2000	06/22/2000	0000	0600	SINGLE FAMILY	WINDOW	BREAK	THU	THU
BURGLARY RESIDENTIAL	06/22/2000	06/22/2000	0000	0600	SINGLE FAMILY	WINDOW	BREAK	THU	THU

Step 5 – Enhanced Analysis: The analyst performs exhaustive research on case variables and utilizes Geographic Information Systems (MapInfo in example) to gain visual representation and analysis of the location, sequence, timeline, and environmental zones of the activity.

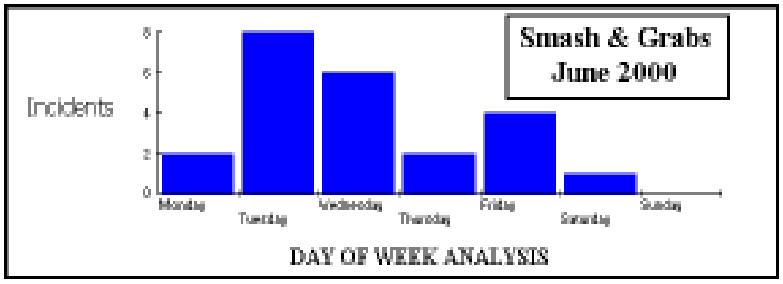


The analyst identifies a temporal pattern in the activity which appears when studying the cases of highly similar MO with multiple commonalties, and reduces when the criteria is broadened.

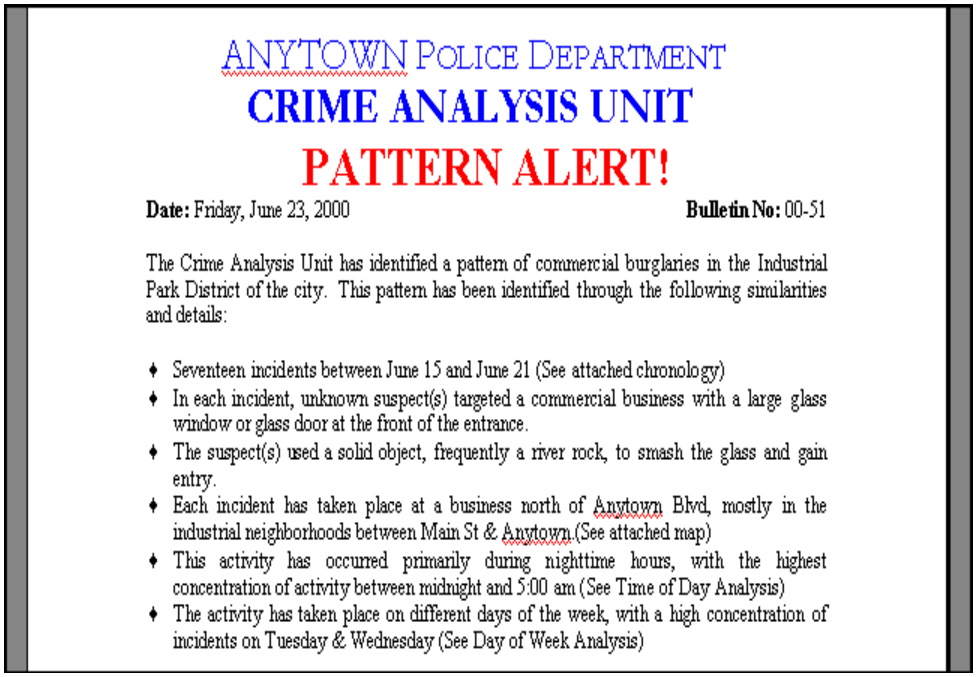
The analyst then broadens the search criteria again to apply to suspicious field contacts in the same travel pattern as the active area, within similar time frames. As the MO would imply that the suspect would be on foot, or limited in transportation (very few items taken from each location; suspect in and out very quickly), the search criteria focuses on individuals contacted on foot or bicycle. After generating the list of contacts, the analyst then performs criminal history checks to ascertain any behavioral patterns that would imply continued activity of this type (repeated burglary charges, drug arrests, possession of stolen property). The analyst then reduces the list to high-risk suspicious contacts that have been seen in that area at high-activity times.



Step 6 – Target/Investigative Awareness: This information is then consolidated into a bulletin format. The bulletin contains a description of the similarities and case links, a detailed chronology listed by report number, time and day of week charts and a sequenced map of the incidents and area of the pattern, as well as an explanation of the temporal and spatial relationship the incidents possess. Finally, a list of the suspicious contacts/known offenders/ investigative leads that have been generated is included. Based on the time and location pattern that has emerged, the analyst also attaches recommendations for the best times and days to direct patrol for the area, as well as crime prevention advisories to be forwarded to businesses whose environmental factors make them prone to be future victims (target hardening). The analyst then forwards this bulletin to the agency's sworn personnel, as well as any jurisdictions bordering the activity for the purpose of data sharing and increasing



awareness of the problem. The analyst makes contact with affected patrol squads, detectives and specialty units to gain feedback and extract new information.



ANYTOWN POLICE DEPARTMENT

CRIME ANALYSIS UNIT

PATTERN ALERT!

Date: Friday, June 23, 2000 **Bulletin No:** 00-51

The Crime Analysis Unit has identified a pattern of commercial burglaries in the Industrial Park District of the city. This pattern has been identified through the following similarities and details:

- Seventeen incidents between June 15 and June 21 (See attached chronology)
- In each incident, unknown suspect(s) targeted a commercial business with a large glass window or glass door at the front of the entrance.
- The suspect(s) used a solid object, frequently a river rock, to smash the glass and gain entry.
- Each incident has taken place at a business north of Anytown Blvd, mostly in the industrial neighborhoods between Main St & Anytown (See attached map)
- This activity has occurred primarily during nighttime hours, with the highest concentration of activity between midnight and 5:00 am (See Time of Day Analysis)
- The activity has taken place on different days of the week, with a high concentration of incidents on Tuesday & Wednesday (See Day of Week Analysis)

Step 7 – Continued Support/ Monitoring: The analyst then continues to monitor the pattern, watching for any changes in activity or new leads that may develop. They maintain contact with operational personnel, and make themselves available for briefings or information exchange. If no arrest is made, the analyst studies the environmental changes that may have deterred further activity. The analyst also watches other areas in the city for flare-ups of the same pattern (monitor to assure if there has been displacement rather than dispersion of the activity).

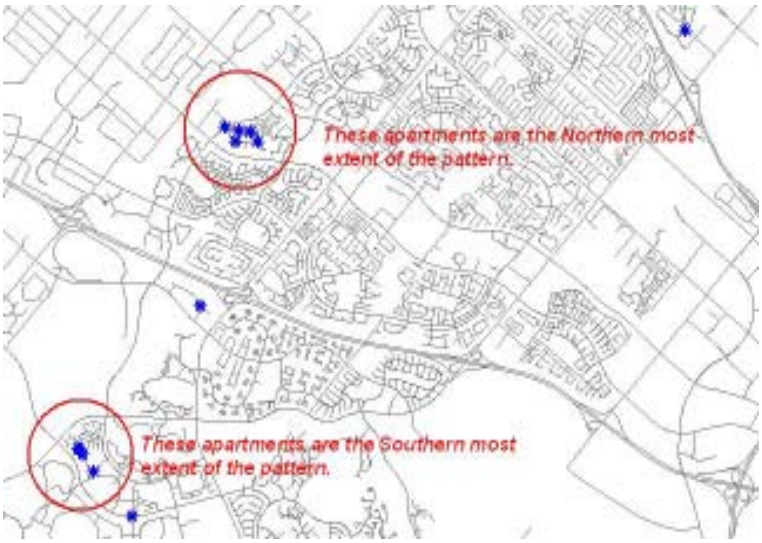
Step 8 – Prosecutorial Support: When an arrest is made, the analyst then assists detectives in generating a history of the activity, providing the documentation detailing the suspicious contacts relating to the suspect, as well as how the pattern was identified. Here is the stage where it is important to be able to substantiate a standardized practice for Tactical Analysis. Juries will not abide "educated guesses," and any information presented by Analysts must be able to withstand the same scrutiny applied to any other police science. The analyst presents his findings as fact, based on defined practices and exhaustive research.

Step 9 – Inmate Notification/Monitoring: The analyst enters the convicted suspect into a database of known offenders, and based on available probation and parole data, is able to access and determine the possibility of further activity from the same subject when using similar MO characteristics in conjunction with release dates and future field contacts.

"Panty Theft and Return"

Step – Case Initiation: Officers in Anytown, USA responds to the call of a petty theft of laundry at the common laundry room at an apartment complex. During the course of the investigation, officers have determined that the suspect is taking women's lingerie only. This case gets documented as a petty theft. No prints are found and not other physical evidence or witnesses are located. Upon review of the calls, the Crime Analysis Unit has determined that this general pattern of activity has been occurring for about six months.

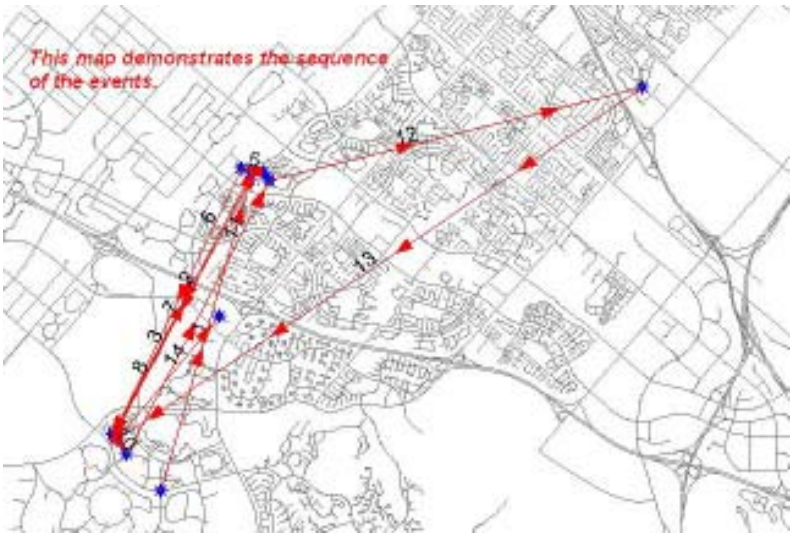
Step 2 – Initial Analysis: Within the pattern, a specific signature has been identified. The signature involves the return of the stolen lingerie to the victim's door. Victim calls the police department to say that although the lingerie has been returned, it is stained with some unknown substance. Further investigation reveals that the stains are human sperm. The Crime Analysis Unit notes the cases and begins the case linkage process. While other thefts of laundry rooms have been included in the analysis, vehicle burglaries with luggage taken, trespass, prowling, residential burglaries, suspicious persons and vehicles have all been incorporated into the analysis.



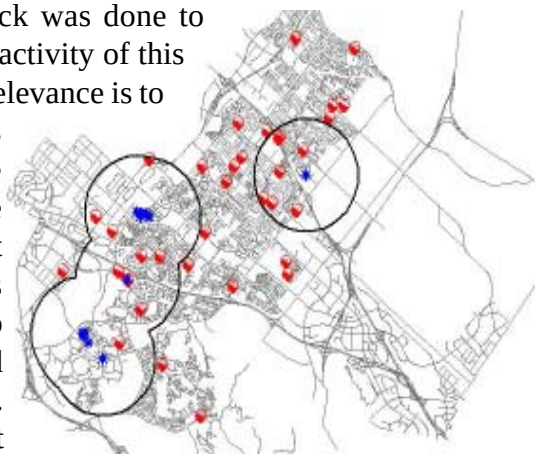
Step 3 – The 5 W's & Real Time Analysis: Using the trigger case, the analyst begins to study the elements of the selected cases looking for both similarities and difference in as many variable and variations as possible. To facilitate this; the analyst uses the tried and true matrix table method to outline and view the case information. This preliminary matrix is composed of all possibly related crime types. The analyst must hone down the list to a workable size. With the identification of the laundry room theft of women's lingerie as the primary MO upon which to base the search, other crime types with no similar elements were eliminated. The prominent signature becomes the identifying element that will separate the "thefts only" from the "thefts and returns". The analyst gives the most weight to the signature and only those cases with that variable are to be considered part of the pattern. The analyst is then left with a subset of records that most closely are related in MO.

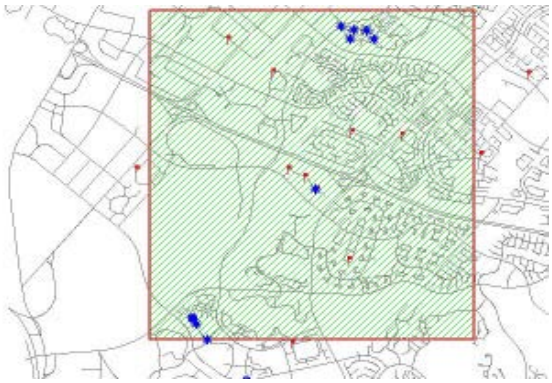
DR_NUM	DATE	TIME	DOW	CODE_SEC	ADDRESS	CIRCS
00-11988	62300	1915	FRIDAY	487(a)	2 BERKELEY AVENUE	THEFT AND RETURN
00-12183	62600	2200	SUNDAY	484/488	1 DURANZO AISE	THEFT ONLY, SUSP OWEN, DAVID
00-15197	80500	1615	SATURDAY	487(a)	400 STANFORD	THEFT AND RETURN
00-20597	102200	1330	SUNDAY	484/488	187 DURANZO	ALL LAUNDRY, NO RETURN
00-20784	102500	2113	WEDNESDAY	484/488	333 DRANZO AISE	THEFT ONLY
00-24501	121700	1645	SUNDAY	487(a)	1 SAN LEON	THEFT AND RETURN 3X (RETURN AT 2200)
01-1636	12401	2000	WEDNESDAY	484/488	405 STANFORD	THEFT AND RETURN
01-2734	21101	2240	SATURDAY	459	197 SAN LEON	THEFT ONLY, SUSP OWEN, DAVID
01-3497	22201	2058	THURSDAY	484/488	426 STANFORD	THEFT AND RETURN
01-07982	50101	1804	WEDNESDAY	487(a)	400 STANFORD	THEFT ONLY
00-9680	52200	2205	MONDAY	487(a)	780 STANFORD	THEFT ONLY
01-10348	60601	338	THURSDAY	487(a)	625 SAN LEON	THEFT AND RETURN
01-10564	60801	2204	FRIDAY	484/488	1284 TAFT	LAUNDRY ROOM 7, ARREST
01-11008	61201	2200	TUESDAY	487(a)	506 STANFORD	ALL LAUNDRY, NO RETURN
01-11306	61801	2400	MONDAY	484/488	3883 PARKVIEW LANE	WITNESS

Step 5 –Enhanced Analysis: The analyst performs exhaustive research into the cases, and utilizes Geographic Information Systems (ArcView in this example) to gain a visual representation of location, sequence, timeline, tempo and environmental zones of activity. The offending space was very specific to a communal laundry room in a large apartment complex. GIS was utilized to re-create the environment with the analyst having to leave the desk and go out into the field. GIS spatial relationships are used to further analyze the pattern by taking into account geo-graphical boundaries and enabling layering of themes.



Utilizing the "Animal Movement" script[2], the sequence of these events can be seen in the above map. There were 3 "outliers" that were eliminated from the spatial analysis given their lack of geographic relevance to the overall pattern. This allowed the analyst to concentrate on the Northern most and Southern most extents of the pattern. Once the spatial and temporal aspects of the pattern have been identified, the analyst must now try to identify investigative leads. Creating a layer of known offenders did this, whether they were sex registrants, drug registrants, and subjects of FI's, arrestees and suspicious persons. Once the layer was identified, the analyst must then begin the tedious process of eliminating those subjects who were not geographically or elementally related to the pattern. A criminal history check was done to determine any behavioral patterns that would imply continued activity of this type. Additionally, the analyst should see what the geographic relevance is to anyone within a defined buffer. Once the list of individuals has been identified, the list can further be developed to exclude those individuals that clearly did not meet the established profile. The analyst then creates a list of high-risk suspicious contacts that have been seen on the area of the activity. An investigative list is created and forwarded to the case investigator. To further add to the analysis, the analyst will conduct analytical processes beyond time of day and day of week, and forecast future occurrences. This creates a workable timeframe from which to conduct productive directed patrol efforts and or surveillance. This truly can create an effective tactical plan to deal with specific crime problems.





Step 6 –Target and Investigative Awareness: This information is then consolidated into a bulletin. The bulletin contains a description of the similarities and case links, a detailed chronology listed by report number, day and time of week charts and a sequenced map of the incident and the area of the pattern, as well as an explanation of the temporal and spatial relationship the incidents possess. Finally, a list of the suspicious contacts/ known offenders and investigative leads that have been generated is included. Based on the time and location pattern that has emerged, the analyst also attaches recommendations for the best times and days for directed patrol deployment and/or investigative surveillance. The example in the above map uses Steve Gottlieb's Probability Rectangle as developed by Bryan Hill[3], a crime analyst with Phoenix Police Department. This rectangle determines the area in which the offender will strike again with in 68% likelihood. From this, all the apartment complexes with communal laundry rooms were identified and surveillance units were posted at each during the specific temporal pattern associated with the thefts. In addition, the analyst should work closely with crime prevention efforts for advisories to be forwarded to

businesses and residents whose environmental factors make them prone to be future victims (target hardening). The analyst then forwards this bulletin to the agency's sworn personnel, as well as any contiguous jurisdictions for information sharing and awareness.

Step 7 – Continued Support/Monitoring: The analyst, in concert with the investigator then continues to monitor the pattern and watches for any changes in activity or new leads. They may maintain contact with operational personnel, and make them selves available for briefings or information exchange. If no arrest is made, the analyst studies the environmental changes that may have deterred further activity. The analyst also watched other areas of the city for flare-ups of the same pattern (monitor the displacement).

Step 8 –Prosecutorial Support: When an arrest is made, the analyst then assists detectives in generating a history of the activity, providing the documentation detailing the suspicious contacts relating to the suspect, as well as how the pattern was identified. The development of standardized practices for tactical/investigative crime analysis will be important on this front. Juries will not abide by "educated guesses", but rather, fact, defined practices and exhaustive research.

Step 9- Inmate Notification/Monitoring: Once an arrest or arrests have been made, the analyst enters the subject(s) into a database of known offenders and is able to access and determine the possibility of further activity from the same subject when using similar MO characteristics in conjunction with release dates and future field contacts.

Conclusion:

Analysts play a vital role in law enforcement agencies throughout the world. The skills and training honed by analysts are only limited by the lack of automation and lack of immersion and inclusion into all facets of case investigation. Just like a business, analysts must market their abilities and skills to all potential customers. Beyond being accessible, analysts must have a defined role within their agency and be located in an open and central location. Analysts also need to facilitate or ensure the following:

- Cross-jurisdictional sharing of information is pursued and achieved.
- Continually look for outbreak, ongoing, recurring themes or patterns.
- Cite sources, date range, filters, comparison variables, and date run on documents.
- Prepare and use maps as a tool to support or thwart an analytical theory, dots on a map alone are not analysis.
- Utilize analysts as coordinators of; information exchange, liaison in the investigative process, gatekeeper of data/information.
- Standardize analytical definitions, terms and practices.
- Define all aspects of terms and modus operandi utilized to analyze crime.
- Keep apprised of ever changing technological advances and practices within the field of crime analysis.
- Strive to perform "real-time" analysis.

Although there is no definitive, all-inclusive, listing for tactical/investigative crime analysis personnel to follow, it is important to ensure that all information has been continually verified at all levels against several variables.

It is important to understand that the role of a tactical/investigative analyst is a varied one, which involves supporting many different functions within the overall mission of law enforcement (e.g., patrol, investigations, intelligence, surveillance, crime prevention, community policing, public information, etc.). An analyst should avoid becoming pigeonholed into thinking of their role in the terms of doing "Pattern Identification," or "Crime Mapping." Debates over whether or not it is the analyst's role to "identify" or to "catch" the suspect should also be avoided. These terms are fruitless in that they end up reducing the scope of the analyst's involvement until the overall effectiveness of the information being analyzed and provided to operational units becomes compromised. These overly narrow definitions and arguments about what an analyst "should" or "should not" be doing are, in the end, purely academic. When all is said and done, a fully functioning analyst will provide support in accomplishing all of these goals on different occasions and under different circumstances. The role of the analyst is to use all of the tools, skills, and information they have at their disposal in which to provide effective analysis to support the operational goals of the department and law enforcement as a whole.

Once the role of the analyst has been defined, he or she must then be willing to employ common practices for successful and productive tactical analysis. The success of any crime analyst is their ability to take bits and pieces of information and make sense out of them and connect them in such a way that the accurate scope and nature of the crime problems in a community can be determined. Information by itself does not substantiate intelligence. The goal of tactical/investigative crime analysis is to supply patrol and investigative personnel with information/intelligence they need to make informed decisions about how best to suppress and solve criminal activity. Unfortunately, tactical/investigative crime analysis is time dependent. The analyst must be willing to process large volumes of data within 24-72 hours, and then turn that information around into a cohesive tactical plan to address the criminal activity.

Crime Analysis is a tool that will yield great results in all aspects of a law enforcement agency's mission. Whether investigative, tactical, strategic or administrative, a thorough and continuous analytical process is vital to the success of an agency's mission. It follows along a continuum of tools that can be employed by any member of the department, each tool progressively building on the previous to clearly meet the mission of the law enforcement community.

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[3] **Gottlieb, Steven L**. (1994), *Crime Analysis: From First Report to Final Arrest.* California: Alpha Publishing, p143-145, 449-456.

The Role of Tactical Crime Analysis in Serial Rape Investigation

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Introduction:

In 2000 a rapist posing as an Immigration and Naturalization Services agent escalated his assaults against Spanish speaking residents in Austin, Texas. The offender targeted Hispanic women at bus stops, convinced them of his official status as an immigration officer, implied or explicitly warned of deportation consequences for the victim or her family unless she cooperated with his demands, and eventually raped them in his vehicle. He struck during daytime or early evening hours and had recently begun displaying a gun. The cases, like all violent crimes, demanded immediate attention and resolution.

From a tactical crime analysis perspective there are a number of elements here to research and analyze: encounter sites, routes taken with the victim, victimology, *modus operandi*, and temporal preferences. A number of methods were employed to succinctly bring together the most salient data for the most effective review and understanding of the series. Database searches, matrix development, mapping, and environmental surveys were utilized as a means of data collection, analysis, and presentation.

The evolution of crime analysis has been hastened significantly by recent technological leaps in hardware and software that have made data management a swifter and more accurate process. The role of automation in locating, storing and updating key investigative data is crucial in handling the enormous data sets from which analysts routinely query suspect, offense, and geographic information. From highly specific inquiries for a suspect or vehicle description to broad searches for all offenses occurring in multiple districts, both types of searches can now be performed in seconds giving the analyst the necessary data foundation. Without this speed and uniformity in collecting and assessing data the analyst is at a sharp disadvantage, limited by time, and deprived of information.

Ultimately the methods and products developed by the crime analyst serve the larger goals of an effective law enforcement response to a series or trend. This response ideally is multifaceted and includes provisions for target hardening, deterrence, interception, or arrest by identification through investigation.

First Steps:

The initial phase of identification and analysis in the INS imposter series began with the simplest, no-tech approach of thoroughly reading the most recent reports. All rape and sexual assault cases are read daily and logged by the analyst with an emphasis on unsolved cases. These are compared against a database of known and unknown offenders to link additional cases. There is still no substitute or shortcut for a line by line reading of offense report narratives. Besides providing a chronological summary of the case, the narrative is also a rich source of factual and incidental information that may not be recorded anywhere else. Databases deftly extract enormous amounts of data from specific RMS (record management system) fields but falter in respect to capturing the full content of interactions, conversations, and observations provided by victims, witnesses, and first on the scene officers.

When a series is isolated a simple, customized matrix is then developed containing basic descriptive information about each case – the who, what, when, where, and how in every linked crime. In this series we also added fields describing initial contact sites by the suspect, routes taken, weapons used, and evidence collected.

During the 2000 series the offender began offending in the fall, prompting further searches for related cases. Our matrix began with 4 cases and eventually grew to 12 reported cases (rapes and suspicious persons cases) associated with this offender. Part of this growth stems from database and record management systems queries on suspect characteristics and vehicle description. Instead of limiting ourselves to similar unsolved rapes over the last year or two we were able to search back as far as the early 1990s and uncover this offender's first reported case in 1994. He then re-offended once a year or greater until 2000 when his frequency of assaults increased. Part of the difficulty in linking early cases lay in his not using the INS agent ruse (he began by asking for directions or offering rides) and in the initial infrequency of reported cases. However our matrix provided a number of other distinct and stable identifiers that could be researched separate from m.o. that sharply decreased the chances of a case remaining unlinked. Some of the distinct constants seen across the cases were his physical description, his ethnicity, his bilingualism, his use of a vehicle, his victim selection, and his time and place preferences.

At this point we also expanded our search beyond rape title codes to include attempted rapes, kidnappings, suspicious persons and vehicles, and impersonating a public servant codes. Additionally we queried the addresses and districts within a week before and after the offense for criminal and non-criminal activity in close proximity to the rapes. These customized, precise searches culled a manageable amount of a few dozen offenses which warranted a harder look from thousands of records over the course of nearly a decade. Each additional case added to the matrix gave us more information to work towards a formal analysis and possible prediction about this offender's next assault. Satisfied that we had captured all reported cases involving this offender we then turned to mapping his activity.

The Map:

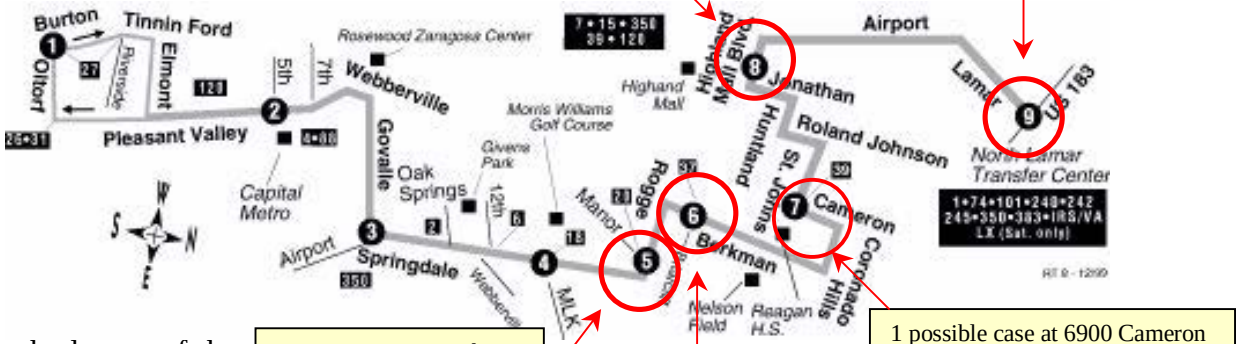
One of the stable component's of this offender's M.O. was his use of a vehicle to transport the victim away from the encounter site to secluded area. After the rape he would then drive the victim to her intended destination. In a number of the cases the victims were able to provide partial or entire route information. Thus we could not only plot encounter and assault sites but also trace which streets and neighborhoods the offender had traveled with the victim. Once mapped this gave us a clear overview of this offender's comfort zone, his overall directional range, where he's been and where he's likely to come back to. The map was initially created as an aid in visualizing this offender's spatial choices, however it also provided the opportunity for summarizing the entire series

and was expanded to include case information, a comprehensive suspect description and composite and bus stop data. Bringing together text, graphics, a map, and photographs onto one large product consolidated the series for investigators who could then concentrate on finer points of suspect lead development and interception strategies. The temporal sequence of rapes was also analyzed by calculating a standard deviation of days between assaults but no clear pattern emerged. Normally this would provide some basis for a prediction. Hindering this effort however was the early low rate of offending and the greater than average potential for underreporting. Rape is still an underreported crime, in this series underreporting was further heightened by the offender's fraudulent INS claims. Undoubtedly many more victims than the ones who came forward were doubly terrorized into silence: first by the rape and then by the threats of deportation.

Environmental Surveys:

The use of environmental surveys by analysts cannot be overemphasized. Maps and reports typically provide a basic, static account of a crime giving an analyst a true but not wholly accurate representation of the offense and its environment. Similarities of crime scenes jump out in stark relief when actually visited and assessed, especially when with visiting the site at the same time of day as when the crime occurred. The placement of buildings, traffic flow, landscaping, issues of visibility and obstacles, the overall rhythm of the site will dictate the ways an offender can move in this environment with respect to avoiding or attracting detection. It also underscores the most vulnerable areas for victims, information which then can be used proactively as warnings in crime alerts. A sample site survey form is provided in an appendix. The form lists a number of environmental characteristics to be aware of which may determine an offender's spatial choices.

In this instance we visited two of the major bus stops that were repeat encounter points. During the course of noting the layout of the first bus stop the Number Eight bus was seen as the most frequently arriving bus. At the second bus stop, the Number Eight bus seen again. Naturally this prompted a closer look at the Number Eight bus route. The whole route was downloaded from the Capitol Metro Transit Authority webpage. A quick overlay of the entire Number Eight bus route against all 12 cases showed an extremely strong connection; 10 of the 12 cases happened along or within a 300 yards of the route. Only the two earliest cases deviated from this pattern. The bus route connection also corroborated by one victim's account of having seen the offender riding the bus with her previous to her assault.



This was exciting news and provided investigators a highly concentrated area to begin searching for the suspect. This was a basis for a possible interception plan. However other aspects of the investigation had also been providing fruitful results. A case found among the earliest assaults had a partial name the suspect had given a victim.

This pattern provided us with a highly concentrated area to begin our search for the offender and was the basis for a possible interception plan. However other aspects of the investigation had also been providing fruitful results. A case discovered among the earliest rapes revealed a partial name the offender had given a victim. At that time the name he had given her was actually his middle name which he used as a last name. It did not produce any associations when originally searched. It would be years before the suspect's full name appeared on an unrelated domestic violence case. A new search in late 2000 by a sex crimes investigator utilizing a different ordering of his name produced the domestic violence case. A photo line-up was then prepared and a victim identified the offender. This was an excellent example of the successful use of arrest by identification through investigation. And while the findings of the environmental survey and spatial analysis did not have the opportunity to be tested it still served as an additional strategy available to investigators in the absence of other suspect leads.

The Media:

Deterrence and target hardening were also practiced. Once the series had been solidly identified press releases and news stories in English and Spanish informed Austin residents of the series and how to respond. A suspect composite and information about the suspect posing as an INS official was publicized not only in an effort to alert residents but to encourage further reporting of additional cases. The last mapped case in the series was not a rape but a suspicious person report. The intended victim was approached by the offender but since she had been warned by her husband not to get into any car with a man claiming to be an INS agent she fled in time. Her husband had seen the story on a recent news broadcast. In this instance more information became available about the offender's time and space patterns which we included in our data set but without the traumatic consequence of another rape.

The Offender & The Research:

The offender in this series was a Hispanic male in his mid thirties, employed, and married. His victim choice was within his own ethnicity. He had no affiliation with the INS and ironically had the same illegal alien status as the victims he chose. Once apprehended it was revealed that he had previously lived in the area of the assaults, currently worked in the area and had relatives still living in the area. He showed a high familiarity with his environment, fitting in and moving through it easily. He had many legitimate reasons for being there at all times of day or night. The times of the assaults mid-day, late afternoon or early evenings during the week indicated work commitments, the lack of offending on the weekend indicated family commitments.

His behavior towards the victims indicated a compensatory rapist type – he flattered them, expressed a wish to see them again for dinner, assured them they wouldn't be hurt, however in most recent cases of the series he began displaying a gun, with the last rape happening at gunpoint. The offender is currently incarcerated awaiting trial on six indictments.

In the course of this series we also researched the literature on rapists typologies and environmental criminology. Since there was an inherent difficulty in making a prediction of next assault based on time

(there had been too many instances where there were yearlong gaps in the series) we primarily looked to behavior and geography for information on how this offender would move through his environment.

General and specific research was conducted starting with the broad field of Behavioral Geography, a branch of Geography with decades of literature utilizing rigorous research methodologies. Golledge and Stimson's Spatial Behavior (1997) provides a comprehensive collection on behavioral geography which charts human interaction and movement through urban landscapes regardless of criminality. Rengert (1989) provides an analysis of behavioral geography specific to criminal behavior. The field of environmental criminology and 'journey to crime' studies also provide a number of significant findings about how criminals use mental maps for the purposes of committing crimes (Brantingham 1981, Phillips 1980, Nichols 1980). Rossmo (1995) provides data and commentary on serialists' behavior and there is a small but well-researched body of literature that looks specifically at rapists' spatial behavior (Canter 1993 & 1994, Kind 1987, LeBeau 1987a 1987b 1987c 1993, Warren et al 1998). Behavioral information of rapists can be found in Hazelwood (1999), Amir (1971) and Groth (1979). Stevens (1994) examines issues of rape and victim selection.

Tactical crime analysis is rapidly becoming a necessary component of modern law enforcement. Each series successfully concluded or trend effectively responded to with the aid of crime analysis brings a fuller understanding of which techniques and methods produce results. The constant testing of our best practices refines and quickens responses. And ultimately leaves us better prepared for the next, and hopefully shorter, violent series.

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Section-II: Discrete Site Analysis

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As part of the work at the Advanced Crime Mapping Symposium the Discrete Site Analysis working group focused on issues regarding the use of GIS at or around commercial property, parks/recreational areas and school campuses. If the term "discrete site analysis doesn't lend itself to immediate clarification by the reader, it should be pointed out that the panel members had similar difficulty initially articulating what it meant to them as well. Discrete site analysis seems to have evolved as something that everyone does, but no one defines. It can mean many things to many people. For this reason, this working group first went to work clearly defining what discrete site analysis means.

Background:

In the world of mapping and geographic information systems map scale is important. Making a map of the world is one thing. Making a map of your city is quite another. Everyone has seen a map of the world and a map of their city and recognizes that much more detail is possible when making a map of the city, but that detail comes at the expense of mapping larger geographic areas. Conversely, a map of the world covers a large geographic area, but it is difficult to show street-level detail. There is another map scale that is important in crime mapping and analysis. That is the very large scale when you cross the threshold of a campus or building. Not only is scale important, but also level of detail becomes vitally important. Many city and county mapping or GIS departments have done a comprehensive job of mapping geographic features at the street level. Streets, building footprints, and parcels are mapped and included in the database. Other geographic sites often do not get the same attention to detail, primarily due to the high cost of data capture. Features like parks or corporate and university campuses often appear as a simple polygon or area on a map without illustrating any "internal" detail. Sidewalks, playgrounds, ball fields, and campus buildings are left off the map. Building footprints do not indicate how many floors a building has or what the floor plans look like. When you cross the threshold into a city park, a university campus, or a school or office building, you have left the traditional mapping world and entered into a scale that has routinely been "mapped" or drawn by architects, engineers, and site planners. These sites are no less important to law enforcement officials than sites along Main Street that have traditional street addresses.

Purpose:

The next four articles are authored by individuals that make a living dealing with the kinds of places often left out of city and county maps, or if shown, are illustrated with less detail. These places are collectively referred to as discrete sites. The symposium group came up with following working definition for discrete sites: "*A predefined area or structure with unique characteristics that differentiate it from its surroundings*."

When you walk or drive into a city park, you've left the world of street addresses and entered a space that may be acres or square miles in size that is full of locations where law enforcement officers have to work. Ball fields, playgrounds and picnic shelters are all potential sites to respond to a call, yet none have a physical address. In a large park it is important to distinguish between sites rather than mapping every incident that took place in a park at the park entranced as is routinely done now. When you walk or drive into a corporate or college campus you often have entered into a city unto itself. A new private network of streets, walks and buildings exists that probably does not fit into the city-wide addressing scheme. These

locations need to be mapped accurately to integrate data into the larger records system. When you enter a building you are now faced with a level of detail and complexity that is not evident on a city map merely indicating building footprint or outline. Multi-storied buildings, each with a unique floor plan, offer a mapping challenge when analyzing where incidents occurred relative to other incident separated by floors or walls and accessible via stairs and elevators.

You are about to read about mapping a small urban university campus—the University of Denver, about crime mapping at a large urban campus—the University of California at Los Angeles, crime analysis in a large building—the Alfred P. Murrah Building in Oklahoma City, and three-dimensional crime analysis across floors of a building at Temple University. What you will find by reading these papers is that the authors have solved some of the unique mapping problems, but there is still much work to be done in spatially analyzing our three-dimensional world. Collecting and analyzing data for discrete sites often does not fit into our "address-based" conventional data collection procedures.

Creating a Functional GIS Basemap for use in a Discrete Site Environment

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Introduction:

When CMAP brought together individuals from various law enforcement and crime mapping backgrounds at the 2001 Advanced Crime Mapping & Analysis Symposium, June 25th through June 27th, a small group was asked to discuss crime mapping & analysis techniques as they apply to a discrete site. When this group began their discussion, the first item on the agenda was to collectively agree upon a definition of a *Discrete Site* as it applies to crime mapping and crime analysis. The agreed upon definition is given below:

Discrete Site: *A predefined area/structure with unique characteristics that differentiate it from its surroundings.*

Some examples of these discrete sites are correctional facilities, parks, shopping malls, business parks, airports, convention centers, and university/college campuses.

The successful implementation of Crime Mapping in any law enforcement agency can and will involve the surmounting of many obstacles. However, these obstacles are magnified when attempting to implement Crime Mapping at a *Discrete Site*. This is because a discrete site, using the definition above, has unique characteristics. These characteristics define the boundary of the site with respect to its surrounding area. Because of the uniqueness of each discrete site, much of the GIS data will need to be collected and created "in-house". Another option is to have this work contracted. In either case, the results will be a customized product that is unique to the discrete site.

This article will attempt to guide the reader through the required steps for creating a discrete site basemap by using, as an example, the steps taken by the author when creating a GIS basemap of the University of Denver campus. Although the basemap requirements for a college campus may be different than the requirements for another discrete site, it is the hope of the author that the information provided in this article will provide some insight as to how a basemap can be created for any discrete site.

Before the individual steps for creating a discrete site basemap are described, this article will first discuss some background information with regards to mapping that the reader should have a basic understanding.

Large-Scale Mapping:

Map scale is often displayed as a ratio between the measured distance on a map to the actual distance on the earth's surface. For example: a large wall map of the United States may have a published scale of 1:2,700,000. This can verbally be stated as: "the measured distance of 1 inch on the map equates to 2,700,000 inches on the earth's surface".

Large-scale and *Small-scale* are relative terms that are easily misunderstood. To qualify a map as being large-scale or small-scale relates more to the amount of detail a map displays than to the size of the area that is displayed. For example: the wall map of the United States discussed above displays a city as an individual

point. Details such as city streets are not shown on this map; hence the wall map is a small-scale map because it does NOT show a large amount of detail. The reason that the terms large-scale and small-scale are relative is because a printed map of the United States is considered small-scale relative to a printed map of the City of Denver. However, a printed map of the City of Denver may be considered small-scale relative to a printed map of a Denver neighborhood, which may show the outlines of each building or structure. For further information regarding map scale and how it applies to crime analysis, please refer to *Mapping Crime: Principle and Practice* by Dr. Keith Harries.

Because a discrete site is typically a small area and a large amount of is needed to be displayed, large-scale mapping techniques need to be applied.

Raster-based and Vector-based Mapping:

Computer users interact with raster-based technology everyday by using a computer video monitor. The term *Raster* refers to a matrix or grid of pixels (or picture elements) on the monitor's screen. The size of this matrix is determined by the product of the number of rows multiplied by the number of columns of pixels on the screen. A common setting (referred to as the monitor's *Resolution*) for computer monitors is 480x640, which produces a matrix of 307,200 pixels. Each pixel is assigned a value. The value assigned to a pixel on a computer monitor represents a certain color. Current technology in computer hardware can allow computer monitors to display over 2 million pixels with several million different color shadings.

Digital aerial photography and satellite imagery are both raster data formats that are commonly used as background layers in a GIS. Similar to the computer monitor, in the example above, a digital photograph has a matrix of pixels, each with an assigned value of brightness and color (or shade of gray with regards to black and white photography). The quality of a digital photograph is often determined by the photograph's spatial resolution, or the size of the pixel. The size of a square pixel represents a square area on the ground when referring to spatial resolution. If a digital photograph is said to have a resolution of five meters, then the pixel represents an area on the ground measuring five meters by five meters, or 25 square meters. That 25 square meter area is displayed as one color. Obviously this would be a low-resolution photograph and would appear very blocky or "pixilated" when viewing at a large-scale. You would not be able to see your car in the parking lot at this resolution. What you need to remember is: the smaller the pixel size, the higher the resolution. Most aerial photographs that are used for large-scale mapping have a resolution of between one meter and one-half foot. An aerial photograph with a pixel size of one-half foot, for example, may allow you to see a fire hydrant in your front yard.

A vector-based data format stores spatial data as a point, line, or polygon in a GIS. Points represent the location of single objects, such as a fire hydrant or a streetlight. Lines represent linear features, such as roads, rivers, or pipelines. Polygons represent features that are areas, such as lakes, or political boundaries.

With large-scale mapping, some features that are normally represented as lines at smaller scales will typically be represented as polygons. For example: you may hear of a street layer referred to as a *Street Centerline*. A street centerline would be represented as a line that follows the center line of a street. At large scales, you can also represent a street as a polygon, where the area shown would be the actual area of pavement. This is commonly referred to as *Edge of Pavement*, where the lines that bound the area of pavement follow the curbs.

Coordinate Systems:

If you were to draw a map on a piece of paper giving someone directions to a picnic, chances are the map would not be to scale. It would just be a graphic representation of how the desired destination relates to the starting point. However, a GIS basemap needs to be an accurate representation of the surface of the earth. Because the surface of the earth is curved and irregularly shaped, cartographers have to take into account map projection, and horizontal and vertical datums when creating a map. These topics are beyond the scope of this article and have very little effect on the spatial accuracy of large-scale basemaps, because the areas being mapped are relatively small. In other words, little error is introduced by the curvature of the earth when mapping an area of one square mile, for example. What does need to be addressed is the unit of measurement that a map is created in and the coordinate system that the map is referenced to.

Most small-scale maps are created using a geographic coordinate system. Typically, a location on the map is referenced by degrees of latitude and longitude. However, with large-scale mapping, it is difficult to visualize the location of one point in relation to another as being a fraction of a degree apart. Most large-scale maps will use the foot or the meter as the unit of measurement. The location of an object on a map can then be referenced as being so many units (feet or meters) to the east/west of a starting point and so many units (feet or meters) to the north/south of a starting point. What is being described here is commonly referred to as a rectangular or Cartesian Coordinate system, where coordinates are given to the right (or east) along the x-axis from an origin point, and up (or north) along the y-axis from the same origin point.

For a large-scale mapping project, it is a common practice to create a coordinate system specifically for use on that particular project. A point-of-origin is determined and each location on the map is referenced to the point-of-origin using a chosen unit of measurement. This is known as a *User Defined* coordinate system. Although this may meet the mapping project's needs, it is the opinion of this author that all large-scale mapping projects use an existing *Real-World* coordinate system. This will allow for data from external sources to be included as part of your basemap. For example: some GIS map data may be available from the city, county, or water department, etc. for use in your mapping project. Use of these data becomes possible if everyone's map data has the same point-of-origin and use the same units of measurement as your data. If you were to use a user-defined coordinate system, you would have to convert all external data to your "proprietary" system. In addition, the use of a real-world coordinate system allows for data collected by a Global Positioning System (GPS) receiver to be included into the mapping project. GPS technology will be discussed shortly.

The most common real-world rectangular coordinate system used in the United States for mapping is the State Plane Coordinate System, developed for each state by the National Geodetic Survey (NGS). The point-of-origin is effectively positioned outside of the state boundaries so that all coordinates are given as a positive number within the state. Larger states are typically split into multiple zones. Each zone has it's own point-of-origin. All coordinates are measured from the point-of-origin in feet. Note: two State Plane Coordinate Systems were developed by the NGS. One system is based on the North American Datum of 1927 (NAD27) and the other system is based on the North American Datum of 1983 (NAD83). Both systems are perfectly valid for large-scale mapping within the United States.

The Global Positioning System:

Created by the U.S. Department of Defense, the Global Positioning System (GPS) provides a means for determining the precise location of any object on the surface of the earth. Signals are collected from a

constellation of 24 satellites orbiting the earth by a GPS antenna that is connected to a GPS receiver. Each satellite orbits the earth twice in one day. With this amount of coverage, five to seven satellites are usually within view at any given time of the day.

GPS basically works by calculating how long it takes for a radio signal, being emitted from a GPS satellite, to reach a GPS receiver on the earth. (We are assuming that the GPS receiver is being held at or positioned over the object being located). Since we know that these radio signals travel at the speed of light, the distance of a GPS receiver to a GPS satellite is calculated by multiplying the time (of the signal) by the speed (of light). For example: if a car travels down a highway at 70 miles per hour, how far will the car have traveled after 30 minutes? The answer is 35 miles. Using this formula, we can mathematically determine the location of our GPS receiver by triangulating the distances between the GPS receiver and at least four visible GPS satellites.

Most GPS come complete with software that allows for the transfer of the GPS data from a GPS receiver to a computer. Typical functions of GPS software include, data collection pre-planning, data dictionary creation, differential correction, and a basic mapping capability allowing for the GPS data to be displayed in various different coordinate systems. GPS software will also allow for the importing and exporting of data to and from a GIS.

GPS software is necessary to correct for errors in the signals received from the GPS satellites. The process of correcting for these errors is known as *Differential Correction*. Some errors are introduced by the earth's atmosphere. However, the U.S. military, for national security reasons, artificially introduced the largest source of error in the satellite's signals. This intentional error is known as Selective Availability (S/A) and it typically results in errors of up to 100 meters. The President of the United States turned off S/A in May of 2000 as per an Executive Order.

Differential correction (also known as Differential GPS) involves the use of an additional GPS unit, referred to as a basestation. The purpose of this basestation is to provide a reference to a known point providing a means to correct GPS data collected in the field. The concept of Differential GPS can be stated as follows:

- *The basestation antenna is located at a known position.*
- *The basestation antenna is receiving signals with the same errors from the same satellites as the GPS receivers in the field. NOTE: Differential GPS is only useful when the GPS data is collected by the roving unit within 300 miles of the basestation. The closer, the better.*
- *The basestation knowing where it is located corrects the errors as the signals are being received using its known point as a reference.*
- *Those corrections are saved in a computer file. One file contains all of the corrections for an hour.*
- *These files can then be used to correct the data received by the GPS receiver used in the field. The GPS software is used to compute the correction algorithm. This technique is called* ***Post-Processing****.*

It is possible to obtain sub-meter accuracy without the use of Differential GPS now that Selective Availability has been turned off, however, using Differential GPS techniques will increase the likelihood of sub-meter or even decimeter accuracy.

Basemap Creation Methodology at the University of Denver:

Phase-I: Determining Basemap Sources:

Founded in 1864, the University of Denver is the oldest university in the State of Colorado and one of the few major private institutions between Chicago and the West Coast. The university has occupied its current location (eight miles south of downtown Denver) since 1890. The campus is approximately ¾ of a square mile in size. In November 1994, the University of Denver announced a multi-million dollar Capital Improvement Campaign. This began a series of major construction projects that continues to this day.

Ground Surveys:

During this construction period (1994-present), many terrestrial surveys were made of each construction sight by a local engineering firm. The output of these surveys was produced in a CAD (Computer Aided Drawing) program called AutoCAD. AutoCAD is a product of the Autodesk Corporation. The AutoCAD drawings provided were very comprehensive and detailed the location of every feature (points, lines, polygons) within the survey area. Since these surveys were conducted using traditional surveying equipment along with newer GPS technology, the surveys were spatially very accurate. This became the starting point for the GIS basemap of the University of Denver campus.

Features, such as buildings, curbs, sidewalks, vegetation, streetlights, to name a few, were all detailed on these AutoCAD drawings. GIS software programs, such as ArcView, can view AutoCAD drawings. ArcView is a desktop GIS software program that is a product of the Environmental Systems Research Institute (ESRI). ArcView was used intensely in creating the university's basemap. To view an AutoCAD drawing within ArcView, the CAD Reader extension must be turned on within ArcView. ArcView allows for individual AutoCAD layers to be viewed separately. From there, the AutoCAD layer can be converted into an ArcView shapefile. The shapefile is the native file format for ArcView.

Although comprehensive and accurate, the terrestrial surveys only covered the construction areas, which were only a portion of the entire campus area. Other sources had to be found to "fill-in" and complete the basemap for the entire campus.

Digital Aerial Photography:

Digital aerial photography can be used as a background layer in a GIS. Features that can be identified on the photograph can then be traced using GIS software allowing for the creation of vector-based point, line, and polygon overlays. For example: a building footprint polygon layer can be created by tracing the outline of each building in the aerial photograph using the computer's mouse. This technique is commonly referred to as *Heads-up Digitizing*.

On three separate occasions, the University of Denver has obtained digital aerial photography. In 1996, digital black and white photography of campus, taken in 1993, was purchased for $20 from Image Scans, Inc. In 1999, the university received color photography from the Denver Water Board. In the summer of 2001, the university contracted Landiscor, Inc. to take new color photography of campus. Be aware: the contracting of having aerial photography taken, which includes putting a plane in the air, can cost several thousands of dollars depending on the specifications required. It may be worth finding a partner to share the costs of putting a plane in the air. Once the plane is airborne, the photography can be taken for your site as

well as the other site that you are partnering with. Another option is to find out if the city, county, or local utility company is planning on contracting new aerial photography. You may then be able to "piggy-back" onto their efforts.

Aerial photography used for mapping requires that a precision camera be mounted within the body of an aircraft and be pointed directly downward through an opening in the bottom of the aircraft. Mapping projects typically require that predefined flight lines be made so that side-by-side photographs overlap each other by 30%. Successive photos are typically taken to overlap each other by 60%, as the aircraft is moving along the flight line. This allows for photogrammetric techniques to be used to remove errors and inconsistencies from the photography. The most common techniques are "rectification" and "orthorectification". Rectification of an aerial photograph produces an image with a consistent scale throughout. Tall objects in an aerial photograph will always appear to lean away from the center of the photograph. The technique of orthorectification corrects for this effect. This resulting photography is commonly referred to as digital ortophotography.

Digital aerial photography is usually delivered in the TIFF file format. ArcView can read TIFF images. However, TIFF images can be rather large in file size (commonly 100Mb to 200Mb for aerial photography). Because of the large file size, a TIFF image may take from several seconds to several minutes to refresh on your computer screen within ArcView. This can become quite annoying when you have to wait for the screen to refresh every time you pan or zoom within ArcView. To avoid this, you may want to purchase the Image Analysis Extension for ArcView, or have the TIFF image converted to a MrSID file format. The MrSID software compressor is specifically designed for compressing large raster images. The resulting MrSID image file is much smaller than a TIFF image file without the loss of quality. The University of Denver contracted Genesys International to convert the TIFF files to MrSID files.

For more information on the Image Analysis Extension, visit ESRI at (http://www.esri.com/). For more information on the MrSID file format, go to the Lizardtech web page at http://www.lizardtech.com/.

Phase II: Using GPS to Create a Geodetic Control Network:

Before an aerial photograph can be used for mapping, it must be rectified using some existing geodetic control network. This rectification process (mentioned earlier) enables the photograph to be displayed in a GIS at the correct coordinates with a consistent scale throughout. In most cases, a company producing digital orthophotography will use United States Geological Survey (USGS) data to orthorectify the photography. However, this may not always position the photograph accurately enough spatially to overlay existing vector-based points, lines, and polygons. A GPS control network may need to be created for your discrete site to aid in increasing the spatial accuracy of your aerial photography.

Most companies that produce orthophotography will mark or "panel" points on the ground so that those points can be seen from the air. GPS is used to identify the location of those points and a geodetic control network is created. This network of points is then used in the rectification and orthorectification processes discussed above.

The University of Denver's Department of Geography owns several Trimble GPS receivers. Some of these receivers are capable of locating a feature within 50cm of its actual location on the surface of the earth. Using these GPS receivers, twenty-five GPS control points were created at various locations throughout the entire campus using the following criteria:

- *The location of each control point must be identifiable from the sky. Areas underneath tree branches should be avoided.*
- *The location of each point must be away from tall objects like buildings. An error known as "multi-path" can occur if the GPS signal bounces off of a building before being received by the GPS receiver.*
- *Locations must be chosen so that the GPS control points are somewhat evenly distributed throughout campus.*

All twenty-five control points were collected by a Trimble PRO XRS GPS receiver in Carrier Phase mode to obtain the highest level of accuracy. The GPS antenna was mounted over each position using a tripod to minimize movement. Data was collected at each position for 20 minutes at 5-second intervals. Trimble claims an accuracy of 20 centimeters when GPS data is collected in this manner. The collected data was then downloaded to a personal computer for post-processing. Differential corrections were processed by Trimble's Pathfinder Office software. Pathfinder Office was also used to project all of the control points into the Colorado State Plane Coordinate System, Central Zone, using the North American Datum (NAD) of 1983/92.

Once the post-processing was completed the control points were exported into ArcView as a data layer. Landiscor, Inc. then used this data layer to rectify the aerial photography that had been flown in June of 2001. This control network was also used to tie together other data sources, which included earlier aerial photography and some of the AutoCAD ground surveys. The rubbersheet function in AutoDesk's CAD Overlay software was used for this purpose. The end result was a collection of source materials that were all in the same projected coordinate system, having been tied together using a common control network.

Phase III: Creating the Basemap Layers:

The third phase involved the actual work of creating the basemap layers within ArcView. This was possible now that all of the source material was pulled together into a common coordinate system. Below is a list of the individual layers that were created:

- *Property Boundary (Polygon)*
- *City Blocks (Polygon)*
- *Street Centerline (Line)*
- *Street Edge of Pavement (Polygon)*
- *Water (Polygon)*
- *Sidewalks (Polygon)*
- *Parking Lots (Polygon)*
- *Buildings (Polygon)*
- *Outdoor Athletic Facilities (Polygon)*
- *Open Space (Polygon)*
- *GPS Control Network (Point)*
- *Elevation Contour Lines (Line) (where available – source: Ground Surveys)*

These basemap layers were created by converting the AutoCAD layers from the ground surveys into ArcView layers using ArcView's CAD Reader extension. Because ground surveys were only conducted in the construction areas of campus, basemap layers were completed by using the aerial photography and performing heads-up digitizing.

Phase IV: Basemap Attribute Data:

The types of attributes that are collected for each of the basemap layers will vary according to the discrete site's individual needs. The type of attributes will also depend on who are the users of the basemap layers. For example, at the University of Denver, the campus basemap will be used by Facilities Management, Campus Safety, Parking Services, and other departments. Facilities Management may have a need to know which segments of the sidewalks are brick, and which segments of the sidewalks are concrete. This information may not be a concern of Campus Safety.

Provided below are some ideas for attributes that may be of value for your basemap using the basemap layers listed above:

- *Property Boundary – Name of Discrete Site*
- *City Blocks – Block Number*
- *Street Centerline – Street name, Direction of traffic flow, Address ranges, Prefix direction, Street type abbreviation*
- *Street Edge of Pavement – Street name*
- *Water – Water feature name, Feature type*
- *Sidewalks – Pavement Type*
- *Parking Lots – Lot name/number, Number of spaces, Number of handicap spaces, pavement type, Date of last striping, Parking restrictions*
- *Buildings – Building ID number, Name, Alias Name, Address, Year Built, Number of Floors, Height, Gross square feet, Assignable square feet, Construction type*
- *Outdoor Athletic Facilities – Name of facility*
- *Open Space – Identifier*
- *GPS Control Network – Date collected, Easting value, Northing value, Elevation*
- *Elevation Contour Line – Contour elevation*

Conclusions:

It is important to keep in mind that the basemap is a starting point for mapping your discrete site. Many other data layers should be considered with regards to Public Safety and Law Enforcement. Some suggestions are as follows:

- *Fire Hydrant Locations*
- *Points of ingress and egress for emergency evacuation purposes*
- *Building Floor Plans – These can be linked to your Buildings Layer*
- *Vegetation – Locations that may be conducive to pedestrian attacks*
- *Emergency Phone Locations*
- *Outdoor Lighting – Building lights, Light pole locations, and Light post locations*

Another consideration involves the geocoding of crime locations. One of the benefits to having an accurate basemap, is that it allows for the use of GPS to show the location of the occurrence of crimes within your discrete site. This will allow your discrete site to benefit from Crime Mapping. Crimes can be mapped based of the x,y coordinates of the crime incident location. If GPS is not available, a grid layer should be developed that covers the entire discrete site. Crimes can then be mapped based on the grid cell that they occurred in.

As a final recommendation, it should be important to consider that for a basemap to be of any value, it needs to be maintained and updated as changes to your discrete site environment occur. A process and schedule should be created for this purpose.

Site Mapping Technology and Crime Mapping

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Overview:

NIJ's Crime Mapping and Analysis Program (CMAP) managers assembled a group of recognized experts in the fields of law enforcement and crime analysis and presented us with a challenge. We were asked to explore areas of law enforcement that would benefit from enhanced and innovative analysis and mapping techniques. The areas identified included deployment, forecasting, problem solving, emergency response and discrete site analysis.

The focus of this paper is Discrete Site Analysis: what it is, why it should be an integral part of every organization's crime analysis efforts, and a very basic guide to getting started. (Note – *This paper is intended to provide the rationale behind discrete site analysis and a very broad overview of the steps necessary to do it. My colleagues in this CMAP study can provide more detailed examination of each of these steps.*)

Basically, the job of law enforcement is to identify bad guys, get them behind bars and try to make the community a safe place. That job is increasingly challenging as society becomes more complex and the number of "discrete sites" within every community continues to grow.

A Discrete Site is a "*predefined area/structure with unique characteristics that differentiate it from it surroundings*[1]." This definition can be applied to many hubs of activity within every community: colleges/ universities, airports, local shopping malls and sports stadiums, regional parks with their barbeque pits, picnic tables and baseball diamonds, and those high-rise office buildings down town. These are all predefined areas or structures that have unique characteristics different from their surroundings.

The question as to why do we need to analyze crime within these sites, is of even greater importance. In order to fulfill our responsibilities as police administrators and crime analysts, we must understand how the discrete sites play a very decisive role in defining the very nature of the community. It is the character of these sites that makes them unique; that sets them apart from the rest of the jurisdiction and gives the community a certain identifiable "character." The airport represents the community's status and role within the region or state, the shopping mall represents convenience for shoppers and revenue for the city; the college/university represents prestige and opportunity for the future; the downtown high-rise buildings stand as symbols of leadership and the potential for growth. Even the county jail or prison represents the community's adherence to the rule of law and justice. All of these sites represent the very essence of the community – its identity. If for no other reason, analyzing crime activity within these discrete sites is important to protect and clarify that identity.

Advantages of Analyzing Crime at Discrete Sites:

Every crime has three components: the suspect, the victim and the location. Analyzing crime within a discrete site enables law enforcement to exercise more control over these components, control that can result in more efficient use of scare resources and better accountability to the general public.

The *location* component is the discrete site. Control over entry and exit to the site, as well as channeling movement within the site, can reduce unwanted activity. For example, CPTED[2] concepts can be employed to create safer surroundings and situational crime control strategies[3]can enhance citizens' perceived level of safety.

Users, or potential *crime victims*, of discrete sites generally have different, more narrowly focused expectations of their personal safety within the site. But as they move from site to site, these user expectations, a part of their victimology, will change. Recognizing and addressing these expectations is essential to maintaining the quality of that site and its role within the community. For example, university students expect an environment that is conducive to learning while users of the football stadium expect to be able to enthusiastically root for their favorite team; inmates at the county jail expect a tightly structured routine of activities while shoppers at the mall expect to be enticed by the merchants to spend money.

Increasing the risk and reducing the rewards for *criminals* is another major advantage of discrete site analysis. By controlling the physical layout of the site through CPTED-type efforts and activities, and by clarifying the victimology of the users of the site, law enforcement can greatly reduce the appeal the site may have for criminals. For example, cutting back on path foliage and increasing lighting on a college campus plus on-going safety awareness programs can greatly increase the risk of discovery and apprehension of campus criminals.

Clarifying Goals:

Before constructing an analysis program of a discrete site, a clear understanding of your goals *must* be established.

Identify the Audience for Your Analysis:

Every analysis results in the dissemination of useful information to the people who need it. Deciding what is useful and who needs it are issues that encompass privacy, political or financial concerns. Who will be the recipients of your analysis? Will the analysis be intended only for the management of the site (including security personnel and staff) or is there a broader audience? Will it be shared through the Internet (worldwide dissemination), only within the immediate community or across a broader political and regional community (the entire jurisdiction or related sites)?

Identify the Limitations of Your Analysis:

Discrete site analysis implies limitations, if nothing more than the physical or geographic limitations of the site. Additionally, the more in-depth your analysis, the higher the costs of the resources needed. For example, using Enhance GIS technology for discrete site analysis can be very beneficial and informative. However, there are added costs for necessary hardware, software and staff training.

During these preliminary planning efforts, consideration should be given to establishing short and long-term budget goals. As the quality and demand for the analytical product grows, these other costs can be factored in.

Necessary Elements:

Data Capture: As with any analytical effort, the quality of the output depends on the quality of the input. The analyst must have an efficient method to acquire reliable data from a wide variety of sources and manage it so as to meet not only today's needs but also future needs.

Agencies often purchase computer systems that are programmed to meet reporting requirements rather than to perform analysis of data. While containing valuable historical data, these systems often can be more of a handicap than an aid to the analyst. Relational database applications, which are very reasonably priced and can reside on desktop computers, should be considered. If historical data is needed, there are several excellent conversion programs on the market that will enable the migration of data from older systems into these desktop applications (particularly when dealing with ODBC[4] compliant systems).

The vast majority of data that you will capture for your analysis will come from police department/security crime reports. While most of these reports will be comprehensive and professional, they often become a mere record of the event rather than an investigation. Police officers, like everyone else, can fall into report writing routines. Efforts must be made to insure quality investigations because the officer's observation skills and ability to record them accurately and thoroughly are critical to identifying any crime series, patterns and even trends that are taking place. One way to assist officers in capturing not only the sought-for *type of data*, but also the *amount of data* needed for analysis is to use force-choice reports.

Forced-Choice Reporting: Reports that force a selection, generally from a list or menu of options, can be a very powerful and easy tool in data capture. For example, providing specific selection options that indicate the method of entry into a vehicle (pry tool, window smash, lock punch, etc.) will insure that the original crime report captures needed information and will greatly aid the subsequent search and pattern-matching analysis of related cases. The availability and flexibility of computer technology, (i.e. word-processing and desktop publishing applications), makes the development of these force-choice reports easy and economical. A force-choice report can not only meet the changing needs of the administration dictated by judicial or legislative mandates but also of investigators and analysts.

Another important aspect of using force-choice forms is that collected data can be standardized. For example, patrol officers may deal with certain crimes so infrequently that use of force-choice formats will insure they capture all the details required by investigators or analysts. Often, the first-responder's view of the incident is the most critical, (lighting, dew conditions of the grass, odors at the scene of suspected arson or drug lab) and again, a force-choice form will greatly aid in collecting important evidence.

Data Sources: Most ***preliminary crime reports*** provide basic, but essential, data – crime type, location, date/time, involved parties, loss (if applicable) and the corpus of the crime, including any weapon or force that was used, method and point of entry into a structure or vehicle. Identifying patterns and matching cases begins with these basic elements. ***Supplemental reports***, such as follow-up interviews, forensic examination of the scene and/or evidence and the results of investigative leads, can often supply key case linkage information. This is particularly important when suspect behavioral patterns, such as *signature*[5] and *staging*[6], can be identified.

Field Interrogation (FI) reports are among the most valuable piece of police intelligence available. At the same time, they can be tremendously underutilized. Because an FI will placed a person (plus companions and, possibly, a vehicle) at a particular place and time, the report can be invaluable. However, the method

of recording these data (generally hand written with varying degrees of legibility) and the intensive computer data entry process can greatly slow the use of that data.

Many agencies are capturing FI information with more advanced technology (PDA devices, scanning devices for drivers' license, etc.) or through force-choice format FI's. This makes the gathering process easier for the officer and more readily available to analysts and investigators.

Many states and municipalities are providing legislative support and funding that enables Pawn Brokers to computerize their ***pawn slips*** and provide that information to local law enforcement in digitized format. A strong program of property identification and tracking within the site, along with access to pawn slips will provide substantial control over property thefts.

Vehicle Reports, including auto theft/recovery and license plate lost, are important sources of data particularly at sites where vehicular traffic is high and generally anonymous such as airports, shopping malls and universities. At sites such as these, parking enforcement and traffic movement databases must be readily accessible to the analyst.

NIBRS[7] vs. UCR[8] Reporting: For many years law enforcement organizations at all levels across the country have found that UCR-based data capture is less than adequate to support a thorough analysis of crimes within jurisdictions. Ideally, most investigators and crime analysts would prefer the use of the more complete and detailed NIBRS approach to data capture. However, there are many issues to be resolved, both locally and nationally, in any movement toward the uniform adoption of an Incident Based data capture and reporting system. Regardless, the issues should not interfere with capturing *detailed* crime data to support the analysis of any discrete site.

The majority of communication systems vendors today (Computer Aided Dispatch, Records Management and Crime Analysis systems) provide Incident Based Reporting capabilities in their products. These are important tools that are highly recommended in any discrete site analysis.

Another recommendation in planning for discrete site analysis is to avoid the traditional UCR grouping of crimes. This will create confusion in the reporting of activity at the site and will greatly restrict the analysis process. Capturing the crime data in locally understood format (i.e., using state penal code sections) will be much easier to work with. Many states have criminal violations that are very distinct in their M.O. and victimology but, to comply with UCR reporting requirements, have been grouped into general and non-descriptive categories. This grouping stemmed from non-automated efforts to apply national reporting standards. However, with today's technology this "grouping" does not need to take place at the capture or analysis level but can take place at the reporting level.

An example is the handling of theft or burglary from motor vehicles (BFMV) where forced entry is made into the vehicle. UCR mandates require grouping these BFMVs with other types of theft. However, while many discrete site thefts are opportunistic in nature, BFMV crimes require a more sophisticated criminal. This distinction permits a closer analysis of MO and/or signature. Grouping BFMV with other thefts prevents such analysis.

Additional Data Sources: To analyze crime activity within a discrete site you will not only need the crime data listed above but site-specific and site-surrounding data, including population density, ethnic breakdown, economic levels, etc. One of the unique features of a discrete site is the narrowly focused goal(s) of its

users. A comprehensive analysis necessitates an understanding of the tenants/residents of the site, the employees who are there regularly but *may* not have a vested or proprietary interest in it and the casual visitors who come to the site for a limited, specific purpose.

Additionally, because the site has characteristics that are different from its surroundings, an understanding of the surrounding population is needed. How can the analyst say that activity within the site is different unless the analyst can say how it is different?

The best way to capture data from these sources is to "harvest" it. The harvesting of data refers to the need to collect any and all data, from varied and multiple sources, which will be needed in any discrete site analysis. While most of these data are more easily applied in a mapping analysis (discussed below), understanding the uniqueness of the site requires you collect and use these data regardless of the tools used[9].

Data can be harvested from free sources and sources that provide specialized data for a fee. Much data is available from city planning, zoning and licensing departments, tax assessor, voter registration and the Census Bureau. There is a wealth of information available for free from the numerous Internet sites (Note: caution *must* be exercised that if Internet-provided data is used, source verification and reliability should be documented).

Many private companies maintain extensive and well-documented databases with information that could be valuable for a discrete site analysis. Lexus-Nexus is a well-known example of such a database. While there are costs associated with "harvesting" this data, this cost may be reduced or shared by using the resources of the discrete site tenants. For example, tenants of a shopping mall or high-rise office building may have access to these specialized for-fee databases, university departments may have access to research databases, and sports complexes may have access to nation-wide, private demographic databases. The important thing to remember is that these sources of information will grow exponentially with each passing day and knowing how to access them will only enhance your analysis.

Mapping Crime Activity:

Mapping crime activity with the new GIS[10] technology has gone far beyond the old pin maps. Mapping can enable you to identify concentrations and movement of crime throughout the site as well as analyzing the temporal and vertical components of that activity. However, while it is a very powerful tool, there are steps that need to be taken in preparing for its use within a discrete site.

Build a Base Map: Any mapping of crime begins with construction of a base map that contains all essential elements needed for your analysis. Avoid local user-defined systems by building on common, standardized cartographic data constructs and a real world coordinate system, i.e., State Plane, UTM coordinates or Latitude/Longitude. Initially, user-defined systems may be very easy and more inexpensive to acquire. However, as the depth of your analysis grows, non-compatibility of new data sources will present nightmarish problems.

If the discrete site consists of streets, roadways, paths or any other "line" components, you will need a mechanism for pinpointing incidents along that line. For example, most street data will have address ranges on both sides of the street for each segment (Odd numbers on the north and west side, even numbers on south and east side). Additionally, street data may include centerlines, curb lines, utility lines (gas lines,

sewers, phone lines, etc.) and specific parcel data. The Census Bureau can provide Tiger files that will provide basic street data for almost all areas of the country. All of this data is useful, but you will need to insure the accuracy of these segments in order to properly geocode the crime incidents.

If the discrete site consists of a single structure (high-rise building) or a structure with a single footprint (shopping mall or correctional facility), you should obtain a floor plan of the structure(s). Every discrete site will have engineering drawings or plans that can be used in mapping applications (CAD data can be obtained from the architectural firms that designed the facility. These CAD data can be read by the GIS/ mapping applications that are used). These plans are usually maintained by the facility group responsible for the planning and maintenance. This source can also provide additional building data such as water, sewer and electrical lines, plus floor levels, square footage, emergency access points, etc. This data will not only assist you in the analysis of crime throughout the structure but with any tactical and emergency planning needed by your agency.

The best sources of base map data are city planning, zoning and utility departments, along with data available from commercial providers such as GDT or Thomas Brothers Maps[12].

Map Symbology: The symbology used in your base map should be standardized across all disciplines (police, fire, security, etc) and agencies (city, county, state, and federal) involved with the discrete site. For example, it is reasonable and prudent for every discrete site to plan for a Fire Department response using standard NFPA 70 and D.O.T. Hazardous Materials symbols. Also, while a nationally recognized police symbology may not yet exist, the mapping symbols used by the agencies that surround the site (city police and county sheriff's departments) should be used for compatibility and standardization.

Monochrome vs. Color Map Symbols: If your discrete site maps are going to be used by a wide audience, and possibly duplicated for further distribution, monochrome symbols should be used. While color maps can be very informative, the distinction between symbols should come from the symbol size or shape, not its color. You don't want the message of your map lost in the black and white copy machine.

Non-addressable Crime (NAC) Locations: Discrete sites that have unique location addresses (street numbers, names or room numbers) make the job of mapping the crime incidents relatively easy. However, how do you map incidents that occur at non-addressable locations, i.e., large open areas, parks, pathways, or convention floors? This can be handled in two ways: using GPS technology and establishing a grid system for tracking incidents.

GPS technology[13] employs hand-held devices that capture longitude/latitude coordinates that are easily downloaded into most GIS computer applications. Use of GPS devises in homicide investigations that cover large areas (a desert, field or forest) enable the pinpointing of the encounter, abduction, kill and dumpsites. However, use of GPS in less horrific and more common investigations cannot be understated. For example, these devices can be a great aid to map incidents of thefts in a state park, auto burglaries and theft in a mall parking lot, assaults in a prison exercise yard or county work farm. These locations can be mapped quickly and inexpensively using GPS technology. A GPS device can give you crime location accuracy to within 3 meters (approximately 9 feet) for as little as $150.

For those locations that may have a single address, but cannot support GPS technology (inside a convention center, a mall or a multi-story building), it will be necessary to "pre-grid" the site. As the incident data is initially captured, a pre-grided map of the floor should be used to pinpoint the various locations. This data

capture form, or *grid map*, can be used by the first responding officer or given to the crime victim to better identify and isolate the occurrence of the event.

These data capture forms, along with other mapping tools, should conform to recognized standards (scale, direction, etc., such as the Atlas Grid System – starting in the bottom left of the form and listing the X coordinates– left to right (letters), and the Y coordinates - bottom to top (numbers)).

One caution when using GPS technology involves the transfer of these data from the hand-held device to your computer-mapping program. Most GPS devices have software that will insure an accurate, automatic download of data. However, manually transferring the coordinate data (longitude and latitude) can lead to unintended errors. Multiple readings should be taken of every incident and those data readings should be consistent.

Summary:

Every community has one or more centers of activity that brings people together for very specific purposes and with which all the citizens share an identity. In years past these centers were the town squares during the summers, the high school gyms during the winter and the church, temple or synagogue at week's end. The attraction of these centers has not changed over the years, but their numbers, complexity and importance to the community has grown with our increasing social mobility and urbanization.

It is incumbent that all levels of law enforcement recognize that the attraction and complexity of these centers, these *discrete sites*, presents us with unique crime analysis challenges and opportunities unlike the community at large. This paper is not intended to be the definitive guide in this area, but rather a template with which to begin.

End Notes:

[1] 2001 Crime Mapping Analysis Advanced Symposium, *Discrete Site Analysis*, Dr. George F. Rengert, Mike Woods, Steven Hick, Jim Howard, Bill Boesch, June 2001.

[2] ***CPTED*** *– Crime Prevention Through Environmental Design* is a branch of situational crime prevention, which has as its basic premise that the physical environment can be changed or managed to produce behavioral effects that will reduce the incidence and fear of crime, thereby improving the quality of life and enhancing profitability for business.

[3] ***Situational Crime Control Strategies***, as used in this paper, are semi-permanent efforts by law enforcement to immediately impact an identified crime problem. For example, placing a police mannequin in a police car near a problem traffic signal or a police kiosk near a subway entrance or within the shopping mall.

[4] **ODBC –** Open Data Base Connectivity is a common database access method, whereby client applications and server applications can exchange instructions and share data without needing to know anything about each other. ODBC permits maximum interoperability in the exchange of data between different database systems.

[5] **Signature** – Those actions committed at the scene by the suspect that exceeded what was necessary for the crime (going beyond MO).

[6] **Staging** a crime scene occurs when the perpetrator purposely alters the crime scene to mislead the authorities and/or edirect the investigation. Staging is a conscious criminal action on the part of the offender to thwart an investigation.

[7] **NIBRS** – National Incident Based Reporting System is an incident-based reporting system for crimes known to the police. For each crime incident coming to the attention of law enforcement, a variety of data are collected about the incident. These data include the nature and types of specific offenses in the incident, characteristics of the victim(s) and offender(s), types and value of property stolen and recovered, and characteristics of persons arrested in connection with the crime incident. Incident based data provide an extremely large amount of information about crime. The information is also organized in complex ways, reflecting the many different aspects of a crime incident. Ref. *NIBRS Resource Guide* – www.icpsr.umich.edu/NACJD/NIBRS/ and Effects *of NIBRS on Crime Statistics* -www.ojp.usdoj.gov/bjs/abstrat/encs.htm.

[8] **UCR** – Uniform Crime Reporting *Federal Bureau of Investigation* – www.fbi.gov/ucr/ucr95prs.htm.

[9] "*Harvesting*" connotes far more than just cutting or picking the crop (data). It refers an entire process – capturing, collating, storing, and analyzing the data and disseminating the resulting information.

[10] **GIS** – Geographic Information System technology refers to sophisticated mapping applications that can reside on desktop computers. The price of GIS applications can vary from under $100 to over $4,000, depending on the complexity of the mapping needs.

[12] *Thomas Brothers Maps* (www.thomas.com) provide detailed street maps for most major cities in the United States. These are digitized versions of the printed maps that are commonly used.

[13] **GPS** - Global Positioning Satellites provide data that pinpoint positions on the earth. Equipment that can read this data are referred to GPS devices and are used extensively today for a wide variety of purposes, 0from survey work where device cost can exceed thousands of dollars to hand-held devices used by hikers that cost under $100.

How to De-Mystify GIS by Understanding the Role of Common Sensed GIS and Blue Collar GIS In Public Safety

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What is GIS? GIS simply put is *Geographic* (the study of geography) *Information Systems* (computer programs). This, of course is much too simple an explanation for most GIS practitioners, but basically GIS is a collection of data sharing a common coordinate system, such as latitude-longitude, that is visualized as an electronic map. GIS provides a vehicle to relate diverse information geographically or spatially. The type and amount of information associated to the map depends on its purpose. A common type of GIS might be developed by a municipal water department, which would track water mains and distribution systems by size and location of pipes. In fact, GIS is a relatively new tool within study of geography. A mere 25 years ago, GIS was the exclusive domain of Universities and a few government agencies because they were the only users who had powerful enough computers required to run GIS. Perhaps this is why many GIS professionals use high-powered words and exude an air of academia, for the profession is literally one generation away from the college campus. This link to academia is not undesirable; it ensures some of our brightest minds are devoting time to improving the state of the art. In the 1970's a landscape developer, Jack Dangermond, established Environmental Systems Research Institute and began marketing GIS commercially. Even the name hints of the academic world. This company has succeeded in proliferating the use of GIS with countless applications throughout the business world. Today they are known simply as ESRI and are the market leaders in GIS software. From Telephone Companies to Defense to Public Safety, GIS is becoming one of the standard tools for analyzing information. GIS has evolved into a highly sophisticated medium for spatial analysis, correlating seemingly unrelated bits of information into conclusions that would only be obvious geographically.

What do I mean by Common Sensed GIS? This phenomenon resides in each of us. We all have some form of internal mapping mechanism that allows us to relate to our world two and three dimensionally. This internal geographic information system (GIS) we all possess is a major contributor to our daily existence. We process thousands of bits of geographic information just navigating from our beds to the kitchen each morning for our first cup of coffee. We travel to work each day without giving a second thought to our route. We rarely give thought to the geographic information we require as we live our everyday lives. In fact, we move through the familiar parts of our world with our GIS in passive (sub-conscious) mode. Another function of our "GIS" is to provide geographic referencing between the surrounding vicinity and ourselves. This spatial awareness of our familiar world is mostly an unsolicited part of our conscious thought that is continually updating information about our immediate environment and its relationship to ourselves and the rest of our world. It is mostly when we venture into the perceived unfamiliar world that our GIS goes into active (conscious) mode. When we enter these new surroundings we first "get our bearings" and then we "get the lay of the land". In reality, our internal GIS is assimilating data about our new environment. We are geo-referencing, measuring and cataloging. Although our attention is focused to this task and our GIS is active, we are still gathering much data passively. Simply put, when we get our bearings and the lay of the land we are developing spatial awareness, turning the unfamiliar into the familiar. Often times our passive GIS detects a change in the familiar and jump-starts our active GIS. Usually this is just a matter of updating information, but sometimes it signals concern and puts our awareness on alert. This alert may also summon other information and experiences, adding them to our GIS and intensifying our spatial awareness.

For the Public Safety professions, the combination of spatial awareness, experience, training and tactical information is known as situational awareness. When law officers patrol their assigned sectors they constantly catalog information geographically and file it mentally. When firefighters approach an incident they are mentally calculating distances from the fire to the water source and selecting a geographically suitable position for the Incident Command Post (ICP). When investigating an accident or crime scene, officers are geo-referencing the relationships between victims, evidence and incident and often sketching the results. For the most part, these are but a few examples of Common Sensed GIS. The traditional GIS available to Public Safety today ranges from Computer Assisted Dispatch (CAD) to Crime Analysis. The CAD systems, although evolving, represent basic dispatch assistance for calls to our 911 centers. Crime Analysis on the other hand, represents the analytical aspect of modern GIS. GIS analysis requires a base map and data associated or referenced to that map. The process of data harvesting is a combination of re-purposing existing data and gathering new data then creating a database inside the GIS. For example, a typical new Crime Analysis division might begin its mission in the following way: First, obtaining an existing GIS land base (base map) from another municipal department such as the water or planning department. Second, selecting a series of crimes determined to be related and reference pertinent information about these crimes onto the map. With this basic beginning much spatial analysis about the selected crimes could be performed. The next series of crimes analyzed will use the same base map but with a new data set. Over time and as the Analyst gains experience, the GIS accumulates much data that is reused again and again. Analysts are typical data hogs, as they never seem to have enough data. The major difference between the traditional GIS and the Common Sensed GIS is the computer programs ability to correlate seemingly random events into a pattern or conclusion when they are placed in a geographic context. Although the birth of a Public Safety GIS seems easy, in fact it can be a laborious task of both creating the base map and maintaining the data sets. The bright side is that once the first hurdles of creation are overcome the process becomes primarily an add/update function.

The base map is the foundation for what we refer to as Blue Collar GIS. Blue Collar GIS is not a labor management issue but instead it is simplified GIS for field personnel. It bridges the gap between the Common Sensed GIS and traditional GIS. It allows the individuals in the field to take notes geographically and the rest of the team visualize this data. The technology, both hardware and software, is here today that will permit this concept. If your agency has invested in a GIS Analyst, whether Crime or Response, and they have begun the GIS birthing process, then you are a candidate for Blue Collar GIS. This form of GIS is not intended to perform complex analysis, but rather to provide a GIS integration tool for the front lines of your mission requirements. Here is a current example of Blue Collar GIS. My company is currently under contract to develop GIS integrated contingency planning aids and disaster recovery software for a major law enforcement agency in preparation for the 2002 Winter Olympics. We were chosen in part because of our involvement in the recovery effort at the Oklahoma City Bombing where we mapped the last known locations of the missing victims of that tragedy. A simple floor plan converted to a map with symbols for missing people allowed Rescue Operations an organizational tool for resource allocation. Some credited these simple mapping visual aids with saving two to five days on this 16-day incident. With this incident in mind we proceeded with implementing the concept of Blue Collar GIS in our current contract. We began like any new GIS enterprise with a data harvest where we re-purposed the existing water department land base and supporting data set. We acquired University utility data for the proposed Olympic Village, augmenting this with GPS readings, aerial photographs and created a new base map suitable for emergency response. Next we converted architectural floor plans of key buildings into “responder friendly” map inlays. Then we preformed a response assessment on these buildings emphasizing worst case scenarios and devised contingency planning aids suitable for fire, collapse, sniper or hostage situations. This process created two separate data sets that were integrated into the existing GIS with extensions that allow users to determine

line of sights in case of snipers, view sheds for safe approaches to hostage situations and a crane sizing application in case of structural collapse. These data sets and extensions are warehoused at the administrative, or some might say strategic level of the existing GIS infrastructure. Although the analyst can accomplish much with this data, an important ingredient was still missing, that is the input of the front line responder. The key to adding these valuable team members' knowledge and experience to the data sets can be accomplished through the preplanning process. We felt this could best be accomplished with a simplified, affordable and lightweight GIS dedicated to preplanning and situational awareness for field personnel and front line responders.

Fire Services have been preparing Fire Attack Preplans on major buildings for years. Because of recent increases in work place and school violence, the law enforcement community is also beginning to preplan selected facilities. These plans are usually a combination of text, photographs and sketches and are mostly maintained at the responder level and are rarely stored in a format that maintains relationships between documents, images and spatial data. With the objectives of integrating the responders experience and knowledge into the GIS infrastructure and providing an intuitive GIS interface for responders, we created a *geographic utility for mitigation and planning,* which we call GUMP. GUMP is fully compatible with the existing GIS using the same base map and data sets created for our project. The responders can visualize, manipulate and update the same maps that the analyst uses. The GIS layering convention segregates the responders input at the administrative level while providing only essential data at the responder level. Users are able to display and mark-up the maps, query the data, insert preplanning symbols, measure distances and hyperlink photos, documents or other programs maps. GUMP, as a solution, is more a philosophy than a product. Common sense is the driving force behind the design philosophy of GUMP. Besides being affordable to municipal Public Safety budgets, I feel it must meet five more criteria. The software must be ***Scalable***, from a single crime scene to a catastrophic event, from patrolman to command center. It must be embedded in ***Commercial off-the-shelf software***. It must be ***Open*** and modifiable. It must be ***Redundant*** in the sense that super and casual users use the same data structure. And finally it must be ***Easy*** to learn and use. The solution must ***SCORE***. GUMP is the chosen vehicle that interjects the Blue Collar GIS into the overall Strategic Mission of our project. The integration of preplans to an administrative level GIS will add the tactical element and begin defining it as a Public Safety GIS.

Blue Collar GIS and Common Sensed GIS are not unique concepts or philosophies, although I did arrive at these principles independently and as a result of experiences. Similar philosophies from academia are referred to as "societal GIS" and "mental mapping". Likewise, GUMP as a product is not the only responder friendly application available. Max Responder by PSC is a "Fat Button" in-vehicle solution utilizing the similar technologies as GUMP. The SCORE philosophy residing in GUMP, on the other hand, is rooted deeply in what I observed and learned as a "drafted responder" to the Oklahoma City Bombing incident. As a Technology Project Manager for Southwestern Bell Telephone Company in Oklahoma nothing in my experiences had prepared me for my introduction to Public Safety and the world I entered in April of 1995. On the fifth day of the incident I was summoned to a 2:30 meeting at the bombed out Murrah Building much like I had been invited to countless corporate meetings throughout my career. As I journeyed the short two blocks from my office to the meeting, my active GIS was on full alert. Although this was my work neighborhood and I was taking a route I had traveled many times before, it was totally unfamiliar. As I entered the bombed building I left unfamiliar surroundings and entered "does not compute" surroundings. There were no reference points for my internal GIS to ping off of. The entire contents of the building seemed as if it had been funneled through the world's largest blender and regurgitated into a giant rubble pile. Floor, ceiling and wall boundaries were defined by carved out sections of the rubble pile with no orientation to an actual building infrastructure. As I was briefed on the mission requirements for which I

was being recruited, I realized that the lack of familiar “geographic” reference in the building was the root of the problem. Simply put, my commission was to provide the hardware, software and personnel to create maps of the building prior to the explosion, complete with geo-referenced last known occupant locations and interior reference points to be used as navigation aids. Even at a more basic level these maps were used to validate collapse theories that would ultimately provide guidance on where to dig. The next ten days saw the mission accomplished. The post-incident debriefing for me lasted almost 18 months as responders of all disciplines re-visited the building site and somehow found their way to my office where they viewed photographs and talked of their experiences. Others sought me out to learn more about single building GIS and occupant mapping. As anyone can see, my introduction to Public Safety solutions is rooted in a truly rare and catastrophic event. Consequently, I scale back a workable disaster solution to an everyday solution as opposed to scaling up an everyday solution. It is this perspective that led me to the SCORE philosophy. Scalable, commercial and open software is the key to disaster operations. In true catastrophes mutual aid will be the order of the day and even civilian volunteers will be employed. Ad hoc solutions will be programmed on site. Information will need to travel up and down the command hierarchy. In normal operations custom extensions developed on the same commercial platform can meet everyday needs. In fact, standards and standardized software would greatly benefit the Public Safety community. However it is unlikely that any organization has the power to set these standards. The safe bet is to invest in the market leading software of a particular discipline. For GIS it would be ESRI’s ArcView or ArcGIS, for computer-assisted design (CAD) it would be AutoCAD and for word-processing it would be Microsoft Word. The selection of any of these products would ensure a trained work force in any American community when mutual aid is needed. It also ensures a large pool of third party developers for the custom applications needed for daily work processes. Integration of these products into the daily workflow also ensures a trained responder force in case of catastrophe. Both high end and responder friendly tools will be operating in the same technology, which saves expense by utilizing data re-use and data re-purposing. Finally the ease of use is the key to integrating the Blue Collar input into the Public Safety GIS.

Measuring Barrier Effects on Criminal Activity

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Barriers are designed to stop or alter the spatial behavior of potential criminals. They often are so obvious that we do not think of their subtle aspects or effects. Locks and alarms are designed to keep people out. However, fences may be decorative and may or may not be designed to keep people off a premise. Since the effects of barriers are not always obvious, crime analysts may wish to measure their impact on criminal behavior.

Theoretically, barriers are classified into three categories. The first is an *absorbing barrier*. An absorbing barrier completely stops spatial movement through or beyond the barrier by absorbing all the energy required to overcome the barrier. An obvious example of an absorbing barrier in criminal justice would be a maximum-security prison. The bars, walls and razor wire are designed to completely stop all unauthorized spatial movement across them. Absorbing barriers are rare beyond the prison example. Usually a barrier takes on one of the two following forms.

The second category of barrier is termed a *reflecting barrier*. Upon striking a reflecting barrier, the direction of movement is changed but the energy is not absorbed. Therefore, a reflecting barrier actually may intensify the activity along its edges. In criminal justice, such a barrier is termed "spatial crime displacement." An example is if we improve the lighting in one section of a parking facility but not in another section, the auto thieves may focus their activity on the area not advantaged by the improved lighting. Security cameras also may displace crime beyond the area they are designed to survey. Again, if a given amount of energy is applied to criminal activity, a reflecting barrier may intensify this activity in the area it is reflected into. However, neither absorbing nor reflecting barriers are absolute in most instances. Normally, a certain amount of criminal activity passes through these barriers.

Criminal justice practitioners can never hope to completely eliminate crime, only to slow it down. One method of accomplishing this is through the establishment of the third type of barrier termed *permeable barriers*. This barrier is the type that absorbs or alters the direction of only part of the energy involved in criminal activity. If some criminal activity passes through the barrier, it is termed a permeable barrier. Permeable barriers are the most common forms of barrier in the criminal's environment.

Permeable barriers can take a variety of forms. To this point, we have generally discussed "physical barriers" associated with locks, walls and fences. However, permeable barriers can take on at least two other forms. The first is a *cultural barrier*. Examples of this exist in almost any American city: it is the rather sharp divide between racial residential areas. These racial divides are permeable—although the vast majority of crime is black-on-black and white-on-white, there is a certain degree of interracial crime. This has never been carefully measured as a barrier effect (Pettiway, 1982), although the technique outlined below is well suited for this purpose.

The second is termed a *psychological barrier.* This type of barrier describes human behavior where individuals make decisions as to how to behave upon crossing a psychological barrier. For example, the purpose of barriers often is not to restrict movement but to change behavior when a potential offender enters an area. We can keep some offenders out of an area with gated communities and restricted access to schools. However,

shopping centers, center city districts and even colleges wish to welcome every potential customer or student but have them behave in an appropriate manner while on their premises.

This can be accomplished with psychological barriers. Psychological barriers are the inverse of the concept of "broken windows" (Wilson and Kelling, 1986). It also is akin to Newman's (1972) concept of "defensible space" that projects clues as to what behavior is acceptable and will be tolerated and what behavior will not be tolerated. This can be made obvious with such things as park benches and tables. It also can be made obvious by a clean, neat, well-landscaped environment that harmonizes with its surroundings. Barriers can be such things as changes in the texture of walking surfaces from concrete to pebble. This change will stimulate pedestrians to think that they are entering a different environment and perhaps also to think of what behaviors are appropriate for this new setting.

Shopping malls, center city districts, college campuses and even residential neighborhoods use a variety of signals that one is entering a new setting. These may be banners hanging from utility poles, signs declaring a neighborhood watch residential area and/or ornamental arches, fences, plantings or hedges marking the entrance to a special use district. These signs usually are designed to be inviting but at the same time signal that certain behavior will not be tolerated. These may be psychological barriers to criminal behavior. The following illustrates a method of measuring the permeable effect of a psychological barrier on criminal activity.

Data Source:

The data are taken from the records of the Temple University Department of Public Safety (police) for a ten year period from 1988 to 1998. Temple University is an urban campus of about thirty thousand students. It is 36 square blocks covering about 95 acres of land in north Philadelphia. Temple police patrol not only the campus proper, but also a two-block perimeter of the residential community that surrounds the campus. Data are taken from these police records of crime occurrences.

Temple University uses a variety of psychological features to signal when one is entering the campus. There are banners hanging from utility poles declaring this is Temple University, ornamental gating at the main entrance, and most important, a neat, clean campus with tasteful plantings and sculptures scattered throughout. In short, it is obvious when one passes from the surrounding community of row houses onto the campus of high-rise buildings. The question addressed here is whether the psychological barrier of the campus boundary has a permeable effect on criminal activity.

As with all barriers, one must consider the question of whether criminal activity is being "fenced in" or "fenced out." For example, if crime is committed by criminals from the surrounding community who choose Temple University because it contains many opportunities for crime, then one would expect crime to cluster around the campus boundary since there is no reason to believe a criminal will travel farther than necessary to locate a criminal opportunity. On the other hand, if crime is clustered near the center of campus and declines as one enters the surrounding community, this indicates that most offenders are members of the campus community and the barrier effect of the campus boundary will have little effect on campus crime (although it may decrease crime in the community surrounding the campus.

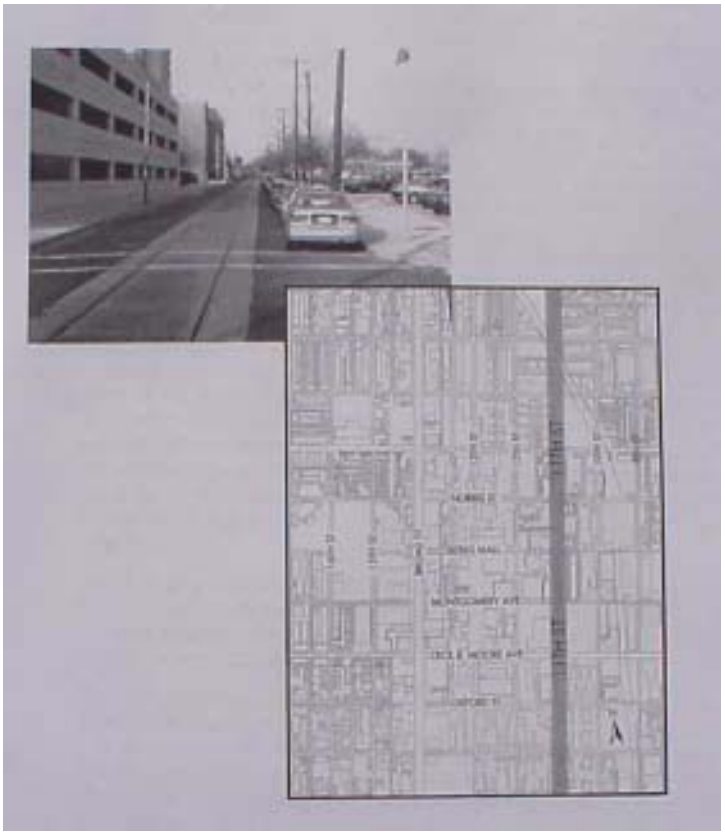
The crime used in the present example is one that is a major problem for college campuses such as Temple University that are largely commuter schools. It is auto vandalism, theft and break-ins. These also are crimes that are especially prevalent at shopping malls and center city districts. Eleventh Street forms the

eastern boundary of Temple University. The following is an example of how to measure the effect of this permeable psychological barrier on criminal activity.

Methodology and Findings:

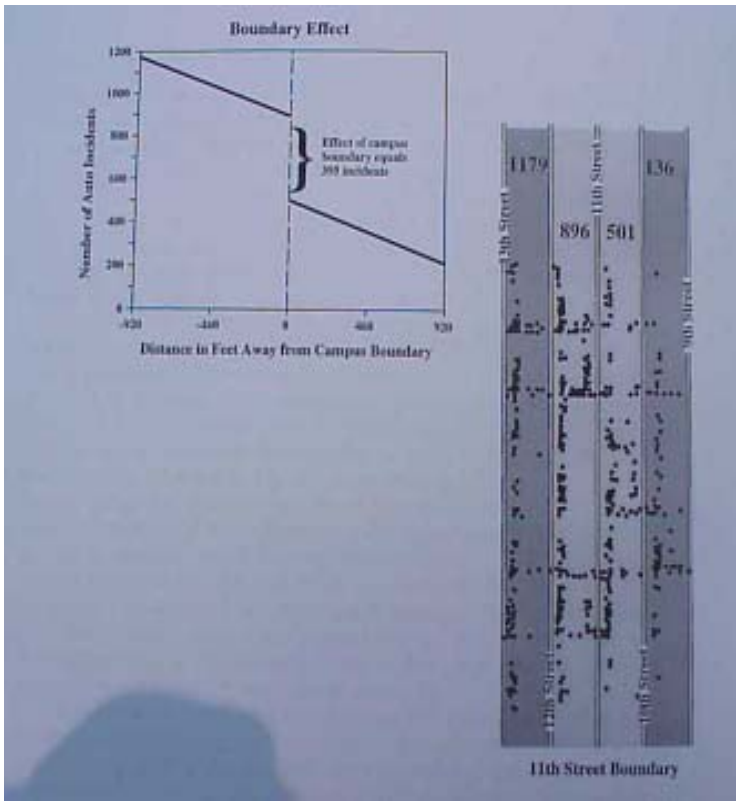
The eastern boundary of Temple University is sharp: east of 11th Street the area is largely residential with row homes scattered among old abandoned factory buildings. To the west of 11th Street is Temple University's main campus of high-rise office buildings, dormitories and classroom buildings. Landscaping changes from the clutter of old row houses and abandoned factory buildings to a neat, clean environment of plantings and formal landscaping. One is keenly aware of passing from one environmental setting to another on crossing 11th Street.

In order to measure the permeable effect of this boundary on criminal activity, a map of the campus is loaded into a geographic information system such as Arc View or Map Info. Buffers are created on each side of 11th Street in order to measure the spatial arrangement of crime on each side of this campus boundary. The number and size of these buffers is left to the discretion of the analyst. In the present case, we constructed buffers about a city block in width (460 feet). A minimum of two buffers must be constructed on each side of the boundary. A buffer was constructed 460 feet east of 11th Street and a second one 460 feet further east or 920 feet from the boundary to examine the campus side of the boundary. Then, two buffers of 460 feet each were constructed on the community side of the campus boundary.



The coverage of the locations of auto theft, break-ins and vandalism for ten years was then over laid on this coverage. The counts of each crime in each buffer are then noted. This provides us with four data points, two on each side of the campus boundary. A least squares (first degree polynomial) line is fitted to these four data points with distance from the boundary on the horizontal axis (independent variable) and the number of crimes (dependent variable) on the vertical axis. At this point, we know the slope of the line and whether it is linear or curvilinear. Recall that if it is curvilinear with crimes clustered about the boundary, it is an indication that members of the surrounding community commit most of the crimes. On the other hand, if the least squares line is linear with most crimes committed near the center of campus, this indicates that most crimes are perpetrated by members of the campus community and decline as one approaches and enters the surrounding community. This assumes that opportunities for crime are uniformly distributed. In the present case, Figure 2 clearly indicates that most of these crimes are committed by members of the campus community and decrease markedly as one crosses the campus boundary into the surrounding community. Therefore, the Department of Public Safety can concentrate on the campus community rather than on members of the surrounding community.

To this point, we still do not have a measure of the effect of the campus boundary on criminal activity. This can be measured either in terms of the number of crimes "absorbed" by the campus boundary, or on the amount of distance the effect of the boundary is equivalent to in the drop-off of crime. The latter measure has the theoretical advantage that the effect of the boundary on different crimes can be compared since we have a common parameter (distance). Since different crimes are more common than others, we cannot compare the number of burglaries absorbed by a barrier with the number of murders absorbed. However, the distance effect of each can be compared.



In order to measure the number of crimes absorbed (barrier effect) of the campus boundary, change the origin point at the campus boundary so the least squares lines (with equal slopes) best fit only those data points on one side or the other of the barrier. The distance these origin points are apart on the vertical axis is the effect of the barrier in terms of how many crimes are deterred (or absorbed) by the barrier. In the present case, the boundary had the effect of absorbing 395 incidents over a ten-year period. However, this measure cannot be used to compare the effect on crimes that are more or less common. In this case, we need a common parameter such as distance.

Distance almost always has the effect of decreasing the number of crimes as it increases. This common phenomenon is termed *distance decay* and can be used to determine whether a barrier has he same effect on all criminals or just those who engage in a particular type of crime. What we wish to determine is the effect of the barrier in terms of adding so much distance to the criminal activity. For example, we might determine that the effect of a barrier is equivalent to adding ten miles to the journey to crime. Or, the crime is as likely to occur on the other side of a barrier as if it were ten miles further away with no barrier effect. That is to say, the effect of the barrier is equivalent to adding ten miles between the location of the criminal and the opportunity for crime.

This common parameter is identified by moving the bottom line (in this case to the right) until it is again a straight-line extension of the top line. The distance the origin point of the bottom line had to be moved is a measure (in terms of distance units) of the permeable effect of the barrier. Thus, the effect of a barrier or boundary on different crimes can be compared since there is a common parameter (distance).

Conclusions:

Security personnel have a common sense that psychological barriers work well to deter some criminal behavior. Whether it is lighting, landscaping or signage, making users aware they are entering a different environment generally changes their activity patterns including criminal activity patterns. The intent is to

deter as much crime as possible by creating spaces that signal deviant behavior will not be tolerated and will be sanctioned by simple disapproval to more formal sanctions.

Although we know through the vast literature on "broken windows" and "defensible space" that psychological barriers are effective, few direct measures of their effect have been identified. In the present case, geographic information systems and simple statistical and graphical methods allow us to measure not only the specific effect in terms of the number of crimes deterred, but also the general effect in terms of the distance decay equivalent of a barrier effect.

The theoretical basis of psychological barriers is rooted in the social psychology and criminology literature on human territoriality (Ashcroft and Scheflen, 1976; Scheflen, 1976; Sommerc 1969; and Taylor, 1988). This base has been extended and applied by Carter and Hill (1979) to examine the psychological barriers that effect specific racial groups in the city. Pettiway (1982) follows this approach to explain why most crime is intra-racial—the boundaries between segregated housing in Milwaukee were psychological barriers to the spatial movement of criminals of either race. Finally, Rossmo (2000) has argued that psychological barriers need to be considered in the geographic profiling of serial offenders. The obvious example is the buffer zone identified about the homes of the offenders that acts as a psychological barrier due to the concern on the part of the offender for recognition and detection in this zone. With the exception of Rengert *et al* (2001) and Rossmo (2000), no analysis has focused specifically on measuring the strength or effectiveness of these psychological barriers on the spatial movement of criminals.

The technique illustrated in this paper has great theoretical implications in terms of measuring the effect of psychological barriers between socioeconomic groups as well as between different land uses in metropolitan regions. For the practitioner, this measure allows one to determine the effect of established boundaries on criminal activity. Fisher (1998) illustrates how this is accomplished with respect to college campuses.

There are several things a crime analyst must keep in mind when measuring a barrier effect. First, the barrier must be functionally defined. As already stated, a particular barrier may have different effects on different types of criminals (lighting on day and night time crime for example). Furthermore, what is an absolute absorbing barrier for an opportunistic amateur criminal may be a permeable or reflecting barrier for a more determined individual (a drug dependent property criminal for example).

Secondly, the methodology described above is designed for analyzing barriers of extensive length. For shorter barriers such as campus boundaries, the analyst must consider that criminals may be entering the area from the top and bottom as well as across the boundary. This can be corrected by dividing the angle of a turn in a barrier (campus boundary in this case) in half and draw a line from the boundary outward to the edge of the area under analysis using this angle (half the angle of the turn in the barrier). Crimes occurring above this line on the top of the map or below this line on the bottom are likely to have been committed by criminals coming in from a different direction rather than crossing the barrier under analysis. In this case, those crimes should be eliminated and crimes per hundred square feet (or other measure) calculated for the remainder of each buffer. Then, the expected crimes from across the boundary (barrier) can be calculated by multiplying the crimes per unit area for the remaining buffered area by the total area in each buffer. Then the analysis proceeds as above.

For crime analysts, future research should focus on what type of psychological barrier works best under which circumstances. The other side of the coin is to identify which are ineffective but makes users feel good because they think they are protected (town watch signs and programs perhaps). Measures to date

have been rather limited such as the decrease in the number of crimes after a fence was built around a public housing project (Newman, 1972), or the proportion of crimes in an area that are intra racial as opposed to inter racial (Pittiway, 1982).

Clearly, all crimes are not affected equally by a boundary. For example, by definition, hate crimes would be predominantly interracial while residential burglaries would tend to be intra racial. We are only beginning to probe the issues that face both crime analysts and the theoretician. In the present case, crime analysts are likely to take the lead and inform the theoreticians rather than the other way around.

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Section-III: Problem-Solving

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Introduction:

This section of the Advanced Crime Mapping Symposium, held in June 2001 and sponsored by the National Law Enforcement and Corrections Technology Center's Crime Mapping and Analysis Program, is entitled Problem Solving, Research, and Evaluation. Notably the words "crime" and/or "mapping" are not in the title of this session as the focus is not on crime mapping itself, but on the broader concept of merging systematic research methodology, data, and analytical techniques with police practice. Although mapping crime is one of many methods of analysis, it is not the primary focus of this section of the symposium as the analysis of geographic data should accompany qualitative and/or quantitative analysis of other variables of crime and law enforcement information. Instead, this section focuses on more general issues such as: the evolving role of analysts; developing research partnerships; employing theory in law enforcement problem solving, research, and evaluation; utilizing multiple and various types of data sources; and applying spatial analytical techniques in problem solving.

As participants in this section, each author presented particular concepts and/or analytical techniques. However, with a topic so broad, the concepts that were discussed were limited in that they were fairly specific with a purpose of providing ideas and techniques for current analysts in a law enforcement setting. Therefore, the articles may not cover a large range of topics, but are comprehensive in what they do cover. The articles in this section cover 1) the evolution of the role of crime analysis in research and problem solving, and the importance of theory in crime analysis, 2) the collection and use of primary qualitative data sources in problem solving research and evaluation, and 3) the use of a geographic information system (GIS) and geographic data to develop problem solving, research, and evaluation measures.

The first article in the section is a preliminary discussion of the evolving role of crime analysis in research and problem solving. It discusses the current trend of crime analysis and includes suggestions for how both law enforcement agencies and researchers can contribute to incorporating formal research and statistical methods thoroughly into the discipline. It also includes a brief discussion of the importance of theory in guiding the use of analytical techniques in crime analysis.

The second article is a discussion of the use of primary data collection to enhance problem solving analysis and assessment. Many police agencies and analysts have begun utilizing alternative secondary data sources such as census data, business information, and school records, but few have conducted primary data collection. This is particularly important as many times data already available do not adequately assist in the detailed analysis or assessment of a problem. This article focuses on providing practical problem solving examples of different types of primary data collection techniques.

The third article provides an example of the use of spatial analysis and GIS for developing and assessing a response to a robbery problem in Baltimore County, Maryland. This article provides specific techniques in the context of a practical problem solving example that can be applied in different situations.

Integrating Systematic Research and Analysis Into Police Practice

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Jamie Price • Assistant Professor, Criminal Justice • Florida Atlantic University

The Evolution of Crime Analysis:

In preliminary findings from a study assessing crime analysis in police agencies with more than 100 officers, Dr. Timothy O'Shea has found that though crime analysts conduct a variety of tasks, much of the focus of crime analysis throughout the country is on tactical crime analysis; that is, on the identification of short term crime trends and patterns. He finds that less time is spent on tasks such as victim analysis, spatial analysis, program evaluation, and long term crime forecasting (O'Shea, 1999). Furthermore, some analysts are called upon to carry out functions that are not crime analysis at all, such as developing a Web site for the police department or answering citizen questions. Seldom is there enough time or staff resources in the crime analysis unit to perform all the analytical, much less non-analytical, functions requested.

These findings suggest that the role of crime analysis is more centered on assisting the investigative function of the police agency rather than conducting analysis or research of larger, long term problems. Herman Goldstein describes problem-solving as a proactive approach to addressing crime and fear in our communities which is in contrast to analyzing individual events or occurrences. Employing in-depth analysis may require collecting information from a variety of sources beyond what is collected by the police department (Goldstein, 1990). Thus, we assert that the role of the analyst in law enforcement is not just to read reports and identify patterns, but also to collect or obtain data and employ research methodology to analyze and inform the response to current crime control problems.

In a recent report that evaluates the last twenty years of problem oriented policing, Mike Scott discusses how, although problem solving and problem oriented policing have been adopted by many police agencies, research and evaluation within law enforcement agencies have not been equally incorporated: "Problem analysis remains the aspect of the concept [problem oriented policing] most in need of improvement" (2000: 7).

Why is this so? Why does crime analysis seem to be more investigative than research oriented? There are many reasons this may be so. The first is that the investigative process is the traditional and most established process of law enforcement. It is most relevant to street level officers who make up the highest number of potential customers for crime analysis. The investigative process focuses on linking recent incidents together in hopes of identifying and/or apprehending the suspect; that is, "catching the bad guy." Thus, conducting investigative analysis elicits more recognition and support for crime analysis and mapping from police officers and management. In contrast, problem solving, research, and evaluation are newer concepts to law enforcement, and there may be less knowledge or support of the concept throughout a particular agency because, unlike tactical crime analysis, its benefits may not be immediately apparent. In addition, problem solving attempts to get at the root of a problem in order to develop a solution which oftentimes is a much more ambiguous and difficult process than identifying and "catching the bad guy."

Time may be another significant reason for the emphasis on investigative analysis in crime analysis. Law enforcement has been traditionally reactive to issues and problems and has been required by a community, even our entire society, to react quickly. The investigative process, compared to the research or the problem solving process, occurs very rapidly. The investigative information is compiled and analyzed daily to produce patterns that can be acted upon as soon as they are identified and disseminated. Task forces seem to be created and disbanded in the time it would take to conduct the first step of the problem solving process. On the other hand, problem solving, research, and evaluation all require time–time to determine the problem at hand, time to analyze the problem, time to respond, and time to evaluate the response. Oftentimes, this takes a year or more which could be considered an eternity in the culture of police response and action.

Another reason is that the skills of the analysts are oftentimes more suited to conducting investigative analysis. Many analysts have been or are officers or have worked in the law enforcement setting, particularly in patrol and investigations, for a long period of time. They often do not have formal research methodology, program evaluation, or statistical backgrounds that would enable them to conduct research and evaluation more effectively. Additionally, analysts are often required to conduct data entry and create lists of incidents or simple reports, which, in reality, is not analysis at all.

One solution to these issues is for police agencies to look to the research community for assistance in various ways. Because problem solving approaches involve broad inquiry into the nature of particular problems, crime analysts should attempt to gain more widespread participation in their research and problem solving endeavors. Law enforcement agencies and their crime analysts need to acknowledge the possibility of extending this activity to the broader community such as university scholars, research organizations, and relevant community groups. Without partnerships, external concerns and insights could be overlooked or misrepresented.

However, there are problems to overcome before involving the research community. Mike Scott states in his report:

> Some police officials are impatient with extensive research, preferring to work on smaller-scale problems with rudimentary research than to wait for more sophisticated research to shed new light on larger problems. Researchers, for their part sometimes find it difficult to make the transition from pure social science research methods to the action research called for in problem-oriented policing. Criminology and related criminal justice sciences have been slow or reluctant to substantively engage in problem-oriented policing (35).

In addition, Scott states that many academic researchers do not have practical problem oriented policing experience. Thus, police agencies have difficulty finding assistance for smaller, more immediate research projects even if they do seek it, and furthermore, police agencies are less likely to see the relevance of abstract criminological ideas in their everyday work.

Closing the gap between law enforcement and research is important for an effective use of problem solving, research, and evaluation, and crime mapping in law enforcement agencies as both law enforcement and researchers can help and learn from one another. There are ways in which law enforcement agencies and researchers can help to close this gap. The first, and the most important, is to ensure that crime analysts or other analysts in the police agencies have the necessary skills to conduct quality problem solving and evaluation. Police agencies can encourage current crime analysts to obtain more formal research and statistical skills through college classes, training, and individual initiative, or they can hire individuals with formal

research and statistical skills, who will, by being in the agency everyday, apply their skills in the practical setting. The second is that police agencies can allow researchers to conduct studies in the department, yet insist that they work with analysts or other police personnel. In other words, they conduct research "with" the police agency, not conduct research "on" or "for" the police agency.

Correspondingly, research organizations can offer their services to police agencies for short term projects that, although they may not answer large theoretical questions, may foster relationships in which the police agency and researcher learn from one another and which may develop into a larger undertaking. In addition, research and teaching organizations can offer classes on practical research and evaluation for law enforcement practitioners as well as traditional college students. In addition to learning the concepts and examples in class, this would create relationships among instructors, students, and practitioners in which they work together and consult one another. These classes could be a networking opportunity for students who want to participate in internships, for practitioners who need assistance from researchers, and for researchers to develop practical research forums.

The Importance of Theory:

As crime analysts and other law enforcement analysts bring research methodology and statistics into their work, it is important that this work all be guided by criminological theory. Thus, developing knowledge about research and statistical methods should be accompanied by knowledge of the application of criminological theory to everyday crime problems. According to John Eck, "the more explicit and precise analysts can state their expectations, the greater the ability to interpret what is observed from crime maps and/or analysis" (Eck, 1995). Theory is important in structuring research questions and developing analytical techniques that can ultimately help in developing policy. Theory not only helps to structure questions and techniques, but it can also change how we interpret the data. Unfortunately, crime analysis and mapping are often employed without a theoretical context.

To use crime mapping as a specific example, there are many statistical techniques used in spatial analysis in various disciplines such as geography, environmental analysis, topography, demography, etc. Similar to how social sciences have borrowed from hard sciences, crime mapping has borrowed software as well as spatial analytical and statistical techniques from these other disciplines. However, borrowing techniques from another discipline does not always mean those techniques will provide results that make sense in a law enforcement setting. For example, there is a spatial statistic that computes the mean bearing in a sequence of events. A line is drawn in order of sequence between each location of a pre-identified series of events. Each of those lines has an angle of bearing. The software takes all of these angles, computes the mean, and draws it on the map. Although this result may be relevant to determining movement patterns of Caribou in Alaska, what does this tell us about the identified commercial burglary pattern? Although such a map may be both visually appealing and complex, how is it relevant for officers on the street?

The point of this example is to show that although a technique is available in a software package and used by other disciplines, that does not mean it is relevant with crime data if there is no theory on which to base the results. Thus, theory can help us answer these questions, even though, in some cases, the answer may in fact be that the results tell us nothing.

Conclusion:

These are just a few examples that show the importance of theory in structuring how and when we use particular crime analysis and crime mapping techniques in law enforcement. This article has only briefly addressed the issues of the role of the crime analysis in research and problem solving and the use of theory in crime analysis. The goal of this article is to begin a dialogue and focus attention on the issues of incorporating formal research methodology and theory into law enforcement as they are important to the success of police agencies and crime analysis.

Although we advocate that current crime analysts obtain the necessary skills to do this type of work, we recognize that some departments have and will create positions separate from the crime analyst, in some cases called a "research analyst" or "problem analyst." This is an appropriate solution to bringing formal research and statistical skills into a police department. However, this may not be realistic for the large number of medium to small departments as their staffing levels may not permit more than one "analyst" in the department. Thus, it is important that all individuals conducting analysis, no matter their job titles and focus, obtain knowledge of criminological theory, formal research methodology, and statistical skills, so that crime analysis is conducted in all departments as "the systematic study of crime," not just "identifying short term patterns," "bean counting," or "making cool maps."

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Primary Data Collection: A Problem-Solving Necessity

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Introduction:

Quite frequently, quantitative analysis of crime and calls for service data serves as the basis of inquiries into crime and disorder problems. While these data sources can be highly informative, they typically do not provide a comprehensive picture of the nature of a problem, but rather a limited snapshot of the specific locations, dates, and times when police attention is drawn to it. In order to conduct a thorough problem analysis and evaluation, many law enforcement professionals have come to rely on a number of other data sources and analysis methodologies.

In addition to traditional law enforcement data sources, problem-solvers have made use of non-traditional secondary data sources such as school attendance logs, public transportation routes, demographic information, tax records, local laws, and Alcoholic Beverage Commission (ABC) records, among others. Law enforcement agencies across the country are forming collaborative problem-solving partnerships with agencies such as probation/parole, housing, schools, courts, neighborhood and business associations, and universities and research organizations. These types of strategic partnerships, encompassing many stakeholders, are much more likely to provide useful data on the focus problem and meet with success than those based solely on the data and efforts of one agency.

Efforts to incorporate a wide variety of secondary data sources and stakeholders into the problem-solving process, exemplified by Department of Justice programs such as the Strategic Approaches to Community Safety Initiative (SACSI) and Community Mapping, Planning, and Analysis for Safety Strategies (COMPASS), have met with success. Through the support of agencies such as the Office of Community Oriented Policing (COPS) and the National Institute of Justice (NIJ), problem-solving efforts around the country are becoming more sophisticated and as a result, more successful.

While secondary data sources have proven to be extremely useful for providing another perspective on a crime or disorder problem, they, too, have their limitations. For example, school data on truancy rates can identify which students are most likely to cut school, but may not shed light on why they do not attend school or where they go when they are truant. Similarly, transportation records can be used to determine how many people use a particular bus stop, but not what safety concerns they may have when using that stop or which stops they avoid out of fear.

In order to answer the “who, what, when, where, how, why, and why not” questions raised during the analysis phase of a problem-solving effort, it is almost always necessary to collect original data. Also known as primary data, this type of information is collected directly from an individual or a location by a police officer, crime analyst, or others involved in a problem-solving project. Original data sources may be crime victims; suspects or offenders; interested third parties, such as residents living in a target area; social service providers; or any other people who can shed light on a problem. Original data sources may also be the locations themselves.

In a law enforcement environment, primary data can be collected through various means, including interviews, surveys, focus groups, and field or observational research. These methods of research typically produce qualitative results, in that they result in non-numerical data that the researcher must then interpret to look for underlying patterns and meanings.

The second section of this article describes several methods that law enforcement professionals have used to collect primary data. The following examples have been drawn from the authors' professional experience as well as from examples of high quality problem-solving efforts recognized by the Herman Goldstein Award for Excellence in Problem-Oriented Policing. The Herman Goldstein Award recognizes outstanding problem-solving efforts, both in the United States and abroad, that employ innovative methods to successfully reduce selected crime and disorder problems (for more information about this award, please see www.policeforum.org).

Primary data collection is often integral to the success of these specific problem-solving efforts and, one might argue, essential to the success of problem-oriented policing in general. In fact, a review of recent Herman Goldstein Award winners and finalists reveals that almost every honoree employed some method of primary data collection to gain a comprehensive understanding of the selected crime and disorder problem.

Primary Data Collection Examples:

Interviews:

To analyze a prostitution problem, problem solvers in Buffalo (NY) conducted 15 in-depth interviews of prostitutes and 116 surveys of johns. From these discussions, they learned two key facts: that the possibility of arrest was the major deterrent to solicitation for johns, but not much of a deterrent for prostitutes themselves, many of whom expressed relief upon arrest[1] because it gave them a chance to rest and stay off drugs. Although these findings were not surprising, they were critical to garnering community support for the interventions. Staff working with the police department subsequently interviewed residents who were concerned about prostitution and informed them of their findings from the interviews with prostitutes and johns. Based on that information, Buffalo community members expressed support for increased john enforcement, as well as increased drug treatment and court options for prostitutes. After implementing these and other responses, the Buffalo Police Department, a 2001 Herman Goldstein Award Finalist, was able to reduce prostitution-related calls for service by more than 60 percent over a 3-year period. The interviews with the prostitutes also provided police with important information about the operation of the prostitution and related drug markets in Buffalo. "They were a wealth of knowledge for us," said Lt. Patrick Roberts.

It should be noted that interviews that can provide helpful information on crime problems are not limited to victims, offenders, and residents. For example, maids and property managers at a problem motel could be interviewed to determine their perspective on a drug-dealing problem on the premises and gain information on business practices that may contribute to the problem. Social service providers could be interviewed about their specific expertise in addressing a focus population. Police officers themselves are often some of the best sources of information about the nature of a problem and the kinds of responses that might be most effective. Virtually any individual who has knowledge of or a vested interest in a particular problem can provide useful information on it.

Surveys:

Problem-solvers in agencies across the country have used surveys in a wide variety of ways to shed light on crime and disorder problems. Most frequently, police officers, crime analysts and community members have made use of two types of instruments: environmental surveys and victimization surveys.

Environmental Surveys: Qualitative assessment of the physical features and management of high crime locations has proven to be a valuable analytical strategy. This process is based on several concepts, including situational crime prevention, which involves blocking crime opportunities specific to certain times and places, and the concept of Crime Prevention Through Environmental Design (CPTED). CPTED is a prevention strategy organized around the principle that proper design and effective management of the physical environment of business areas, residential neighborhoods, parking lots, and other public and private spaces can prevent crime. CPTED maintains that physical features such as lighting, proper maintenance, access control, and natural surveillance are essential to effective crime prevention. (For more information on CPTED, please see www.cpted.net and www.ojp.usdoj.gov/nij; for more information on situational crime prevention, see *Situational Crime Prevention: Successful Case Studies* by Ronald V. Clarke, 1997.)

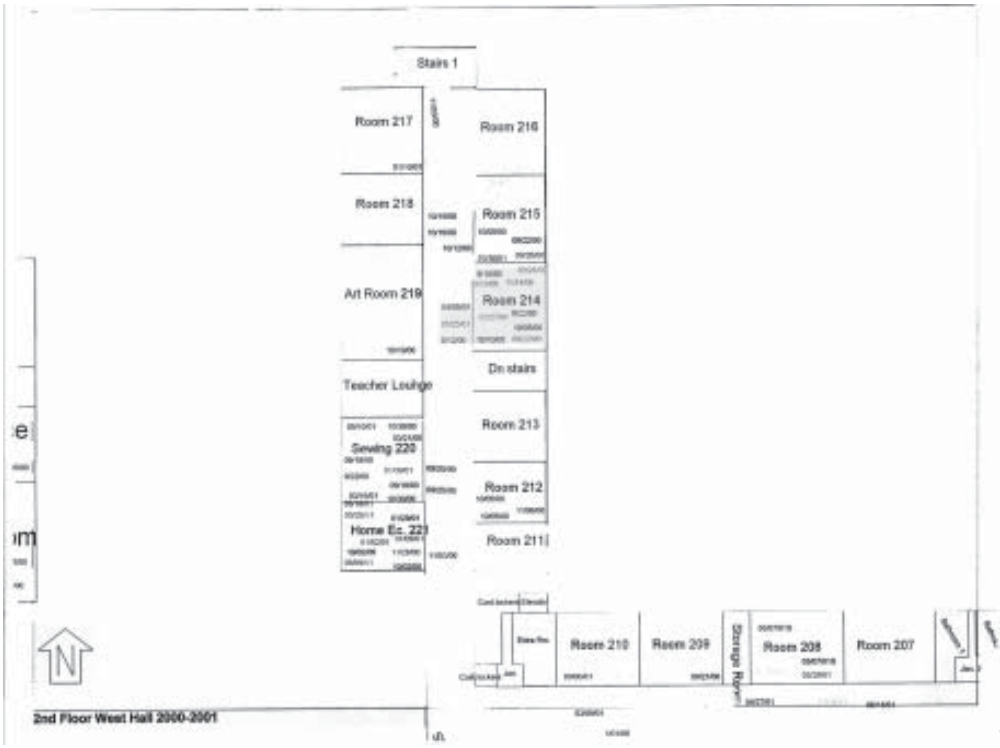
Observation of environmental characteristics at high crime locations, or even high accident areas, can prove to be very informative. The California Highway Patrol (CHP), winner of the 2001 Herman Goldstein Award, used this technique with much success. After identifying a deadly rural stretch of roads connecting two interstate highways near San Luis Obispo, a 31-member CHP task force boarded a bus and spent five hours personally inspecting 20 miles of roadway. The bus stopped about once a mile so that task force members could get out and assess various environmental factors that could affect road safety, including passing lines, shoulder problems, lighting, curvatures in the road, glare, fog, and signage. One of the key recommendations of the task force that came about as a result of the road survey was to adopt a 24-hour "headlights on" policy on the problem roadways. That policy "played a significant role in our success," said Joe Farrow, Assistant Commissioner of the CHP. This particular problem-solving initiative reduced traffic fatalities by 35 percent on the target roads.

Victimization Surveys: These types of data collection tools have provided problem-solvers with a great deal of information regarding the extent and nature of victimization. Because the rates of crime reporting are frequently so low (only 56 percent of robbery victims report being victimized to the police, for example), victimization surveys can provide a more accurate picture of the incidence of a problem. Victimization surveys can also provide valuable insight into why a particular person or target was selected. To better understand why some homes were "successfully" burglarized when others were only the site of burglary attempts, the Chula Vista (CA) Police Department surveyed victims to determine what security measures were in place at the time of burglaries (both completed and attempted break-ins) and contrasted the two scenarios. Using this approach, Chula Vista, a 2001 Herman Goldstein Award Finalist, was able to determine the relative effectiveness of the various security measures.

From the victim interviews, the problem-solving team identified vulnerable points and methods of entry. For example, victims reported that in 87 percent of the break-ins that occurred when intruders defeated locked doors with tools such as screwdrivers or crowbars, burglars targeted "the one door that had no deadbolt lock." Victim reports also indicated that burglars had an easier time entering through sliding glass doors that did not have channel locks or slide bolts. Another major finding from the victim interviews was that windows with simple stock latches were easily pried open, whereas those with locks were not. Perhaps the most important finding from the victim interviews was that not one burglar attempted to break a double-

pane window during the course of a successful or attempted burglary. As a result of these findings, Chula Vista negotiated with the five major home developers poised to construct 30,000 new homes in the city to shore up vulnerable points of entry in every home built in Chula Vista after February 1999. Since these responses were implemented, residential burglary has declined by 43 percent.

Other types of victimization or victim behavior surveys use objects rather than people as the units of measurement. For example, vehicle security surveys, conducted at high frequency locations for auto theft and/or theft from vehicle, can indicate whether or not motorists are employing adequate safeguards to prevent vehicle crime. A vehicle security survey involves a visual inspection of parked vehicles to look for the presence of unsecured doors and windows, valuables in view, and visible anti-theft measures such as a steering wheel lock or car alarm. By surveying all vehicles, or merely a sample of cars at problem locations for vehicle crime, the surveyors can determine whether or not victim behavior may contribute to the problem. Rather than relying on property sheets and incident reports to inform their understanding of the vehicle crime problem, the surveyors can determine why vehicle crime is a problem at certain locations. This information can also inform response efforts, as it may be necessary to implement educational efforts at parking lots where surveyors record a high percentage of unsecured vehicles or visible valuables.



Focus Groups:

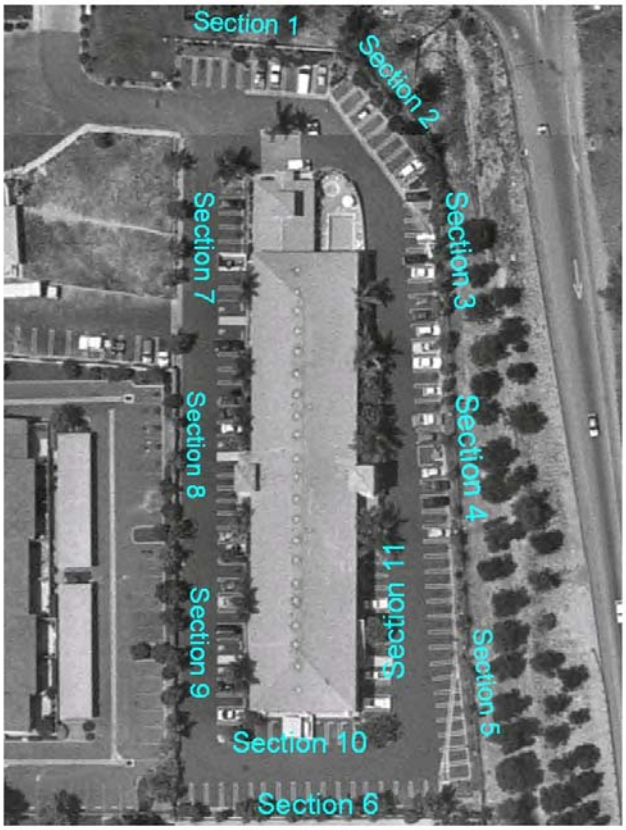
Focus groups, which can be used to elicit in-depth information from a key group of people, have also provided critical information to problem solvers. The South Euclid (OH) Police Department, a 2001 Herman Goldstein Award Finalist, conducted focus groups of students to determine if they felt unsafe at school, and if so, in what locations and at what times. Information from the focus groups identified hallways and class change times as high-risk places and periods for bullying, the focus problem of the initiative. Like many good problem-solvers, the South Euclid team corroborated their findings from focus groups with student surveys and maps of bullying incidents, which pinpointed the locations of hallway bullying incidents (see map below, which captures bullying hotspots by date of incident).

Based on these findings, class change times were staggered, and teachers worked in teams to increase hallway monitoring. As a result of these and other measures, South Euclid was able to achieve a 60 percent reduction in bullying in hallways.

Observational Research:

At times, the only way to find out information about a crime or disorder problem is to watch and record information about what can actually be seen or visually verified. A motel problem in Chula Vista provides a good example of why observational research may be necessary to get a handle on the nature of certain problems.

Calls for service to motels in Chula Vista indicate that the most frequent call type is the "disturbance" call. A catchall category, disturbances can range from a public argument, to loud music, to a person behaving irrationally on the street. Although disturbances were the number one type of call being received about motels in 2000, police officers believed that more serious problems, such as drug dealing, were commonplace. As might be expected, Computer Aided Dispatch (CAD) records did not reflect these perceptions, because neither guests nor motel clerks tended to call the police about drug dealing.



Three motel surveillance efforts at separate properties over a period of three to five hours each confirmed the existence of drug dealing and use at the motels. The orthophoto map (left) of one Chula Vista motel was used to track where guests tended to park, where pedestrians congregated, and which sections of the hotel were most active.

These observations also documented the wide variations in the types of guest behavior at the motels. One mid-range property that was thought to have serious problems only had one drug-dealing guest at the time of the observation; the vast majority of guests appeared to be either tourists or business people. In contrast, at one of the worst properties in the city, guests routinely left their doors wide open. Pedestrian traffic onto the property was extremely frequent compared to other motels, and visitors on foot rarely stayed on the property more than a few minutes. The motel observations, which are still in progress, underscored that each property and guest make-up is different; as such, each will require different interventions. A broad "disturbance" intervention would not be appropriate or effective.

Pathway and/or neighborhood analysis are additional examples of how observational research can inform problem-solving efforts. Pathway analysis refers to observation of the physical characteristics and the types of activity that occur along pedestrian pathways. For example, as students travel to and from school, they use a variety of informal pathways (e.g., through parks and/or parking lots) that are not captured with a traditional street map. By determining where these pathways are and observing the types of activity that occur there, police and school officials can analyze student offender and victimization patterns along these specific routes.

The aerial photograph (right) depicts observed student pathways around a school (red lines) along with the street network (yellow lines). The use of aerial photographs to illustrate the pathways allows for a much more detailed analysis; note that the students appear to cut through a park area that does not appear on an ordinary center-line street map.

Neighborhood analysis can include conducting observation at a given location at different times of day. For example, pedestrian activity in the downtown area may vary considerably over the course of a single day. In the morning and afternoon hours, downtown streets may be filled with commuter traffic, lending a feeling of "safety in numbers" to pedestrians in the area. In the evening, commuter traffic may give way to families and individuals visiting downtown events, restaurants, or retail centers. However, pedestrian traffic and activity during the late night hours may change considerably as bars and businesses close and fewer people are on the streets; further, the types of people who are out in the late evening may be more prone to criminal activity. As these examples demonstrate, first-hand knowledge of an area and observation of the different activities that take place there can be a useful supplement to an analysis of calls for service and crime data.

Conclusion:

We present these examples to illustrate the potential utility of primary data collection for understanding and responding to persistent crime and disorder problems. While it may not be feasible for a law enforcement agency to collect extensive primary data for every problem-solving effort, readers may find that collecting these data on even an ad-hoc basis will ultimately serve to better inform their knowledge of the problem. For example, a quick visit to a frequently targeted ATM machine may indicate that environmental factors such as poor lighting and inadequate maintenance make the location an attractive crime target. If additional research assistance is needed to analyze a particular problem, a local university may be able to provide the necessary support without draining police department resources.

The purpose of this article is to demonstrate how law enforcement professionals have used primary data to achieve a reduction in problems as diverse as prostitution, school bullying, residential burglary, and highway traffic accidents. It is our hope that, from these examples, readers may derive information that will be applicable their own agencies and will be encouraged to employ primary data collection as part of their future problem-solving efforts.

End Notes:

[1] Long sentences stemming from arrest (15 to 90 days) were found to be deterrents to prostitutes, but several days in jail was not.

Using Geographic Information Systems for Problem Solving Research

Phil Canter • Crime Analyst Supervisor & Chief Statistician • Baltimore County Police Department

Introduction:

Police have long recognized that some communities experience rates of crime higher than the general population. These high crime communities are often referred to as "hot spots" or "hot areas." The use and validity of methods used to identify high crime communities has received considerable attention and discussion. Methods include computing counts and rates for polygons corresponding to community boundaries, proportionate circles associated with point locations, density measures such as kernel smoothing, and distance measures including nearest neighbor analysis, spatial autocorrelation, and k-means.

There are advantages and disadvantages associated with any method used to identify hot spot areas. One issue concerns the use of point locations exclusive of other possible factors such as land use or population that may be influencing crime and the identification of high crime areas. It is suggested that geographical information systems (GIS) could be used to introduce for consideration additional information contributing to high crime areas. It is further suggested that similar methods could be used to establish control or comparison groups needed to evaluate the effectiveness of crime control strategies. In effect, the use of GIS for problem solving is important in the research process.

Background:

The use of GIS in policing typically has two broad applications. The first application, tactical crime analysis, is used to map recent criminal incidents and related information for the purpose of identifying a crime problem for interdiction or prevention. The objective in tactical crime analysis is to quickly and accurately identify and communicate a crime problem to the appropriate responding units. Tactical crime analysis generally involves identifying a crime pattern or series depending on spatial-temporal elements and event characteristics. A GIS is effective in displaying incident locations over time, or case attributes suggesting commonality in target, offender, or victim. Spatial statistics can be used in GIS to identify areas with high concentrations of crime, or areas defining an offender's activity space. A GIS can be used to introduce information from other sources to improve an analyst's ability to associate crime with other factors. Examples include relating sex offenses to a registered sex offender database, or street robberies occurring in proximity to transit stations.

The second GIS application in policing is strategic planning and analysis. Examples include redistricting, response time analysis, crime prevention programs, community policing, and problem solving. Strategic applications in GIS can involve the use of geographic data from a variety of sources depending on the program objective. Redistricting studies, for example, may want to consider elementary school zones, land use, community boundaries, barriers to movement, and officer workload to aid in the redesign of police posts. Although uses of GIS in policing are varied, it is generally agreed that the technology has many benefits.

Since most information has a geographic component, GIS for problem solving is particularly useful for SARA modeling and research. The scanning phase of SARA is used to identify a problem based on a

review of data and information collected for a particular location or type of area. Data analysis, which can be qualitative or quantitative, is performed on data for a study area having tangible boundaries. Examples may include the amount of drug activity on a street corner, or number of crimes committed by juveniles within one-half mile radius around a local high school. The methods of response include actions taken to address the identified problem. The assessment phase of SARA is used to determine outcomes and effectiveness of the implemented responses. A GIS can be used to determine whether a crime problem was displaced, reduced, or unchanged within a target area.

Using GIS for Problem Solving and Research:

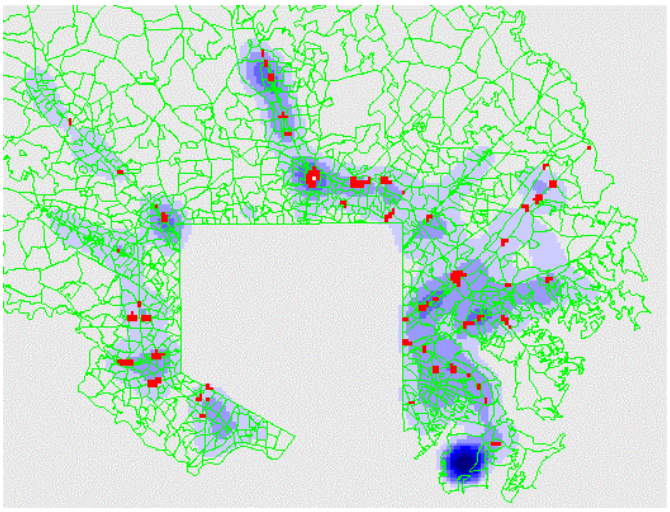
Our example using GIS for problem solving and research was in response to increases in robberies and crime in commercial areas in Baltimore County. Robberies in Baltimore County had increased by 45% between 1990 and 1997. By 1997, robberies were the highest reported in the county. To place the robbery problem in perspective, the 1997 robbery rate in Baltimore County was 343 per 100,000 residents, 11 times higher that rates reported for suburban counties nationwide. Most important, businesses were complaining about high robbery rates. Some businesses, discouraged by a perceived increase in crime, indicated they might relocate to "safer" areas of the county, or to other jurisdictions.

The scanning phase of the SARA model determined that commercial robberies were a problem in Baltimore County. Significant increases were reported in convenience store, commercial house, and highway robberies. It is significant to note that commercial uses make up 2.1% of the county's land area, yet 47.5% of all reported robberies in the county occurred in these areas. Commercial robberies also tend to occur during the afternoon and evening hours, with 72% of reported cases occurring between 1 PM and midnight.

Analysts mapped three years (1995-1997) of crime countywide. Incident records were obtained from the department's tactical crime analysis database. Three crime types, motor vehicle theft, robbery, and burglary, were geocoded and mapped. A total of 43,015 incidents were mapped and compared against land use information obtained from the county's Office of Planning.

Neighborhood Statistic Map and Density Themes

Commercial Uses (Blue) and Commercial Crime (Red)



Since a significant number of robberies were occurring in commercial areas, a GIS was used to identify areas having the highest concentration of commercial crime. Point locations corresponding to robberies geocoded by street address can be used to identify high crime density areas. Several methods can be used by a GIS to identify high crime areas, including kernel smoothing and various clustering techniques such as nearest neighbor hierarchical clustering and k-means. To further define commercial areas targeted for interdiction strategies, a GIS was used to identify areas having the highest concentration of commercial crime *and* commercial activity. The same method used to identify high crime density areas, kernel smoothing, was used to identify districts having the highest concentrations of

commercial activity. In the latter example, the centroids of building footprints were used to identify high density commercial activity. The rationale behind identifying high density commercial districts was based on the possibility that these locations would be potential targets for commercial crime. Furthermore, since the proposed strategy to reduce commercial crime included intensive patrols and outreach, it was believed high density commercial districts would afford the highest amount of patrol coverage.

The department believed that commercial crimes could be reduced by placing additional police resources in high crime areas. The high crime commercial districts were designated as Business Patrol Initiative (BPI) areas. A total of 40 police officers working two 8-hour shifts were to be assigned to BPI target areas. The BPI officers would monitor crime data and trends in their responsible areas, implement a full range of enforcement strategies, build partnerships with business owners and employees, employ "Stop, Walk, and Talk" strategies to develop cooperative relationships with commercial establishments, and coordinate prevention efforts such as Business Watch, and CPTED.

County zoning parcels were used to identify commercial districts. There are 39 zoning codes in Baltimore County and 19 different commercial zones. A new classification field was added to the zoning shape file by using ArcView's dissolve feature to consolidate 39 zoning codes into 6 broad categories: business, residential, manufacturing, office, resource conservation, and high rise residential . The 43,015 incidents were merged and queried with the new zoning shape file to identify crime incident records for all locations within commercial districts. As a result, a new shape file for all crime occurring in commercial districts (n=9,317) was created for subsequent analysis.

Analysts were interested in introducing an opportunity measure to crime occurring in commercial districts. The opportunity measure, defined as the number of commercial buildings in police reporting areas, would be helpful in identifying similar commercial districts not designated as a BPI area. Analysts could use these commercial areas as a comparison group to assess the impact of the BPI program. Two themes, buildings

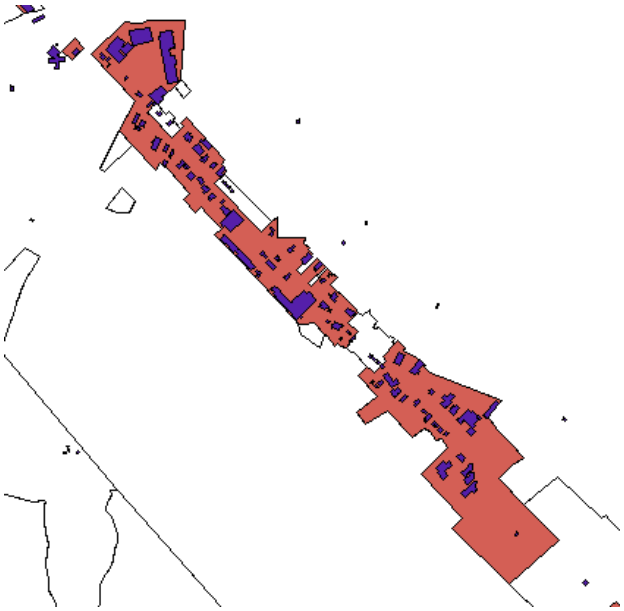
Commercial Districts

Before Dissolving

After Dissolving

and reporting areas, were put together using ArcView's geoprocessing union feature. Each building footprint had a reporting area id attached to the record, allowing the number of buildings to be totaled for each police reporting area. A density map of commercial districts weighted by number of buildings was used to identify commercial activity.

Commercial Use Buildings

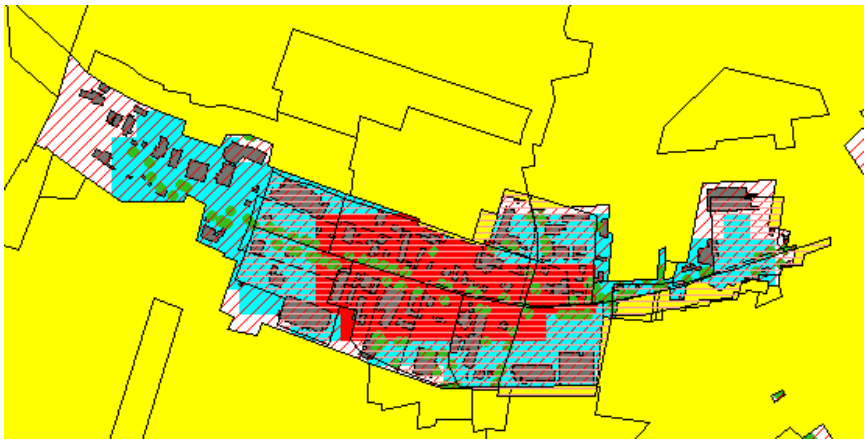


Two maps were now available to assist in identifying BPI areas: high commercial crime density map, and high density commercial activity map. Analysts recognized a need to refine existing police reporting areas to better correspond to the high density crime and commercial activity maps. Several large scale map themes and images such as zoning, planimetrics, and aerial photographs were used in conjunction with the density maps to define BPI areas. Patrol officers were subsequently placed in the identified BPI areas.

Research Design:

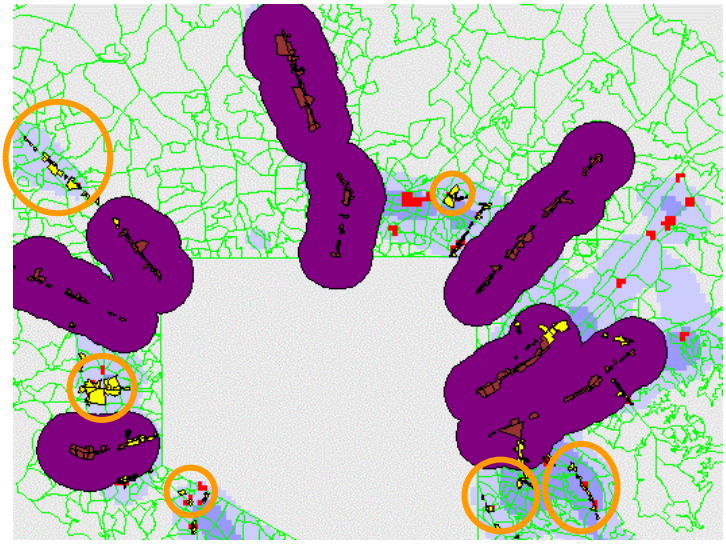
The final phase of the SARA model requires assessing outcomes associated with the response phase of the problem. Specifically, did additional police presence in high crime commercial districts impact crime? The question appears to be easily answered, but in fact there are many variables that can influence the number and location of crime. The presence of additional police in high commercial crime areas can not be assumed to be the only variable influencing crime; the model is overly simplistic. The research design needed to provide meaningful information about the impact of BPI officers on commercial crime will need to be carefully considered. A GIS, however, can be used to assist in identifying comparison and control groups for further analysis.

Composite Map Themes Used to Define BPI Areas



A meaningful assessment of the response used to mitigate commercial crime involves two groups: one group receiving the treatment, and the second group serving as either a comparison or control group. The comparison and control groups should be similar or comparable in character to the treatment group. The type of research design determines whether a treatment group is examined relative to a comparison or control group. The

Identifying Areas for Comparison Group



treatment group, BPI areas, consists of high crime-high commercial activity districts identified by a kernel smoothing density map. The same method is used to identify high crime-high commercial activity districts not designated as BPI areas. The non-BPI areas would serve as a comparison or control group. The difference in determining a comparison from a control group is that the later is used in an experimental design. The experimental design randomly assigns high crime-high commercial activity districts to each group, treatment and control. The comparison group is used in a quasi-experimental design where random assignment of treatments to each group is not done.

One concern in identifying comparison and control groups is possible contaminating effects from neighboring or contiguous treatment areas. Since commercial crimes occur along major highways it is possible that a BPI area would be located in close proximity to a non-BPI district. To minimize possible contaminating effects

of the treatment strategy in non-treatment areas, a GIS is used to select non-treatment areas located outside of a one-mile buffer around BPI districts. The comparison or control groups can then be further defined based on information obtained from other map sources, i.e. zoning, tax parcels, building footprints, and aerial photographs.

Conclusion:

A GIS can be useful for problem-solving and research. It is particularly relevant in all phases of the SARA model. It is suggested that a research process be used in the SARA assessment phase to assist in developing a research design. A GIS can be used to identify treatment and non-treatment areas needed to assess impact strategies. The introduction of geographic information influencing the occurrence and location of crime can also be used to identify groups.

Section-IV: Resource Allocation & Acquisition

Noah Fritz • Director • Crime Mapping & Analysis Program (NLECTC)

Introduction:

While focusing on issues of determining appropriate levels of human and material resources, and when and where they are to be deployed, appears to be "boring" or "not what good policing is made of," it is in fact the a priori issue that makes all other forms of police work, including crime analysis, possible. As one of our authors, Dale Harris, so eloquently points out in his title: You Can't Fight Crime If You Don't Have The Time. This is the very essence of what this chapter is about. Issues evolving around resource allocation, human and material resource acquisition, redistricting and forecasting spatial and temporal manpower needs have a primary role because without efficient patrol strengths and accurate schedules, the other elements discussed in this manuscript become secondary if time is unavailable to perform the critical tasks of crime series/investigative analysis, problem solving, and discrete site assessments. Unfortunately, most police managers do not pay close enough attention to this anomaly. This view is equally held by crime analysts, as was evident by one symposium participant's comment: "How could anybody spend two days talking about resource allocation?"

Almost every crime analyst can attest to the fact that it is very difficult to be effective or thorough if you are too overwhelmed with countless tasks or busy work. This is true for sworn personnel as well, especially patrol officers. If we expect our agencies to utilize crime series/investigative products or problem solving inquiries, we must first address the most fundamental question an agency has: How many officers do we need to police our jurisdiction? When and where should these officers be deployed to be most effective? These are clearly key questions for strategic crime analysis to address, and it is within this section that we pose these questions and offer a beginning dialog about the issues and concerns about current techniques and practices surrounding resource allocation.

Our first article addresses these most basic of questions, entitled *You Can't Fight Crime If You Don't Have The Time* by Dale Harris. Mr. Harris offers a distinct overview and critical assessment of why resource allocation is critical to successful policing and lays out in its most basic form the importance of spatial and temporal inquiry. In a clear and concise way, Mr. Harris tells us about the myths of patrol management, offers insight into the information needs to address these shortcomings, and describes in layman terms the necessary components for determining the geographic deployment and the scheduling of patrol officer resources.

Our second article focuses on the history and longevity of automated resource allocation models, with particular attention to one of the most popular models in use within the public safety community. In our second piece, entitled: *Management of Police Planning Tools: Lessons from the Field*, our author, William W. Stenzel, draws upon his familiarity with the implementation and use of the Police Allocation Manual (PAM). He identifies and discusses key elements that have contributed to the successful use of the procedure. Mr. Stenzel raises a number of critical questions that focus on how and why the model has succeeded in some agencies and not in others. Any agency willing to address the caveats offered in this piece will be much more prepared to succeed in their efforts to determine appropriate staffing levels and produce efficient schedules.

Our third piece is evidence that an agency can address the aforementioned caveats in a practical and operational setting. Paul Bentley, a seasoned analyst who has focused his efforts over the last decade on resolving resource allocation dilemmas for Scottsdale and Tempe (AZ) Police Departments, brings us his professional hands-on experience in addressing our key questions in his article: *Putting Patrol Allocation, Deployment, and Scheduling to the Test, A Case Study*. Mr. Bentley walks us through the process for determining how many officers are needed to meet citizen's demand for police service within one agency. He shares with us the lessons learned regarding (a) data sources and data integrity, (b) patrol allocation factors and formulas, (c) the importance of policy decisions effecting patrol allocation results, and (d) the impact different models can have on the outcome. Mr. Bentley offers a birds-eye view of the detail and idiosyncrasies that present themselves when an analysts is required to perform resource allocation studies.

Our final article directs us toward a broader perspective when considering resource allocation, particularly in regard to detecting change and making predictions about criminal activity within and around a given jurisdiction. Keith Harries offers his more abstract point of view in his article entitled: *Change Detection And Prediction: Issues In Crime Analysis And Resource Allocation*. Mr. Harries offers a critical discussion about a term he calls "jurisdictional fragmentation" and the consequences it has on detecting and predicting change. The five independent issues he addresses are: (1) the consequences of intra-metropolitan variation in crime, (2) the impact of jurisdictional fragmentation, (3) issues relating specifically to boundaries, (4) detection of demographic change and its implications, and, finally, (5) the need for data integration. Mr. Harries' piece calls for us to consider the consequences of a fragmented government, concomitant boundary and demographic conditions, and the lack of data availability, data sharing and its integrity. He boldly states that the "Community-centric databases [currently being utilized] blind us to changes in neighboring places that may impact our own situations."

This section attempts to develop the discipline of crime mapping and crime analysis by focusing on strategic crime analysis issues and techniques. It is our hope that the dialog at the symposium and these subsequent articles will provide insight into the importance of resource allocation, deployment and scheduling within an agency and particularly as it pertains to crime analysis. While it poses a unique challenge for improving the efficiency and effectiveness of policing, this panel certainly holds the view that addressing the pitfalls and caveats inherent to resource allocation must occur if other crime analysis models and techniques stand a chance to be successful. While we have only scratched the surface in this regard, we challenge the readers to use this section as a catalyst to further the dialog and invite comments and concerns regarding each article.

You Can't Fight Crime If You Don't Have the Time

Dale Harris • President • Corona Solutions

If we accept the premise that a major function of police patrols is to fight crime, and if we accept that these crime-fighting efforts require time and effort from patrol officers, then it is only logical that police executives and managers must staff their patrol forces so that there is sufficient time available for these efforts. As elementary as that sounds, it is quite common for the incoming demand for service to completely consume so much of the officers' time that there is not enough left to prevent, interdict, or even investigate crimes.

Just as common as *insufficient* staffing of patrol operations is *inefficient* staffing. Some agencies actually do have enough officers that they could fight crime, but they are allocated and scheduled so inefficiently that their best efforts are useless.

Patrol is typically the most visible and the most expensive operation for local law enforcement agencies. Usually half or more of the sworn officers are assigned to regular patrol duties, plus there are supervisors and support personnel to help complete the mission. Personnel costs are typically about 85% of a police agencies budget. Given these, it is clear the good management of patrol operations can have a very positive impact, and poor management can cripple the agency.

For all the importance of patrol management, it is often surprising how little knowledge there is in most agencies of the proven concepts and techniques for conducting this management. This paper will review some of the major patrol management principles and perhaps offer some ideas for improvement.

"You will never have enough officers, and no one else does either."

In over 25 years of working with police agencies, we can count on one person's thumbs the number of agencies we have come across that said they were sufficiently staffed. Nearly everyone says they need more people, and backs that up with budget requests for more officers every year. The question of how many would be enough is usually asked at that point, but seldom satisfactorily answered.

The reason that the question is so difficult to answer is that most agencies have not developed a set of operational goals for patrol. The most common stated goal is to respond to emergency calls within a specific amount of time, often five or six minutes. While having such a goal is laudable, there seems to be no scientific basis for it. Arriving at emergencies in four minutes is better than five, which is better than six, but there is little evidence as to how much better the outcome of the emergency would be with a four-minute response time. Generally, these are numbers chosen because they are perceived to be achievable and are acceptable to the public.

Another common driver for police staffing is to have enough officers on duty to "fill the districts." This can be a valid argument for staffing if the number of districts to be filled is appropriate for achieving the operational goals. Filling districts is not an operational goal. Later we will discuss how to determine the appropriate number of districts, or beats.

To resolve the question of how many are enough, we suggest that the agency make a careful study of what the demands for their services are, develop operational goals that will meet not only the demands for

service, but allow sufficient staff time to pursue proactive work, then calculate the staff resources necessary to achieve those goals.

The above is easily said, but often difficult to accomplish. Actually, *accomplish* is not the appropriate word because this is a task that is never completed. Policing is dynamic, filled with constant changes and unforeseen demands. There are, however, predictable patterns in police work and understanding those will allow competent staff management.

The demand for service for most patrol operations is recorded very well by their computer-aided dispatching (CAD) systems. Nearly all CAD systems automatically record the critical information for each incident. That information includes:

- *Incident number*
- *Source of the information*
- *Nature of incident*
- *Location*
- *Date and time of:*
    - *Receipt of the call*
    - *Dispatch of each unit*
    - *Arrival of each unit*
    - *Clearing of each unit*
    - *Closing of the incident*
- *Disposition*

This is by no means a complete list of necessary information from a CAD system, but it does include all of the critical data items for patrol staffing analysis.

Source: The Source is important because it allows the determination whether the time consumed on the incident resulted from a demand for service (call) or from officer-initiated activity. The distinction is important because the agency has little control over when a citizen will call for service. While the volume and frequency of those calls is measurable and predictable, it is not controllable.

Nature: Police dispatchers and call takers typically classify each incident to one of a list of nature codes. These lists vary among agencies in length and detail, but there are common features among them. Essentially, they give the officer some idea as to what he is responding to. From an analytical standpoint, it allows calculation of how much time is being spent on each type of incident. This then allows informed management decisions to be made on possible alternative means of handling some incidents.

Location: Because a significant portion of the time consumed in handling calls for service is spent on traveling to the call, it is important to be able to track the locations with the goal of better geographic deployment of units.

Date and time: As mentioned above, workload from calls for service can be calculated and predicted if it is collected. CAD systems are excellent data collectors. This information is required for each action or each unit because the total time consumed is critical to good analysis. Time is all that patrol officers have to spend, so knowing how it is spent is essential.

Some systems do not record time stamps for each unit on an event, but rather only collect one set of time stamps for the incident in general. This is very unfortunate because different calls require different numbers of units for different amounts of time. For example, some calls that may be serious receive a large number of units initially. Once the situation is stabilized, most of the units leave the call. Failing to collect individual time stamps has a tendency to seriously inflate the amount of time consumed on the incident.

Disposition: For staffing analysis, this is less important than the other items, but can be useful in tracking time consumed by false calls, calls resulting in reports, and calls resulting in arrests. Regarding calls resulting in reports, this is an issue that can have a huge impact on the determination of staffing requirements.

Report writing, or data entry, usually consumes a significant portion of a patrol officer's day. For some agencies, this time is recorded with the incident that caused the report to be written. Others record the time as a separate incident or status code, while others, probably most, do not record this time at all. This is a serious weakness in data collection and should be recognized by the analyst.

Once the data has been collected, from a CAD system or from a manual log, it can be analyzed with any of a number of tools. These tools range from simple hand calculations to computer spreadsheets to sophisticated computer models specifically designed for patrol analysis and optimization.

The analysis of staff needs must be based on time, that is time consumed or available to be consumed performing the patrol operation. The most common sophisticated method for this kind of analysis, used in policing as well as widely used in industry, is the queuing model. In essence a queuing model allows the analyst to infer the impact on operations by manipulating the number of calls for service, the amount of time required by each call, and the number of units providing the service. These models have been shown to be very accurate in predicting the service environment.

So back to the central question of how many are enough. The results of the queuing model, or whatever other technique is used, will indicate what level of service can be provided by a certain staffing level. Alternatively, the model should calculate the staff requirement for a stated service level goal.

After the data collection and preparation, the operation of the model is actually the easy part. It is normally a matter of plugging in the input values and reading the outputs. Using the outputs, however, is another matter.

A common standard for patrol staffing is to have enough units to allow the on-duty hour to be broken down into three equal parts: calls for service, officer-initiated or administrative activities, and uncommitted patrol time. The calculations will reveal how many units are required for this distribution of time, and if desired also reveal how many are necessary for response time standards and other goals. Now it is likely that the agency will need to do one of two things: either increase staff or reduce workload. Assuming for the moment that the preference is to add staff, then the number of staff required to achieve the stated on-duty complement must be calculated. That leads to the next enduring issue in patrol staffing.

"Somebody won't show up for work."

Although it is universally recognized, it is seldom managed well. People get sick, take vacation, have personal and military leave, and have many other reasons for not showing up. In the United States, it is common for a police officer to actually work about 80 percent of the hours for which he would be scheduled.

That calculates simply to an overall average of 80 percent of the scheduled staff showing up for duty when normally scheduled. A sergeant with a squad of ten officers then should expect to work with an average of eight.

Now having an average of eight officers appear for duty means that most likely the squad will work with seven, eight, nine, or maybe occasionally ten. If the workload analysis demands seven units to provide the necessary level of service, then this is not much of a problem. When more than seven appear for duty they will all have more time available for proactive work. If, however, the analysis shows that ten units are required and someone staffed the squad with ten officers based on that, then a serious mistake has been made.

We call the ratio of people who appear for duty compared to those scheduled for duty to *Availability Factor*. From the above example, that ratio would be .80 or 80 percent. The inverse of the Availability Factor is the *Staffing Factor*. Again using this example, the Staffing Factor would be 1/.80 or 1.25. The practical use of the Staffing Factor would be to analyze the on-duty staffing demand, then multiply the result by 1.25, rounding up to the next whole number of units.

"You will never be up to staff."

One often hears, when discussing an activity that requires patrol staff, that nothing like that can be done until the squad/shift/department is "up to staff." This is an understandable and convenient response from the patrol supervisor or commander who has been told he has twenty officers to manage, but finds he is down four due to resignation, transfer, promotion or injury His plans and expectations depend on having twenty officers, and, having fewer, he responds into a protective mode for his remaining resources. This is neither desirable nor necessary.

Let us assume that a patrol force is authorized 100 patrol officers of 200 total sworn officers. Let us also assume that the agency has an annual turnover rate of ten percent, meaning that ten percent, or 20, officers leave the department each year. The next concept we need to understand is the *Replacement Cycle*. In American law enforcement it is typical to have one year pass from the time an officer leaves the department until he has been replaced by a trained, capable officer. That year covers the time required for the authorization to hire, the recruiting process, the background investigation, the hiring offer and acceptance, police academy training, and the field training program.

Continuing the above example, this means that of the 200 authorized officer positions, only 90 percent (180) are filled at any one time. Now here is the real kicker for patrol. When a captain retires, you are down a patrol officer. When a detective resigns, you are down a patrol officer. Agencies usually fill their promoted or specialized positions from the pool of patrol officers. If half of the sworn officer positions are for patrol, then the effective turnover rate for patrol is double that of the agency. For this agency, for the 100 authorized positions they should expect to have 80 filled. For an agency this size to be "up to staff" is practically impossible. This agency should plan their operations around a staff of 80 officers, not 100.

"Police work happens at night and on weekends."

It is true that there is more need for police patrol services at these times than at others. To efficiently manage a patrol force, then management must put more people on duty at busy times than at slower times. As elementary as this is, it is often overlooked or ignored in police work.

At some point in the distant past of policing, someone got the idea that patrol officers should rotate their work periods. Presumably, the underlying reason was that it was unfair for an officer to be "stuck" on nights or working weekends while others enjoyed more normal working hours. As often happens in police work, once a practice is in place it is nearly impossible to dislodge.

Policing seems to be the only industry in the world that follows this practice. Private sector businesses, of course, have to be concerned about the efficient allocation of resources to be competitive. Police departments enjoy local monopolies, so they are not subject to the demands of the marketplace, and thus are not so constrained by efficiency. As the cost of employing police officers continues to go up, this luxury may be reduced, but there are better reasons for efficient staffing.

A friend from a large police agency tells the following. Every year he goes to his officers and asks what is the most important issue to them in staffing and scheduling. Universally, the answer is that they need a schedule that gives them more weekends off and not so many night shifts. He carefully records that answer, then asks what the second most important issue is. To that, he is told "We need more coverage on weekends. We're getting our butts kicked out there!" In a nutshell, this is the paradox of patrol staffing and scheduling.

We operate on the principle that every schedule is a compromise between personal preference and efficiency. Where the line is drawn is up to the agency, subject to external constraints such as labor laws, labor agreements, and personnel policies. Personal preference, however, does not necessarily mean rotating shifts. Our experience is that informed officers who have worked both fixed and rotating shifts will prefer the fixed shifts. This is good, because rotating shifts are exceedingly difficult to make efficient.

Police work follows daily, weekly and seasonal cycles. Ignoring those cycles by fielding the same number of officers at all times is both a disservice to the public and a waste of resources, which is in itself a disservice to the public taxpayers. It is first a disservice in that there is very likely to be insufficient on-duty staff to adequately respond to emergencies and crimes in progress, let alone conduct preventive activities. The danger to officers is also increased by having insufficient units available for backup on hazardous calls. Obviously, we recommend proportional staffing.

"There* can *be a cop around when you need one."

Having a sufficient number of patrol officers of staff and efficiently scheduled is very beneficial to a community, but much of that benefit is lost if they are in the wrong place. Here we will discuss the geographical deployment of patrol forces and some of the considerations that should be taken into account.

Virtually all patrol forces assign units to geographical areas. Most common is to have one unit assigned to an area we will call a beat. This concept goes back to the beginning of modern policing in London in the nineteenth century, and is still valid today. In some cases multiple units are assigned to cover an area, and in some cases one unit is required to cover multiple defined areas. These are relatively unusual and we will assume the one unit per area plan here.

A beat is typically small enough that one unit on duty can handle the routine work that originates from that beat. Calls that require multiple units require either that a unit from a neighboring beat come in to assist, or a unit that is not assigned to a beat cover ing.

There are both tactical and strategic reasons for assigning a unit to a beat. Tactically, units will be more likely to be near a call for service if they are dispersed through the jurisdiction, and thus more likely to be able to reap the benefits of a quick response. Strategically, agencies are finding that communication between citizens and officers is enhanced as a sense of community grows in a defined area. This is especially true when individual officers are consistently assigned to the same area.

Once the decision has been made to use a beat plan, then the plan must be established. There are two basic questions that must be answered in creation of a beat plan, plus several secondary questions. First, it must be decided how many beats to establish. Second, the boundaries must be established.

The question of how many beats to have is not easily answered, yet it is very important. Earlier we referred to those who thought minimum staffing should be sufficient to fill the beats. Here we suggest the reverse; that the number of beats should be equivalent to the minimum staffing. By minimum staffing, we mean that level that agency is committed to maintain even if it means calling in officers for overtime. For example, if a patrol force varies between six and fifteen officers on duty, they would have six beats. Any on-duty units above six would be assigned as cover units, as multiple officers in beats, or on special assignments.

In the above example, it is useful to know which beats are busier during different shifts and on different days of the week to the additional officers can be assigned where they will do the most good. Also, these officers can be used not just to handle calls for service, but can be directed to proactive work, so the assignment may not be just to the busier beats, but to targeted areas.

A few police agencies use variable beat plans. Here they have a set of beat plans, each with a different number of beats. They select the one that is appropriate, usually by shift and available staff. Many CAD systems can accommodate rapid and frequent changes of beat plan, but most humans are not so flexible. Where this has been done, our observation is that the dispatchers, patrol officers and supervisors are hampered in their work by having to re-orient themselves not just at the beginning of the shift, but frequently within the shift. An unfortunate result is often that people will ignore the beat boundaries and roam, perhaps limiting themselves to general areas.

Once the question of how many beats to establish is answered, then the next question is where to establish the boundaries. First, though, let us discuss the concept of *reporting districts* or *atoms*. Sometimes called grids, these are typically small geographic areas, generally neighborhood size, or roughly equivalent to a census block group. For convenience, we will use “RD” to refer to these small areas.

Some agencies use a simple grid overlay to establish RD’s, ignoring natural boundaries. These are the least useful for any analytical purpose or for building beat boundaries, so they will be ignored here. Good RD designs do follow natural, man-made, and political boundaries. They do not cross rivers, freeways, railroads, or extend beyond the borders of the jurisdiction.

Most CAD systems identify each call for service by the RD in which it originated. Therefore, all call activity and time consumption is identifiable by RD. Whether or not officer-initiated activity is coded to an RD is usually determined by how the local CAD system is set up. Most agencies probably to not track officer-initiated activity by geography, but that is of relatively little importance here. The amount of work initiated by citizens in an RD is the primary statistic in analyzing beat balances, so that is critical at the RD level.

If possible, data should be pulled from the CAD indicating how much citizen-generated work there has been and will be in each RD. The RD's then will become the building blocks for the beats. In calculating citizen-generated work, it can be useful to include the time between dispatching and clearing for each unit on the event. Doing this includes the travel time to the call, and thus accounts for all of the time consumed by the unit. A caution, though, is that if the beat boundaries or staffing changes, the travel time under the new plan will probably not be the same as the historical data. An alternative is to exclude the travel time, counting only the time from arrival to clearing, then include the land area and/or road miles as part of the balancing equation.

Assuming that the RD's will be the building blocks for the beat plan, and that the desire is to balance the beats, the next issue is to determine what statistics are to be used for balancing. Most agencies seek to balance primarily on workload, which is easily documented from the CAD system at the RD level. Other considerations are natural boundaries, land area, traffic issues, time for suppression of crime and disorder, and many other concerns specific to the agency.

Natural boundaries, including bodies of water, freeways, railroads, etc. can be generally classified as *impediments to response*. These impediments can be anything that slows a responding unit from its normal response speed, or increases the distance to be traveled. Beat boundaries should be arranged along the impediments as much as possible in order to optimize the response time within the beat. If the impediments are arranged along the edges of the RD's, then they can be more easily arranged along the edges of the beats.

Another major consideration for beat boundaries regards major thoroughfares. It seems that major streets show prominently on maps and the eye of the drawer of beat boundaries is naturally drawn to them as a logical dividing line for beats. We suggest that careful thought be given to this. In most urban areas, major thoroughfares have commercial or industrial developments along them, with the same type of developments on both sides of the road. Given that homogeneity, it is worth considering that one beat officer could be attuned to the nature of policing issues that are generated by those kinds of developments and work both sides of the street rather than dividing them between two officers.

General principles of territory alignment try to place the concentrations of work in the center of the territories, or beats in this case. Since major thoroughfares are often the busiest areas, placing them at the edges of beats tends to draw the officers away from the center. That increases response time and reduces proactive work in the rest of the beat. Better to have the busy areas in the center and only draw the officer to the edges when called or when proactive work requires.

After the number of beats is determined and the general design philosophy is decided, then the relative weight of the various statistics needs to be established. Usually workload is weighted heaviest, but of course that is up to the agency. Any other statistics that are available at the RD level can be included and given appropriate weights.

The actual process of beat design comes down to multiple iterations, testing various groupings of RD's. The various iterations are compared by calculating the variance among the weighted variables, with the least variance being the best, assuming all other constraints are recognized. This level of calculation is exceedingly difficult without a software program designed for this purpose. For agencies that do not have access to such a program, less rigorous calculations can be done, usually extending only to manually trying

various aggregations of RD's and watching the totals of the statistics. If more than two or three statistics are used this becomes very difficult for the analyst.

To aid in the manual design process popular geographic information system (GIS) programs include or make available redistricting tools. While they do not automate the iterative process and do not calculate the variance, they at least combine the visual aspect of the map and sum the statistics. More sophisticated automated redistricting tools can handle much more complicated calculations and build the districts while respecting all of the constraints.

The result of the redistricting process should be a beat plan that optimizes the ability of each unit to not only handle the demand for service in his beat, but to have a reasonable amount of time available for proactive work. A good beat plan, combined with a proportional staffing plan and a good schedule will indeed have a cop around when you need one. There are no perfect plans, and you will still be under staff at times, but you will have improved your odds as much as possible. As a further benefit to good management of your patrol force, you will be able to demonstrate to those who pay the bills that you are doing the best you can with your resources.

Management of Police Planning Tools: Lessons from the Field

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Introduction:

The past 30 years have seen computers become an indispensable part of American society including law enforcement. Dramatic advances in processing speeds and storage capacity now allow police agencies to capture and use vast amounts of information. At the same time, reductions in the size of computers and the development of wireless technology have created the potential of computer access from every patrol unit. In addition to the efficient storage and retrieval of data, the increase in computer capability has stimulated the development of sophisticated planning tools for law enforcement in such areas as resource allocation, personnel scheduling, criminal investigations, and crime mapping. Despite significant federal support for the development of planning tools over the past 30 years, critics claim that the benefits of these products have not been realized, not because of a lack of technical capability but rather because of a failure of management to recognize and eliminate barriers to successful utilization (Chaiken et al 1977; Kraemer, Dutton, and Northrup 1981). This paper examines these claims by reviewing the implementation experience of one resource allocation tool: the Police Allocation Manual (PAM)(Stenzel and Lucke 1991; Stenzel and Lucke 1992; Stenzel and Lucke 1994).

The next section reviews the history of automated resource allocation planning tools for law enforcement, and the subsequent analyses that identified factors that limited widespread use of the tools. This is followed by an overview of the development, capabilities, and field experience of the PAM model, and observations based on the implementation experience of six state agencies. The final section offers observations and recommendations.

A Brief History of Automated Resource Allocation Models:

During the 1970's and early 1980's, a number of products flowed from developments supported by the LEAA[1] and other federal agencies including: the Patrol Car Allocation Model (PCAM) (Chaiken and Dormont 1975; Chaiken and Walker 1985), the Hypercube model (Larson et al. 1975), the POLICE/PLAN package (PATROL/PLAN, BEAT/PLAN, and DATA/PLAN) (Stenzel et al. 1979), and SCHEDULE/PLAN (Stenzel et al. 1977). All these models were developed in the mid and late 1970s. Implicit in the support for these projects was the belief that if given tools to more efficiently utilize resources, law enforcement would have more equipment and personnel to fight crime. By the early 1980s, however, the limited implementation and use of these tools was evident and was itself becoming the subject of research (Chaiken 1978; Greenberger, Crenson, and Crissey 1976; Hebert and Colton 1978; Lawless 1982; Lawless et al. 1982; Lawless 1987).

These early investigations identified a number of factors that retarded the adoption and use of the planning tools by law enforcement. These factors include:

- **Police culture** – It is well documented that the insular nature of the police culture tends to foster organizations that are resistant to change particularly if the change is perceived as opening police operations to greater public scrutiny.

- **Lack of police input –** Several investigators noted that some tools were developed without adequate involvement of police planners and field personnel.

- **Lack of flexibility –** It was also observed that some tools could not be easily tailored to the operational environments and practices of individual agencies.

- **Lack of assessment tools –** Few tools included guidelines on how police agencies could evaluate the benefit of using the planning tool.

- **Organizational use of the tools –** Most police agencies placed use of the tools in planning-like units that often had limited contact with field personnel and were staffed with civilians with little or no field experience.

- **Limited training and inadequate time –** Personnel who were given responsibility for using planning tools received little training and were not given adequate time for data collection.

By the mid 1980s, little development work continued due to the limited success of the planning tools that had been produced, changing national priorities, and limited federal budgets. One indication of the lack of development of resource allocation tools, for example, is the continued use of derivatives of the microcomputer-based PATROL/PLAN program, initially developed in the late 70s.[3] The last major federally-funded resource allocation planning tool for law enforcement was the Police Allocation Manual, completed in 1993.

Police Allocation Manual (PAM):

The Police Allocation Manual was developed by the Northwestern University Center for Public Safety (NUCPS)[4] in the late 1980s and early 1990s with support from the National Highway Traffic Safety Administration (NHTSA, U.S DOT). The purpose of the project was to develop a procedure for determining the staffing and allocation requirements for police traffic and patrol personnel. The model was developed in three phases. The first phase (1989-1991) developed and field-tested a procedure for state-level police agencies.[5] The second phase (1992) revised and field-tested a revision for sheriff's departments, and phase three (1993) was used to revise and field test a version for municipal agencies.

The PAM procedure divides all patrol activities into four functions and estimates patrol staffing based on the time required to satisfy each function. The four functions are: (1) reactive activities (e.g., answering CFS), (2) proactive officer-initiated activities (e.g., traffic stops and COP activities), (3) proactive patrol needed to insure patrol visibility and availability, and (4) administrative activities. Times for these functions are determined using patrol and traffic workload data, information about the geography and roadway system of a jurisdiction, the personnel and operating policies of an agency, and user-specified performance objectives. Total on-duty patrol time is estimated and used to determine the number of patrol units and on-duty officers needed per day. Total staffing is determined based on the average number of on-duty officers per day and the shift relief factor for the agency.

The PAM user has the option of specifying several performance objectives including:

- *Average number of minutes for administrative activities per hour per unit,*
- *Average number of minutes for officer-initiated/community-oriented policing activities per hour per unit,*
- *Level of patrol visibility measured by the average patrol interval,*[6] *and*
- *Level of patrol availability measured by the average response time and/or the immediate response percentage.*[7]

Determining total staffing for a jurisdiction involves the following steps:

- *The entire jurisdiction is divided into a number of autonomous patrol areas (APAs).*
- *The PAM procedure is used to estimate patrol staffing for each APA.*
- *Staffing for the entire jurisdiction is determined by adding the staffing estimates of all the APAs.*

Since 1991, between 15 and 20 state agencies have investigated and/or used the PAM procedure.[8] Six agencies (Arizona Highway Patrol, Colorado State Patrol, Michigan State Police, Missouri State Highway Patrol, Oregon State Police, and the Washington State Patrol) have used the model for ten years.

State-Level PAM Implementation:

The following observations are based on the author's contact with personnel in each of the six state-level agencies that have used the PAM model for the past decade. These contacts have been both formal and informal, and not uniformly the same for all agencies. In addition, the author has recently completed a two-year review of the structure and use of the PAM model by one of the agencies. Observations about the management of the PAM procedure are offered as responses to the following four questions:

1. ***Where is operation of the model located in the organization?***
2. ***What data sources are used for the model?***
3. ***What is the context within which the model is used?***
4. ***What are the expectations of the agency?***

It should be noted that these four questions represent four somewhat arbitrary points on a continuum rather than four mutually exclusive topics. For that reason, the response to each question frequently touches on topics that are also discussed for other questions.

Question 1: *Where is operation of the model located in the organization?*

The purpose of this question is to examine who has responsibility for operating the model and what implications that decision has on its utilization. Three related questions are:

1.1 Why was the operation of PAM placed in this office?
1.2 *Do the persons collecting the data and using the model have operational experience?*
1.3 What role do field personnel play in decisions about use of the model?

The six state agencies use three approaches to address these issues:

Planning unit: Three agencies place responsibility for use of the PAM model in a planning-like unit although the name of the unit varies from agency to agency. Although the lead person responsible for using PAM may have little or no field experience, each unit contains both sworn and civilian personnel. No consistent mechanism, however, for including review by field personnel is used by any of the units.

Designated individual: A second and somewhat surprising answer to Question 1, used by two agencies, is the use of a designated individual, rather than a specific unit, to run PAM. In both cases, the person selected is a sworn officer possessing special computer and/or analytical skills. Interestingly, in both cases, the officers selected also have command or supervisory responsibilities and have continued with those responsibilities while running the PAM model. Like the planning units, no formal procedures for insuring field input are used.

Budget and fiscal office: One agency has elected to place operation of the PAM model in a budget and fiscal office, reflecting the agency's goal of using the staffing estimates as part of the budgeting process. Although a sworn officer directs the office, all other personnel are civilians with no field experience, and no mechanism for review of PAM results by field personnel is used.

Question 2: *What data sources are used for the model?*

This question addresses the issues of data reliability and validity. Four related questions are:

2.1 How well do model users understand the assumptions and limitations of the data that are used in PAM?
2.2 How many "guesstimates" are used and who makes them?
2.3 How much follow-up contact is there with field personnel to investigate questionable input data?
2.4 What level of documentation is maintained about the sources and limitations of each data element?

The usefulness of any planning tool, including PAM, depends upon the validity of the logic of the model, the knowledge and experience of the user, and the quality of the input data used. The last factor is always problematic for a resource allocation model for police operations for two reasons. First, the primary source for operational data are police officers who do not, correctly, view data collection as their primary job, and second, the data required by the model may not be collected by the agency. For both reasons, it is usually true that the most effort in using a complex model like PAM is spent collecting and verifying input data. Dealing with data issues requires careful planning, a good understanding of how the data is used in the model, and awareness of the limitations of the data. Few agencies routinely collect all the data required, and for some, the only way to obtain an input data element may be to estimate it based on the perceptions of experienced field personnel. Although one agency uses a survey of supervisory personnel to estimate some operational values, no outside assessment of the reliability of this approach has been completed. With one exception, the level of documentation about data used in PAM is minimal.

Question 3: *What is the context within which the model is used?*

This question addresses the capabilities of the person with primary responsibility for using the model and the manner in which user-specified performance objectives are determined and documented. Two related questions are:

3.1 How much training is given to each person who uses PAM?
3.2 How are user-specified performance objectives determined and documented?

It is a common practice in most police agencies for sworn personnel to rotate through different units and assignments as part of their career development. While there are obvious advantages to this practice, it also imposes an additional burden on the agency to insure that the special knowledge that an officer may gave acquired (e.g., about the use of a planning tool) is passed along to his/her replacement in an orderly and comprehensive manner. This requirement is particularly important if the officer has had responsibility for a planning tool for which outside training may not be readily available. The same problem can arise with civilian employees who move to other positions or leave the agency.

Among the six state agencies observed, training in how to use PAM is based primarily on a philosophy of "jump in and learn to swim." While the new person may learn the mechanics of the process (i.e., what data is needed and how it is entered into the model), there appears to be little emphasis on the helping the user understand the underlying logic of the procedure. Such an approach tends to eliminate training time, and invites the user to view the model as a "black box" with no need to understand the internal logic of the procedure.

User-specific performance objectives are usually obtained by consultation with senior staff. Because these values are user selected and may have a significant impact on the final staffing estimate, there is often a temptation to "run the model backwards" by changing the values of one or more of the performance objectives to obtain the "right" answer. (See discussion below.)

Question 4: *What are the expectations of the agency?*

Related questions are:

4.1 Is there an expectation of finding the "right" answer?
4.2 Does the agency use the model to substantiate a desired staffing level?

These questions address the dangers that can occur when decision-makers, both inside and outside of the agency, have a limited understanding about the appropriate use of models, and a desire to use the procedure to verify a desired answer. These issues may appear more frequently, perhaps, with models that estimate staffing levels that are used to prepare agency budgets. In this environment, two user characteristics often appear.

First is the tendency to sell a staffing recommendation with the argument that the recommendation is based on an "objective, scientifically valid" procedure that produces the "right" answer. Such claims cast the estimating process as a physics-like problem for which there is a right answer, and minimizes the inherent uncertainties introduced by the data used, the skill of the user, and the underlying assumptions in the model that may not be completely valid for every jurisdiction. Such an approach also suggests a greater validity for the procedure than is justified. In addition, such claims often treat PAM estimates as the last step in the decision-making process rather than an intermediate step that should be followed by a review and revision, as needed, of the PAM estimates by senior staff and experienced field personnel. The second characteristic is the tendency to use the model to "back into the right answer." Use of the model in this manner may not be intentional and, in fact, may not be seen as an inappropriate by the user. As an example, the author recently had the following exchange with a PAM user:

User: *I tried 100 for the input value and PAM produced a staffing estimate that was too large.*
Author: *What did you do?*
User: *Well, I adjusted the input value down to 50 and the staffing estimate was more realistic*.
Author: *How did you know to use a value of 50 for the input data value?*
User: *Oh, because it gave me the correct answer.*

The reasoning illustrated in this example is similar to the "speed of light" syndrome note in physics.[9] The inherent conflict between these two characteristics is trying to sell the staffing recommendation by promoting the model as an objective tool while at the same time manipulating the "objective" model to agree with a desired staffing level.

Observations and Recommendations:

The author's perceptions of the implementation and use of the PAM procedure are consistent with many of the assessments made by authors who investigated the implementation and use of other models developed prior to PAM. It should be noted that the development of the PAM procedure did address some of the factors that hampered earlier models. For example, considerable agency input was obtained with a survey of all state agencies at the beginning of the development process. Also, the need to recognize agency differences was given a high priority and produced a model that is very generic (i.e., PAM can be tailored to fit agencies with a variety of operational practices and policies).

However, a number of management practices noted in use of the PAM model are similar to factors that have been identified as limiting the use of other procedures:

- **Lack of assessment tools** – The PAM documentation does not provide the user with any mechanisms for objectively assessing the value gained from using the PAM procedure.

- **Organizational placement of the PAM model** - Most state agencies have placed operation of the model in a planning or administrative office with limited contact with field personnel, and have assigned, in some cases, use of the model to an individual with little or no field experience.

- **Lack of training** – In general, use of the PAM procedure is often handed from one user to the next with relatively little training.

- **Administrative burden** – Often operation of the PAM model is assigned without recognition of the time required to collect and verify the input data.

Additional barriers to the utilization of planning tools, recognized by earlier investigators, also appear in some agencies using PAM. These include:

- *Limited understanding of the unreliability of the input data,*
- *Limited documentation, and*
- *Over-promotion of the model to support staffing requests*

These observations suggest a number of management guidelines that could increase the likelihood for the successful use and institutionalization of planning tools:

- *Provide adequate training for all users*
- *Maintain thorough documentation about the data that are used*
- *Create mechanisms to provide for the involvement and review by field personnel*
- *Educate decision-makers about the appropriate use of models in the planning and decision-making process*

The rapid growth of computing capability has encouraged the development of sophisticated planning tools for law enforcement agencies. Widespread use and institutionalization of such tools has been slower than anticipated due to organizational barriers and a lack of understanding of the kinds of management oversight that are needed. The experience of almost 30 years has helped to identify the barriers that exist and the kinds of management direction that are needed. Experience with the PAM model in six state agencies suggests that many of the same barriers to successful use still exist.

Notes:

1. The Law Enforcement Assistance Administration (LEAA), the precursor agency to the Office of Justice Programs (OJP), existed between 1969 and 1983. Although support for the development of police planning tools diminished in the 1980's, overall federal support for law enforcement remained relatively stable. The FY1973 budget of the LEAA was approximately 850 million dollars, equivalent to 3.4 billion in 2001 dollars.[2] The budget for fiscal year 2001 for the OJP was 3.7 billion dollars. (www.ojp.usdoj.gov)

2. One dollar in 1973 is equivalent to $3.98 in 2001. (Columbia Journalism Review Dollar Conversion Calculator; *www.cjr.org*)

3. Two companies in the private sector that use modified versions of the PATROL/PLAN program are Police Management Advisors (PMA) located in Carlsbad, California; and Corona Solutions located in Thornton, Colorado. The PMA version of PATROL/PLAN is a window-based program called "Managing Patrol Performance." Corona Solutions markets a window-based version of PATROL/PLAN called "Staff Wizard." (More information about the "Staff Wizard" program can be obtained at *http://www.coronasolutions.com*).

4. The Northwestern University Center for Public Safety was known as the Northwestern University Traffic Institute from 1936 to 1999.

5. The two-volume final report for the Police Allocation Manual for state agencies can be downloaded off the Internet at the following site: *http://www.nhtsa.dot.gov/people/injury/enforce/docindex.htm*. Once inside the site, look for the PAM volumes under "Allocation."

6. The patrol interval is used in the PAM model to measure of how much patrol visibility a given number of patrol units will provide for a jurisdiction. Measured in time, a patrol interval, for example, of two hours indicates that, all other factors being equal, a citizen will see a patrol car, on the average, every two hours. In PAM, the user sets the average patrol interval as a performance objective and the model determines how many patrol units are needed to meet the objective. The average patrol interval is determined by the number of patrol units in the jurisdiction, the average amount of free patrol time per hour per unit, the total number of roadway miles in the jurisdiction, and the

average patrol unit speed while on free patrol. The number of patrol units required to meet a specified patrol interval objective increases as the average patrol interval value is lowered.

7. The immediate response percentage is used in the PAM model to measure the availability of the patrol force to response to emergency calls-for-service. The immediate response percentage indicates the percentage of calls for which a dispatcher will be able to immediately assign the call to a free unit. A percentage of 80%, for example, indicates that a dispatcher will find a free unit approximately 80% of the time. In the PAM model, the user can set the immediate response percentage as a performance objective and the model will determine how many patrol units are needed to meet the objective. The immediate response percentage is determined by the number of patrol units, the average number of calls-for-service per hour, and the average amount of time per hour each unit is available for a call. Increasing the immediate response percentage increases the number of patrol units that have to be on duty.

8. The estimate of 15-20 agencies is based on calls to the author about use of the PAM model, the author's contact with state-agency personnel in the classroom, and presentation of papers at the annual conference of the State and Provincial Police Planner's Organization (SPPPO).

9. The "speed of light" syndrome refers to an event that occurred in physics. In the late nineteenth century, two famous scientists conducted an experiment in 1881 to measure the speed of light. Because of the reputation of the two scientists (Michelson and Morley), no correction to their reported value for the speed of light appeared in scientific journals for the next 70 years. Finally, scientists came to realize that improvements in measuring the speed of light were not being reported, not because the Michelson-Morley value was correct, but rather because subsequent investigators assumed that if their experimental results did not agree with the Michelson-Morley value, the error must be with the experiment rather than with the earlier reported value. The parallel of this syndrome to the use of the PAM model occurs when it is assumed that the "right" staffing value is known and that if a PAM estimate does not agree with the "right" value, an error must exist in the data used in PAM rather than in the assumed value.

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Do-It-Yourself Patrol Allocation

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Introduction:

Crime analysts are personnel that decision makers go to for guidance, statistics, and/or data. However, most analysts learn that their bachelors or masters degree program did not cover formulas specifically for patrol allocation, deployment, and scheduling. Regardless, crime analysts are entrusted to find those formulas… those answers. The intent of this article is to share the knowledge this analyst has gained trying to answer, "How many officers and police aides (PA's)[1] do we need to have on the street?" While a simple question, getting to the answer is not. This article will describe the data sources and issues associated with patrol allocation, the methodology followed, findings, and recommendations to make the process better.

This section begins with a brief history on the patrol allocation model used by the Scottsdale Police Department. The Northwestern University Center for Public Safety (formerly known as the Traffic Institute) offers a course on patrol allocation. The model we use is based on this course. The model is an early version of the Police Allocation Model or PAM. PAM was developed by the Northwestern University Center for Public Safety "to develop a non-computerized method for determining the staffing and allocation requirements for police traffic services and patrol personnel for law enforcement agencies."[2] Through trial and error with other models, this early version of PAM was implemented at the Scottsdale Police Department as its patrol allocation model.

Data Sources and Issues (CAD, Patrol Logs, Policy Decisions):

It is important to remember that we utilize the Northwestern Model to determine "Patrol" allocation values. Therefore, all data elements gathered for this analysis only include patrol officers and police aides that are assigned to "patrol." For the rest of this article, the term "patrol unit" will be used to describe police officers and police aides who are assigned to patrol. All other units (Detectives, K9, Bikes, Parks, HEAT, Mounted, etc.) must be excluded from the analysis. Greater detail of this process is given below. The data elements required by the Northwestern Model are as follows **(See Appendix to view the model)**:

- *Citizen-generated Calls for Service*
- *Average Time Spent per Call*
- *Workload Divider*
- *Performance Factor*
- *Shift Length*
- *Total Annual Days Off per Position*

Before discussing each data element, it is important to remember that while raw numbers and statistics are important, the largest impact on the number of units needed in patrol are the expectations command staff has of its patrol units. Some agencies may have a community policing initiative requiring their patrol units to spend a certain amount of time on community policing activities, while some may not. Further, some agencies may require their patrol units to spend the majority of their time on community policing activities, while some may require very little time on community policing. The point is that someone has to make a policy decision to determine what will be required of their patrol units. It is the analyst's job to provide

information to help make this decision, but the decision needs to come from the Chief or the command staff.

The number of *citizen-generated calls for service* can be retrieved from most computer aided dispatch (CAD) systems. When calculating the number of citizen-generated calls for service there are two points of concern. First, identifying what citizen-generated calls for service to include, and second, identify holes (missing data) within the dataset. More specifically, the model is based on the number of citizen-generated calls for service handled by *patrol units*. This means any citizen-generated call in which at least one of the units responding was a patrol unit needs to be included in the analysis. Those calls in which none of the responding units are a patrol unit need to be excluded from the analysis. This process can be conducted by importing CAD data into a data management application like SPSS, SAS, etc. for manipulation. For the Scottsdale Police Department the model functions best when using annual data. However, downloading a calendar year's worth of data and using it for your analysis before checking for problems may negatively affect your final results. This brings us to the second point of concern… holes in the data. In particular, there may be times when the CAD system has gone down, and the calls for service occurring during those times are not included in your total count. One way to overcome this obstacle is to identify how many days are missing within the dataset and then extrapolating the data for a one-year's time. A statistical software package can also be helpful in identifying these holes in the data. One easy way do this is to create a cross-tabulation of the CAD calls for service data by month and by day of week (See Appendix). This cross-tabulation makes it easy to identify those days in which the CAD system went down and data was lost (in the chart you will notice some days of the week where there are no calls for service counts). However, those days in which the CAD system may have been partially down are more difficult to identify. Once you have identified the number of days in the year the system has gone down, you can then extrapolate for a one-year's time.

The *average time spent per call* is another data element that can be gathered from most CAD systems. This average is calculated by adding the total on-call time for patrol units per call and dividing that number by the total number of calls. The on-call time for each unit is calculated by the time when the unit was dispatched until the time the unit clears the call. Since this value is an average, in most cases it will not be affected by data lost due to times when the CAD system has gone down. However, this value poses its own challenge. Again, for our purposes we only want those times in which a "patrol unit" responded. Therefore, of those calls determined to have at least one patrol unit responding, only the times of patrol units are counted for each call. For example, three units respond to a domestic violence call. Two of the units are "patrol units" and the third is a K9 unit. When calculating the total time spent on this call, the K9 unit's on-call time is not included in the total on-call time.

The *workload divider* is a data element based on policy. The Scottsdale Police Department utilizes police aides within its patrol force. Police aides are civilian positions that conduct patrol functions in which enforcement is not required. These functions include writing reports for "cold" burglaries, directing traffic, directed patrol, etc. The Department's goal is to have police aides handle 25% of the workload in patrol. Therefore, when working through the Northwestern Model, we divide the total workload 75/25. Seventy-five percent of the workload will be handled by police officers in patrol, and police aides in patrol will handle 25%. The 25% goal was a policy decision made by the Administrators of the Scottsdale Police Department. Departments not utilizing civilians in their patrol function will not use a workload divider.

The *performance factor* is another data element that requires a policy decision. The "performance factor" is a multiplier to determine "Total Workload." Since citizen-generated calls for service are only a portion of

the total work (i.e. Administrative and Community policing duties) patrol units are expected to handle, the performance factor, in conjunction with the workload hours, determines the entire workload that needs to be fulfilled by patrol units. In Scottsdale, patrol officers are expected to spend 47% of their time on calls for service, 33% of their time on community policing activities, and 20% of their time on administrative activities. This is also known as the 47-33-20 workload model. Patrol police aides are expected to spend 60% of their time on calls for service, 10% of their time on community policing activities, and 30% of their time on administrative activities. This is known as the 60-10-30 workload model. The performance factor ensures that time is allocated in the model for all three types of activities. As stated earlier, the performance factor is based on a policy decision. This policy decision is based on daily patrol activity logs and CAD data. Through the analysis of patrol logs, it has been identified that patrol officers spend 10% while police aides spend 30% of their time on administrative activities. The daily patrol activity logs as well as national standards support time allocated for community policing. As a result of the analysis of patrol logs and national standards, the above performance factor models were instituted. The next section covering the methodology for the Scottsdale Police Department patrol allocation will cover this data element in greater detail.

For some departments *shift lengths* are determined by union contracts. For Scottsdale, the 10-hour shift length is a non-negotiable variable. An analysis is conducted every two years on the affect of changing to a 12-hour or 8 hour shift length, but the 10-hour shift length has been embedded in the culture of patrol. The Northwestern model allows one to compare between different shift lengths. Therefore, this model will facilitate preparing different proposals based on different shift lengths.

The *total annual days off per position* measure is a gauge of patrol unit availability. This is one of the more difficult data elements to calculate. In essence, this value is the total number of hours in a year that one unit is unavailable in patrol. Factors that are included in this measure are medical leave, family medical leave, personal leave, holidays, vacations, unpaid leave, training, and days off. Most payroll departments and training units store these values. However, Scottsdale does not have an automated process to calculate averages for all patrol units. Therefore, we take a random sample of patrol officers and all patrol police aides to calculate the total hours unavailable due to leave or training. The “days off” portion is much easier to calculate. Since our patrol unit functions on 10-hour shifts, the calculation for days off is: 3 (days off per week) X 52 (weeks in a year) X 10 (number of hours in a shift). This “days off” calculation (1,560 hours) is then added to the average time off due to leave per officer to calculate the “total annual days off per position in hours.”

The above section has covered the six main data elements needed when using the Northwestern Patrol Allocation Model. In summary, most agencies will be able to calculate their number of citizen-generated calls for service and average time spent on these calls using their CAD data. It is important to parse out this data so that it only represents patrol unit information and, if needed, to extrapolate the data to ensure you have an entire year’s worth of information. Second, if your agency is using units other than patrol officers to respond to calls for service, a policy will need to be created that determines what percent of the patrol workload this “other” unit type is expected to handle. Third, the performance factor is another policy decision that determines the entire workload for patrol. If units are expected to do administrative duties as well as community policing activities, the performance factor ensures that this time is accounted for in the model. Fourth, the shift length that your department utilizes in patrol affects the model. The good news is that you have the ability to test the affect the different shifts have on patrol allocation rather easily. Fifth, while one of the more difficult data elements to calculate, the total annual days off per position factor

accounts for vacations, holidays, medical leave, scheduled days off, etc. The following section will provide greater detail on how these data elements are put into action.

The Patrol Officer Model:

A major step when using the Northwestern Model is determining how to implement current patrol philosophies into the model. For example, The Scottsdale Police Department wants to allocate a certain percentage of time within patrol for answering calls for service, community policing, and administrative duties. As stated earlier, the Scottsdale Police Department uses the 47-33-20 model, shown in figure 2. The Northwestern Patrol Allocation Model allows departments to include their patrol philosophies through a calculation known as the "performance factor." The following section describes how the Scottsdale Police Department established its 47-33-20 workload model and how it is reflected in the allocation model through the performance factor.

Many police departments over the past 10 to 15 years have tried to implement a community policing philosophy within their agencies. This has required agencies to define community policing, and to create objectives in which to measure their success in implementing the philosophy. For the Scottsdale Police Department, one objective of their community policing philosophy is to have all patrol units responsible for community policing activities instead of mobilizing a few 'designated' community-policing officers. This objective requires allocating time for all patrol units to attend community meetings, to work on special community policing activities, etc. It is important to note, that in order to expect patrol units to participate in community policing activities, they must be allocated the time to be successful in doing so.

At one time, the Scottsdale Police Department intended to apportion patrol units 40% of their time for community policing. A review of patrol log activity initiated a concern that this percentage may have been too ambitious. Therefore, two sources were used to evaluate the 40% allotment. The first source, the officers' daily log, showed that on average officers were spending approximately 26% of their time on community policing activities. This value was 14% shy of the desired 40%. The second source was outside agencies. The crime analysis unit polled surrounding valley agencies, the Police Executive Research Forum (PERF), the International Association of Chiefs of Police (IACP), the Community Oriented Policing Services (COPS) office, and the Community Policing Consortium to gather information on their community policing deployment models. Of those that responded, most reported trying to reach 30% community policing time. In addition, most of these departments reported not being able to reach that desired amount. Based upon the daily logs showing officers 14% shy of 40% and that outside agencies were struggling to reach 30% community policing time, the Department decided to alter its model to 33%.

Administrative time is another area in which time needs to be allocated. Administrative time includes briefings, writing reports, performance reviews, etc. In the past, 20% of a patrol officer's time was determined to be administrative time. The daily log analysis showed officers were actually spending 22% of their time on administrative time. Since these two values were extremely close, the model's 20% administrative time remained the same.

Having allocated 33% of an officer's time for community policing and 20% for administrative duties, 47% of an officer's time is left for calls for service. Calls for service are categorized as citizen-generated or self-initiated. Based on guidance given from Northwestern University, and supported by the Department's historical CAD data (See Appendix Figure 3), officers are expected to spend 75% of their calls for service time responding to citizen-generated calls for service, and the other 25% proactively generating their own

calls for service. Figure 3 shows that prior to Fiscal Year 00/01 the Department remained close to the 75/25 split.[3] When calculating patrol allocation needs, citizen-generated calls for service levels have the largest impact. Since patrol officers must respond to these types of calls, the model ensures time is allocated for these calls and then the model allots for self-initiated calls for service, community policing, and administrative duties.

After defining the Scottsdale Police Department's 47-33-20 model, it is then formulated into the Northwestern Model through the "Performance Factor." As stated before, the "Performance Factor" is a multiplier that determines "Total Workload." Since citizen-generated calls for service is the constant variable, we have to "fill-in" time to ensure patrol units have time for administrative duties, community policing, and self-initiated calls for service. In the Department's 47-33-20 model, patrol officers are expected to spend 47% of their time on calls for service. This equates to 28.2 minutes per hour. We have also identified that of the 47% (28.2 minutes per hour), officers are expected to spend 75% of that time on citizen-generated calls for service, and 25% on self-initiated calls for service. Seventy-five percent of 28.2 minutes equates to 21.15 minutes. Therefore, patrol officers are expected to spend, on average, 21.15 minutes per hour on citizen-generated calls for service. The "Performance Factor" uses this value as a multiplier to ensure enough time is allocated in the model for administrative duties, community policing, and self-initiated calls for service. The "Performance Factor" is calculated by dividing 60 (the number of minutes in an hour), by the 21.15 minutes allocated for citizen-generated calls for service. The result is 2.8. This value (2.8) is then multiplied by the time spent on citizen-generated calls for service to establish the "Total Patrol Time" that is required to be handled by patrol units. The "Total Patrol Time" is the workload value that includes time for calls for service (citizen-generated and self-initiated), administrative duties, and community policing.

The Police Aide Model:

As with the Patrol Officer Model, the Department's philosophy for police aides needs to be reflected in the Northwestern Model. Again, this process is accomplished through the "performance factor" calculation. The expectation is for PA's to handle 25% of patrol's workload. Figure 4 shows that the Department was within 5% of meeting this goal in regards to both citizen-generated and self-initiated calls for service over the past fiscal year. However, as shown in figure 5, when looking at just citizen-generated calls for service, PA's were able to meet 22% of this workload. The Department currently embraces a 60-10-30 model for police aides as shown in figure 6.

As with the patrol officer model, an analysis was conducted on PA daily logs to determine an acceptable level of community policing time for PA's. Their job function is very different compared to a patrol officer. PA's primary function is to alleviate 25% of patrol's workload. In doing this, a PA is required to focus mainly on taking reports. The daily log analyses showed PA's spent 8% of their time on community policing activity. For greater ease in analysis, the department established a 10% community policing allocated time for this study.

The next area of concern focused on the amount of time allotted for administrative time. In the past, 20% of a PA's time was determined to be administrative time. The daily log analysis showed PA's were actually spending 30% of their time on administrative time. Therefore, the model was adjusted to 30% time allotted for administrative time.

Having allocated 10% of a PA's time for community policing and 30% for administrative duties, 60% of a PA's time is left for calls for service. Like the officers' model, calls for service are categorized as citizen-

generated or self-initiated. The expectation is for PA's to spend 75% of their calls for service time responding to citizen-generated calls for service, and the other 25% proactively generating their own calls for service. The Department's computer aided dispatch (CAD) database is used to analyze the number and time spent on these types of calls for service. Like the patrol model, when calculating PA allocation needs, citizen-generated calls for service levels have the largest impact. Since PA units must respond to these types of calls, the model ensures time is allocated for these calls and then the model allots for self-initiated calls for service, community policing, and administrative duties.

Like the Patrol Model, the PA 60-10-30 workload model is formulated into the Northwestern Model through the "Performance Factor." As stated before, the "Performance Factor" is a multiplier that determines "Total Workload." Since citizen-generated calls for service is the constant variable, we have to "fill-in" time to ensure patrol units have time for administrative duties, community policing, and self-initiated calls for service. In the Department's 60-10-30 workload model, police aide units are expected to spend 60% of their time on calls for service. This equates to 36 minutes per hour. We have also identified that of the 60% (36 minutes per hour), police aide units are expected to spend 75% of that time on citizen-generated calls for service, and 25% on self-initiated calls for service. Seventy-five percent of 36 minutes equates to 27 minutes. Therefore, police aide units are expected to spend, on average, 27 minutes per hour on citizen-generated calls for service. The "Performance Factor" uses this value as a multiplier to ensure enough time is allocated in the model for administrative duties, community policing, and self-initiated calls for service. The "Performance Factor" is calculated by dividing 60 (the number of minutes in an hour), by the 27 minutes allocated for citizen-generated calls for service. The result is 2.2. This value (2.2) is then multiplied by the time spent on citizen-generated calls for service to establish the "Total Patrol Time" that is required to be handled by police aide units. The "Total Patrol Time" is the workload value that includes time for calls for service (citizen-generated and self-initiated), administrative duties, and community policing.

Findings:

Figure 7 shows that the Scottsdale Police Department had 99,561 citizen-generated calls for service handled by at least one patrol unit in FY 00/01. On average, patrol units spent 1.15 hours per call. The Department expects patrol officers to handle 75% of the workload, and police aides 25%, this workload divider results in 74,671 calls for patrol officers, and 24,890 calls for police aides. Since "time" is the true workload measure for this model, the calls for service for both types of patrol units are multiplied by the average time spent per call. This result computes time as the workload measure for both patrol officers and police aides in patrol. As stated before, responding to citizen-generated calls for service is a portion of the total workload expected to be handled by patrol units (i.e. self-initiated calls for service, administrative duties, community policing). The "time as a workload measure" values are multiplied by the performance factor (described in the methodology section) to determine the total patrol workload (TPW) to be handled by each patrol unit type. The shift length is important in determining how many shifts will need to be covered in one year. Therefore, this value is identified for future use.

Once the initial calculations are made above, the next step is to determine the "average number of unit shifts required (ASUR)" to fulfill the TPW. The calculation shown in figure 7 shows it will take 67 patrol officer unit shifts, and 17 police aide unit shifts per day to handle the TPW. If the personnel we scheduled in these shifts worked every day of the week, and never had time off due to holidays, vacations, sick time, training etc., we would only need 67 police officers and 17 police aides in patrol. However, we know that in Scottsdale officers work 4 days a week and do take time off for holidays, vacations, sick time, training etc. Therefore, the "Total Annual Days Off Per Position in Hours (TADO)" calculation helps determine

Figure 7

Total Patrol Citizen-generated Calls for Service: **99,561 CFS**
Average Time Spent per Call: **1.15 hours** (69 minutes)

	Patrol Officer	**lice Aide/Teleserve**
Workload Divider	**75%** (74,671 CFS)	**25%** (24,890 CFS)
Time as a Workload Measure	**85,902 hours** (74,671 CFS x 1.15	**28,634 hours** 890 CFS x 1.15 hours)
Performance Factor (PF)	**2.8** (60 minutes / 21.15 mi	**2.2** minutes / 27 minutes)
Total Patrol Workload (TPW)	**243,649 hours** (74,671 hours x 2.8	**63,631 hours** ,634 hours x 2.2 PF)
Shift Length (SL)	**10 hours**	**10 hours**
Avg. # of Unit Shifts Required to Meet TPW (AUSR)	**67** ((1 / SL) x (TPW/365 dL) x (TPW/365 days)) or ((1/10) x (243,649/3/10) x (63,631/365))	**17**
Total Annual Days Off Per Position in Hours (TADO)	**1,913.6 hours**	**1,955.2 hours**
Shift Relief Factor (SRF)	**2.1** ((365 days x SL) / ((365 days xL) / ((365 days x SL) – TADO))	**2.15**
Positions Needed * Numbers are affected by rounding	**140*** ASUR x SRF) o (67 x 2.10)	**38*** (ASUR x SRF) or (17 x 2.15)

how many positions it will take to fill the 67 patrol officer unit shifts, and the 17 police aide shifts understanding that personnel do not work every day. The "shift relief factor (SRF)" takes into account the shift length (10 hours in Scottsdale) and the ADO to determine the actual position needed to fill the AUSR. This final calculation to determine actual positions needed is completed by multiplying the ASUR by the SRF. The results show 140 police officers and 38 police aides are required in patrol to handle the FY 00/01 patrol workload.

Conclusion:

As stated earlier, the intent of this article is to share the knowledge that has been gained by objectively answering the question: "How many officers and police aides (PA's) do we need to have on the street?" The Northwestern Model used by the Scottsdale Police Department is straightforward. The steps include determining your workload, determining how you would like to handle the workload by shift length and calculating how often your personnel will be available to cover the workload. With these steps answered you are then able to calculate the number of positions it will take to cover the workload. Within this model, however, data sources and policy decisions are critical to accurately reaching usable results. This article has revealed data sources and issues that need to be addressed when conducting patrol allocation. With that information, the Scottsdale Police Department has developed its patrol officer and police aide models. Finally, the Department's FY 00/01 allocation budget calculations and findings have been presented using the Northwestern Model. Patrol allocation is a process. While the Northwestern Model helps calculate the numbers, this article has shown that data quality and policy decisions are the main pieces of this process that affect the final results. Further, policy decisions made by administrators like a 47-33-20 patrol officer workload model require measures to assist in verifying and continually analyzing those models.

STAFFING REQUIREMENTS (FY00/01)

47-33-20 MODEL (Officers)

60-10-30 (PA/Teleserve)

Using 83% for Patrol and 81% for PA available time.		
Data:		
Citizen Generated CFS total is based on all calls where a patrol officer or pa (or both) responded.		
CFS value for analysis.	99,561	
Average Time per Citizen Generated CFS =	69	1.15
Number of positions needed for an 75/25 split:		
POLICE RESOURCE ALLOCATION METHOD	**OFFICER**	**AIDES**
TRAFFIC INSTITUTE - NORTHWESTERN UNIVERSITY	75%	25%
COMPUTE THE NUMBER OF CALLS FOR SERVICE:		
CFS x 75% or 25% =	74,671	24,890
COMPUTE TIME AS A WORKLOAD MEASURE:		
Total Obligated Time (in hours) = (# of CFS) x (average time per CFS)	85,902	28,634
COMPUTE PERFORMANCE FACTOR:		
Performance Factor = hourly time divided by the time an officer or aide is anticipated to devote to handling calls for service.		
Performance Factor = 60 / 21.15 minutes or 60 / 27 minutes	2.8	2.2
COMPUTE TOTAL PATROL TIME:		
Total Patrol Time = Total Obligated Time x Performance Factor	243,694	63,631
COMPUTE AVG. NUMBER OF UNIT-SHIFTS REQUIRED TO MEET CFS:		
Unit-Shifts = (1/Shift Length) x (Total Patrol Time/365)	67	17
Shift Length = 10 hours		
TOTAL ANNUAL DAYS OFF PER POSITION:		
Regularly scheduled days off = 156 (3 day weekends)	1913.6	1955.2
Using 83%/81% availability for non-regulary scheduled days off	hours	hours
Training / Other days off = 8 days for officers and 3 days for aides	annually	annually
((156days*10)+353.6 or 395.2hrs =1913.6 or 1955.2hrs		
COMPUTE A SHIFT RELIEF FACTOR:		
Shift Relief Factor = (365 x 10) / ((365 x 10) - 1913.3 or 1955.2) =	2.10	2.15
NUMBER OF POSITIONS NEEDED TO MEET THE 71/25 SPLIT:		
Unit-Shifts x Shift Relief Factor = Staffing Required	**140**	**38**
Current Staffing:	**139**	**31**
ADDITIONAL POSITIONS NEEDED:	**1**	**7**

A) FY99/00 Citizen-generated Calls for Service

B) Average Time Spent per Call in hours (Citizen-generated and Self-initiated)

C) 75% of Workload to be handled by Officers and 25% to be handled by PA units

D) Number of Citizen-generated Calls for Service by Unit Type

E) Time Spent on Citizen-generated Calls for Service by Unit Type

F) Workload multiplier

G) Total time to be accounted for by patrol units.

H) Number of Shifts to be filled by patrol personnel in one year

I) Hours off per year per unit for weekends, training, vacation, sick time, etc...

J) Number of patrol units it takes to fill one shift 7 days a week, 365 days a year.

K) Number of Units required to fulfill deployment needs compared to number of units currently authorized

Appendices:

A) Citizen-generated Calls For Service:

Three main steps are followed in determining the Citizen-generated Call for Service value for the deployment study. First, the fiscal year's CAD data is categorized to determine the raw calls for service levels. Second, only those calls for service where at least one patrol unit responded (ie. Patrol officer, police aide, or teleserve unit) are included in the data set. Third, only those calls that have passed the first two steps and are also citizen-generated calls for service are used for the final analysis.

Step 1: CAD data is divided into four calltype categories: Call for Service, Administrative, Community Policing, and Delete. These categories are used to help analyze the two patrol models (47-33-20, and 60-10-30). Calltypes are coded to fit one of the four categories. Below is a breakdown by category.

Administrative

10-10	Fifteen minute break
BULLS	Bullseye drill
C7	Thirty minute lunch break
CODE5	Surveillance
COURT	Court
DETAIL	Detail
EQUIP	Equipment pickup or repair
F/P	Fuel and paper at the station
K9BREAK	Canine dog break
K9TRAIN	Training for canines
MEETING	Meeting, out of service
PAPER	Doing paperwork
PRISTRN	Prisoner transport
RANGE	Firearms training
RELIEF	Station officer/Sgt. relief
REPAIR	Vehicle down for repairs
TRAIN	Training
WASH	Carwash
YARD	Trip to yard
MAILRUN	Mail run

Community Policing

909	Selective traffic enforcement
10-21	Out on a telephone call
COMPOL	Community Policing
FOOTPAT	Foot patrol
PCR	Police community relations

Delete

KDTFEFLT	KDT user error (correct immediately)
OFFDUTY	Off-duty employment
TEST	Test

Call For Service

All other calltypes.

Those calltypes categorized as “call for service” are selected for further analysis.

Step 2: Each unit that responds to a call for service is categorized as either a patrol officer, police aide, teleserve unit, or other. Only those calls for service in which at least one of the responding units as a patrol officer, police aide, or teleserve unit are selected for further analysis.

Step 3: “Calls for service” are further categorized as citizen-generated of self-initiated. Only those calls that are citizen-generated are selected for the final deployment analysis.

The final citizen-generated calls for service count is considered to be half of the 47% time an officer should be devoting to calls for service, and half of the 60% of time a police aide should be devoting to calls for service. The other half is to be devoted to self-initiated calls for service.

B) Average Time Spent Per Call:

The average time spent on call is calculated by looking at only those calls where a patrol officer or PA/ Teleseve unit responded. This average time includes both citizen-generated calls for service and self-initiated calls. It is felt that by including both types of calls for service in this portion of the analysis, the deployment model better reflects the calls for service demands for the entire 47% (patrol officer) or 60% (PA/Teleserve) of a patrol units workload. Time on-call for citizen-generated calls for each patrol unit is the amount of time between *call dispatch* and *call clearance*. For self-initiated calls, time on-call is calculated by the amount of time from *call arrival* to *call clearance*. The total time spent by patrol units per call is calculated by adding up each of the responding patrol units on-call time for each call. Non-patrol units, such as mounted, K9, detectives, Sergeants, Lieutenants, parks, bikes, HEAT, etc. are excluded from this analysis. Finally, the average time spent per patrol call for service is calculated after following the above processes.

C) Percentage of Workload:

The Department’s mission is to have 75% of the patrol workload to be handled by patrol officers. The other 25% is to be handled by PA/Teleserve units.

D) Number of Call for Service per Patrol Type:

The total citizen-generated calls for service calculated in (A) Citizen-generated Calls for Service are divided to fit the 75/25 patrol workload model.

E) Time as Workload Measure:

The citizen-generated calls for service per patrol type calculated in (D) Number of Call for Service per Patrol Type are then multiplied by the (B) Average Time Spent per Call to calculate calls for service workload hours.

F) Performance Factor (Workload Multiplier):

For patrol officers it is expected that they spend 47% of their time on calls for service. This calculates to 28.2 minutes per hour. It is also expected that patrol officers spend half of this time on citizen-generated calls for service and the other half on self-initiated calls for service. This calculates to 14.1 minutes per hour for citizen-generated calls for service. Using the same process for PA/Teleserve units, they are appropriated 18 minutes per hour for citizen-generated calls for service.

The "performance factor" is a multiplier to determine "Total Workload". Since citizen-generated calls for service are only a portion of the total work (ie. Administrative and Community Policing duties) patrol units are expected to handled in an hour, the performance factor, in conjunction with the workload hours, determines the entire workload that needs to be fulfilled by patrol units.

G) Total Patrol Time:

The (E) Time as Workload Measure multiplied by (F) Performance Factor (Workload Multiplier). The time for citizen-generated calls for service are multiplied by the performance factor to calculate the total workload to be handled by patrol units.

H) Unit-Shifts Required to Meet CFS:

The Unit-Shift value states how many shifts in a year it would take meet the "total patrol time." For Scottsdale, this is calculated using 10 hour shifts.

Annual Days Off per Year

Since patrol units do not work 7 days a week, a calculation is required to determine the availability of the patrol units. The Department's 4-10 schedule means each patrol unit gets 3 days off every week. This calculates to 156 days per year, or 1,560 hours per year. In addition to the regularly scheduled days off, one must calculate the average time off per unit per year for training, sick time, vacation, unpaid leave, etc. Twenty-nine randomly selected patrol officers' files were pulled for this analysis, while all twenty-nine

active PA/Teleserve units were analyzed. The City's payroll department calculated the average amount of time off per unit for medical leave, family medical leave, personal leave, holiday, vacation, and unpaid leave. The Department's training unit supplied the average amount of time, in hours, per unit for training over a one year period. For patrol officers it is also calculated that on average they have an additional 353.6 hours per year off for training, sick time, vacation, etc. This value is 395.2 hours for PA/Teleserves. This calculation identifies the total number of hours per year that the average patrol unit is unavailable.

Shift Relief Factor:

Based on the calculation in (I) Annual Days Off per Year, the shift relief factor is the number of units it would require to fill one shift 7 days a week for one year.

Number of Positions:

This is the final calculation determining the number of patrol units needed to fulfill the workload demand.

Charts and Tables

Figure 1: 2000/2001 Patrol/PA Calls for Service Estimation includes Citizen Generated calls only.

	MONTH	2000					2001					
	JAN	FEB	MAR	APR	May	Jun	JUL	AUG	SEP	OCT	NOV	DEC
1	255	302	273	261	286	289	254	241	298	250	277	304
2	261	291	303	304	287	259	248	255	271	273	271	278
3	263	278	304	238	276	259	256	266	266	238	313	242
4	289	289	307	271	304	284	277	290	247	314	257	238
5	281	304	266	259	294	264	269	303	267	268	249	267
6	284	269	282	336	269	285	276	261	249	286	254	276
7	226	316	277	309	278	276	272	250	266	275	267	257
8	259	253	282	272	261		296	211	251	272	270	281
9	120	283	313	273	250		256	271	307	292	276	275
10	260	269	299	290	271		263	270	238	283	295	254
11	269	265	258	255	290		262	297	254	316	279	244
12	281	238	283	294	362		259	255	270	292	237	244
13	263	285	309	312	281		241	247	262	273	245	255
14	254	257	258	343	290	261	279	261	262	307	221	275
15	261	271	282	280	318	320	247	280	288	257	253	278
16	233	304	314	259	295	299	234	247	261	271	269	262
17	286	303	316	272	267	273	276	270	254	232	306	262
18	278	286	279	309	311	266	269	278	231	262	273	303
19	300	266	291	317	309	255	250	262	253	255	275	250
20	271	266	305	318	254	300	260	243	258	266	272	301
21	239	243	313	309	245	310	313	249	273	290	247	304
22	246	286	285	263	237	316	262	276	279	235	273	309
23	253	291	362	293	264	268	228	253	272	255		263
24	234	298	341	273	313	231	215	228	246	253		212
25	249	241	265	274	299	251	258	282	254	268		189
26	320	259	268	300	283	263	244	263	240	278		246
27	314	235	289	312	220	279	261	237	252	337		282
28	254	243	306	328	245	307	258	261	267	294		289
29	262		311	244	270	288	248	250	275	252		273
30	277		302	301	289	278	241	286	304	278		291
31	250		333		274		282	262		308		254
	8092	7691	9176	8669	8692	6681	8054	8105	7915	8530	5879	8258
										NumDays:	351	
										AvgperDay:	273	
										Year Est:	99,561	

FIGURE 2: OFFICER WORKLOAD

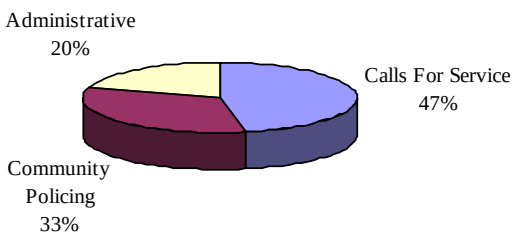
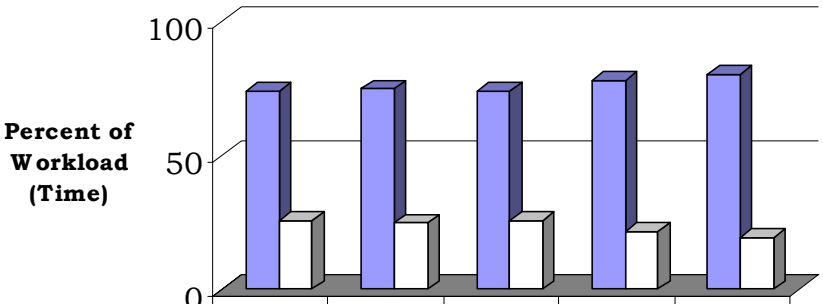
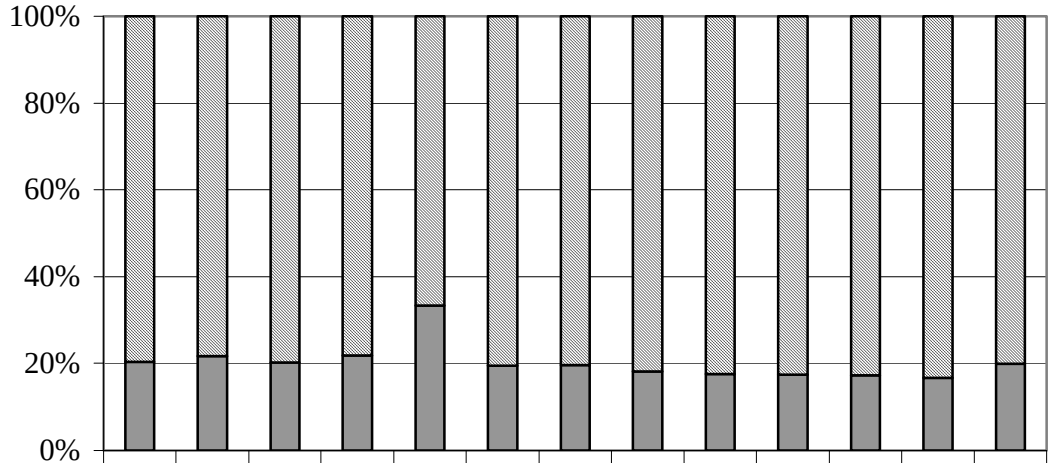


Figure 3: Citizen Generated VS Self-Initiated Workload



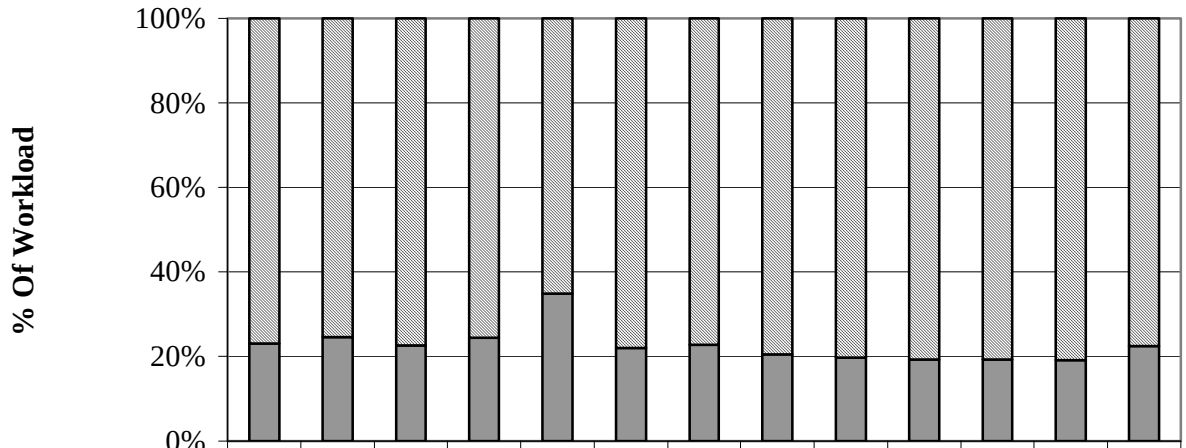
	96/97	97/98	98/99	99/00	00/01
Citizen Generated	74.2	75	74.2	78.3	80.6
Self-Initiated	25.8	25	25.8	21.7	19.4

Figure 4: % Of Workload Handled by Unit Type (FY 00/01)
Citizen Generated and Self-Initiated CFS



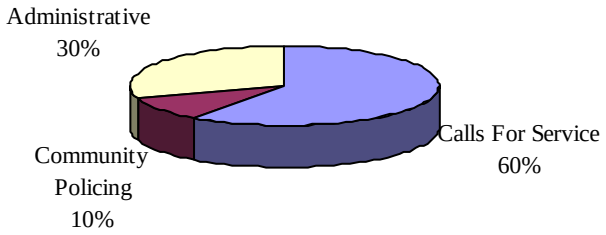
	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	Avg.
Patrol Officer	80%	78%	80%	78%	67%	80%	80%	82%	82%	83%	83%	83%	80%
PA/Teleserve	20%	22%	20%	22%	33%	20%	20%	18%	18%	17%	17%	17%	20%

Figure 5: % Of Workload Handled by Unit Type (FY 00/01)
Citizen Generated (ONLY)



	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	Avg.
Patrol Officer	77%	75%	77%	76%	65%	78%	77%	79%	80%	81%	81%	81%	78%
PA/Teleserve	23%	25%	23%	24%	35%	22%	23%	21%	20%	19%	19%	19%	22%

FIGURE 6: PA/TELESERVE WORKLOAD



Notes:

[1] Police Aides (PA) are civilian positions that conduct patrol functions in which enforcement is not required. These functions include writing reports for "cold" burglaries, directing traffic, directed patrol, etc.
[2] See Police Personnel Allocation Manual published by the US Department of Transportation and the National Highway Traffic Safety Administration prepared by the Traffic Institute Northwestern University (1993)
[3] The disparity in FY 00/01 can be attributed to the number of allocated positions not filled. Since the Department had approximately 10 positions vacant throughout the year, there were not enough resources on the street to meet the model 's goals.

Change Detection and Prediction: Issues in Crime Analysis and Resource Allocation

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Objective:

Unlike the ingenious programs demonstrated at the Denver symposium in June, 2001, this paper offers no off-the-shelf software to solve immediate problems. The emphasis here is on a perspective that may help inform the community of analysts about the consequences of jurisdictional fragmentation, particularly with respect to change detection and resource allocation. This perspective may be more useful in the context of strategic planning as compared to assisting day-to-day tactical operations. Five principal points are addressed: the consequences of intrametropolitan variations in crime, the impact of jurisdictional fragmentation, issues relating specifically to boundaries, the detection of demographic change and its implications, and the need for data integration.

Background:

Crime analysis in the United States may be unique globally in that law enforcement agencies are extraordinarily fragmented, more or less precisely reflecting the remarkable fragmentation of local government. The *Sourcebook of Criminal Justice Statistics 2000* recorded a total of 13,524 local police departments and 3,088 sheriffs departments in 1999. When the 49 state police departments were added, the total number of agencies (excluding those with federal jurisdiction) was 16,661 or an average of about 17,000 citizens per department (Pastore and Maguire, 2000). In reality, the actual distribution consists of a handful of extremely large departments (16 serve over a million each), and many smaller ones, some very small indeed. The *Sourcebook* data show that 12,183 departments serve populations of less than 25,000 and 10,363 serve communities of less than 10,000. Many of the latter are rural, but many are small incorporated entities embedded in large metropolitan areas.

If we think of "crime" as a functional system, criminal behavior typically overlooks the political boundaries that govern our crime control efforts, except in situations in which the functional system of crime coincides with natural boundaries in some way. Thus the shore of Lake Michigan confines all but waterborne crime to the adjacent metropolitan areas of Milwaukee, Chicago, and Gary. But within those metropolitan zones, and most others, numerous smaller jurisdictions with inward-looking crime control efforts hinder attempts to take a regional view of crime problems. From this perspective, criminal activities have an inherent advantage over law enforcement – crime is to some extent a regional phenomenon while crime control is inherently local.

One interpretation of this situation is that it is the natural outgrowth of the individualistic philosophy of the American lifestyle – even city or state collectives insist on retaining a degree of independence permitting some freedom of local expression. It can also be argued that this is the ultimate expression of democracy – local decisions made to reflect variations in local values and opinions. An alternative view posits that the fragmented urban landscape is the result of decisions made by the power structure aimed at sorting people on a class and race basis. As Morgan and Mareschal (1999, 580) have noted, the fragmentation of local governments has the effect of making the complex urban landscape more legible since the various entities develop reputations (with respect to schools, crime, property appreciation, etc.) and potential movers are

attracted or repelled based on those reputations. “Thus” they wrote, “political borders represent powerful cues to persons making locational decisions.”

The latter may include criminal persons, although it is well established that distance decay effects are likely to overcome the logic of target selection on the basis of community characteristics. Nevertheless, what we have here seems to be a situation in which freedoms collide – the (illegitimate) freedom of the criminal to operate anywhere without regard to political boundaries runs headlong into the freedom of citizens to organize themselves into an extremely fragmented structure of local government.

This seemingly abstract view has important implications for law enforcement across the board, including the scope of this discussion focusing on change detection and resource allocation. While the fragmented context of law enforcement makes the situation complicated enough from a tactical viewpoint, the difficulties do not end there. The entire gamut of operations is affected, whether from the point of view of training, standards, planning, pay and conditions, communications, weapons, dispatching, reporting, command structure, review protocols, and a host of matters that are perhaps best subsumed under the heading of “economies of scale,” which implies two conditions – (1) the power of large agencies to get goods and services at a discount compared to small agencies and (2) the fact that small departments cannot possibly employ full-time specialists such as crime analysts or GIS experts. Large departments, on the other hand, can form special units for almost any purpose imaginable.

Traditionally, geographically adjacent police agencies have avoided meaningful contact with each other for a variety of cultural, economic, and political reasons. In some areas, there is evidence of a shift toward more integrated approaches, but the norm is still for independent agencies to operate independently. The ramifications of this are potentially complex, and involve relationships within and between jurisdictions. Such relationships remain mysterious for the most part, illuminated only occasionally by anecdotal accounts of frequently bizarre conflicts between departments as they vie for turf (e.g. state police versus local police) or struggle to get credit for successful operations, and vice versa.

The Five Issues:

1. Consequences of Intrametropolitan Variations in Crime

All crime analysts know that levels of crime may vary greatly across metropolitan areas. This variation generally takes the form of high levels in inner cities and lower levels in suburbs. A trichotomy of levels might be proposed:

- *High levels in permanent inner city hot spots, some of which have been plagued by high crime rates for half a century or more.*
- *Intermediate levels in higher status areas of inner cities and inner suburbs.*
- *Low levels in “outer” suburbs.*

These variations result from demographic and cultural factors including poverty, family structure, and local drug culture. For example, a study of violence against women in Baltimore found that the most powerful predictors of very high levels of violence were poverty and percent of families that were female-headed with related children present. (It should be emphasized that it is where these conditions overlap that the greatest risks exist. After all, single motherhood in itself is not a predictor of crime since this is a condition that is found at all socioeconomic levels.) Areas with high levels of violence had about three times the percentage of such households compared to less violent areas (Harries and Kovandzic, 1999). In practice, these indicators correlate quite strongly with serious violence in American cities. By and large, claims on law enforcement resources are consequently greater per capita in inner cities than elsewhere. This is a serious problem in that resources are weakest in the inner cities as a consequence of population decline and the erosion of the property tax base.

But what does this have to do with change detection and resource allocation? Permanent inner city hot spots are unlikely to change rapidly, given that problems of poverty are endemic and seem to resist amelioration. It seems that change only comes about when such areas are physically demolished. This does not eradicate crime, of course, but merely redistributes crime-prone persons to other locations.

Different levels of crime in different urban context have important implications for change detection, resource allocation, and forecasting. The long-established hot spots in the urban core are the most predictable elements of the overall metropolitan ecology of crime. As noted, they demand high levels of resource allocation, are unlikely to change much in the short term, and are therefore likely to continue to be hotspots. In terms of law enforcement, such areas are easiest to plan for, but virtually impossible to control. Even when levels of crime in those areas decline, as most have in recent years, they still tend to have high levels relative to their surroundings. The intermediate and low crime areas are likely to be more susceptible to change and harder to predict.

> This degree of difficulty of prediction is maximized in the suburbs where change is most dramatic, as evidenced by the 2000 census. The three Colorado counties highlighted in Table 1, for example – Douglas, Elbert, and Park, are on the fringes of the Denver metropolitan area, Douglas to the south, Elbert to the southeast, and Park to the west in the mountains. While the base populations of Elbert and Park were small, and percentage changes less numerically significant, Douglas ranked first in the country in terms of percentage county growth on a substantial base of over 60,000 in 1990, growing nearly 200 percent in the decade. This type of rapid growth makes strategic planning extremely difficult, if not impossible. Bear in mind that during this addition of over 115,000 people, there was no census to provide data on the quantitative or qualitative aspect of population growth. Critical questions would include: What was the age structure of this new population – specifically, what was the proportion of crime-prone youthful males? How was that population characterized in terms of socioeconomic status? Where most data are needed, and at the finest geographic resolution possible — in rapid growth suburbs like Douglas County – we see in reality the most dramatic dearth of data further handicapped by a coarse geography. In the rapid change suburbs, census tracts are largest owing to the census criterion that tracts average 4,000 persons (Figure 1). Thus prior to the 2010 Census of Population, existing tracts in Douglas county will be split in order to conform to the 4,000 criterion, but this does not help our understanding of small area change prior to 2010. Thus crime analysts and planners in the inner city have a relatively easy task in terms of understanding change and predicting needs for resource allocation. By comparison, their suburban counterparts are severely challenged.

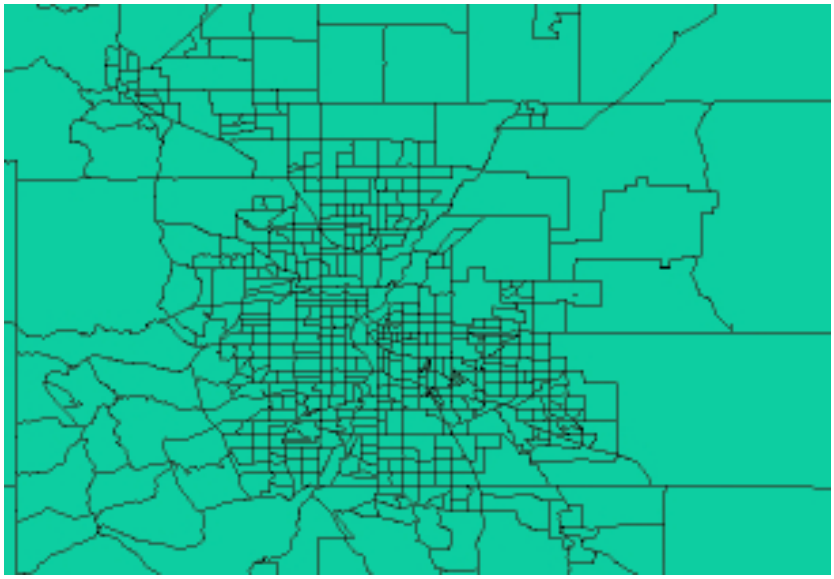

Figure 1. Census tracts in the Denver metropolitan area. Note that tracts are larger further from Denver City. *Source*: http://www.census.gov/geo/www/cob/tr2000.html

Table 1. *Top Ten U.S. Counties Ranked by Percent Change in Population: 1990 to 2000*

Rank	County	State	April, 1990	April, 2000	Number	Percent
1	Douglas	CO	60,391	175,766	115,375	191%
2	Forsyth	GA	44,083	98,407	54,324	123.20%
3	Elbert	CO	9,646	19,872	10,226	106%
4	Henry	GA	58,741	119,341	60,600	103.20%
5	Park	CO	7,174	14,523	7,349	102.40%
6	Loudoun	VA	86,129	169,599	83,470	96.90%
7	Paulding	GA	41,611	81,678	40,067	96.30%
8	Summit	UT	15,518	29,736	14,218	91.60%
9	Boise	ID	3,509	6,670	3,161	90.10%
10	Eagle	CO	21,928	41,659	19,731	90%

Source: Census 2000 PHC-T-4. Ranking Tables for Counties: 1990 and 2000. Table 4: Counties Ranked by Percent Change in Population: 1990 to 2000.

2. Impact of Jurisdictional Fragmentation

The jigsaw puzzle of local governments of vastly varying sizes and capacities makes for a criminal nirvana, although most criminals probably don't realize it. Fairly typical complexity is illustrated in figures 2 and 3, showing the patchwork of incorporated and "census designated places" (CDPs) in the Denver and Los Angeles areas, respectively. In the latter illustration (Los Angeles, figure 3), labeling has been left intentionally chaotic in order to emphasize complexity.

Open debate about the problems presented by fragmentation is taboo. It is in the best interests of police departments and other agencies to sweep such issues under the rug. Overt recognition that fragmentation may not be the best way could result in some undesirable changes, not least of which would be that some chiefs of police would lose their jobs as a byproduct of any political consolidation. This type of retrenchment would have similar impacts down the chain of command. Territorial power bases would shift and change. If two or three jurisdictions consolidate, the top of the hierarchy can only be located in one, so the others lose influence, going from autonomous units to cogs in a bigger wheel.

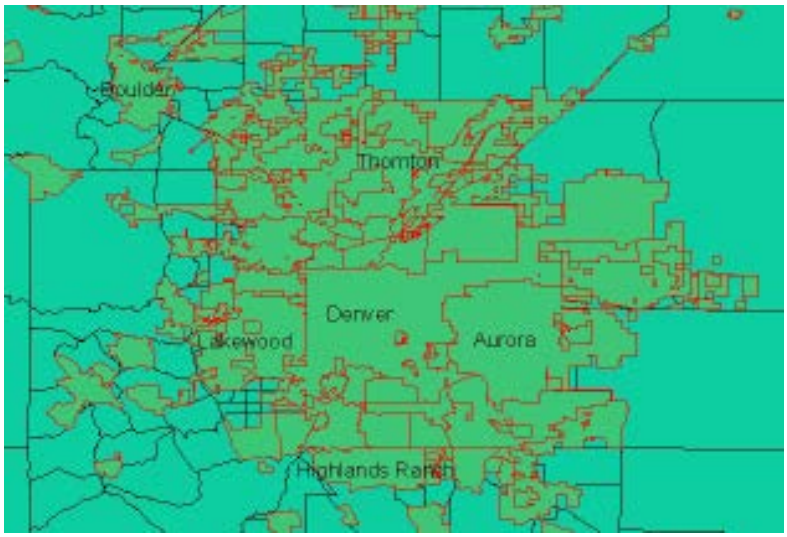

Figure 2. Incorporated and Census Designated Places in the Denver, CO, metropolitan area. Source: http://www.census.gov/geo/www/cob/pl00.html.

What are the day-to-day impacts with respect to change detection and resource allocation? Most serious, perhaps, is that normally only intra-jurisdiction change is monitored and reacted to, even though that change may be the result of processes operating outside the jurisdiction. In the worst-case scenario, the cause of the problem is entirely elsewhere, such as a gang from a neighboring community making incursions. Serial criminals have better chances of evading detection if they move from jurisdiction to jurisdiction, thus failing to present a pattern of incidents in any one community.

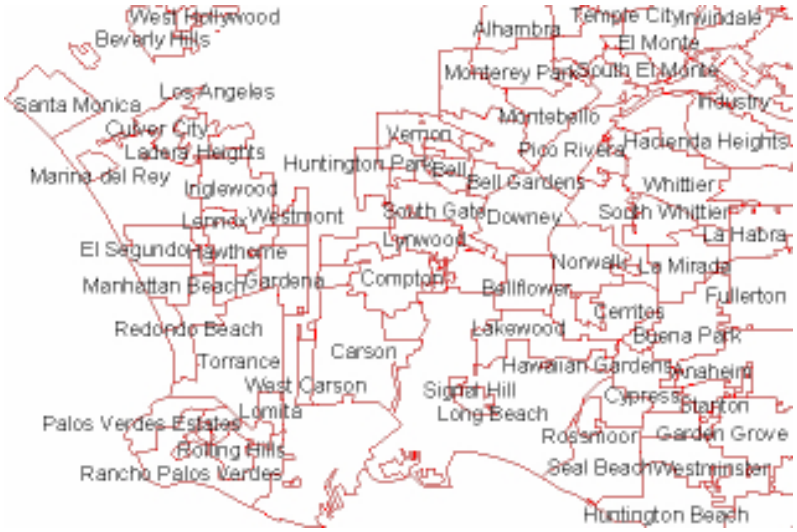

Figure 3. Incorporated and Census Designated Places part of the Los Angeles, CA, metropolitan area. *Source*: http://www.census.gov/geo/www/cob/pl00.html

Fragmentation is actually even worse than it appears, since there are police agencies within police agencies, so to speak, as in situations with, for example, public housing authority, port authority, or transit authority police embedded within the territory of a city police department, but administratively separate from it. This type of fragmentation raises thorny questions of measurement and responsibility that have been discussed elsewhere (see: Hyatt and Holzman, 1999).

From the perspective of resource allocation, fragmentation makes for the inefficient use of resources since problems affecting several jurisdictions are likely to be tackled piecemeal with each of the affected agencies mounting its own tactical effort without regard for the initiatives going on elsewhere. In this type of situation, the worst case scenario is that agencies actually get in each other's way and foil each other with tactics that cause duplication and confusion. Anecdotally, we have all heard of situations in which multi-agency initiatives failed, for example, owing to lack of communication compatibility with the result that the collaborating agencies could not communicate in the field.

3. Issues Relating Specifically to Boundaries

At the macro level, boundaries have a profound influence on the measurement and perception of crime rates (figure 4). If a city is "underbounded," in other words if the city boundary covers less territory than the urbanized, or "bricks and mortar" area, then it is likely that high crime permanent hot spots in the inner city will result in an elevated rate for the city as a whole. However, even with the continued existence of those hot spots, if the boundary is extended outward toward the urban periphery, the overall crime rate drops, as the effect of the inner hot spots is diluted by lower rate suburbs. Thus communities that entirely exclude perennially high crime rate areas will of course enjoy low rates, as in most outer suburbs.

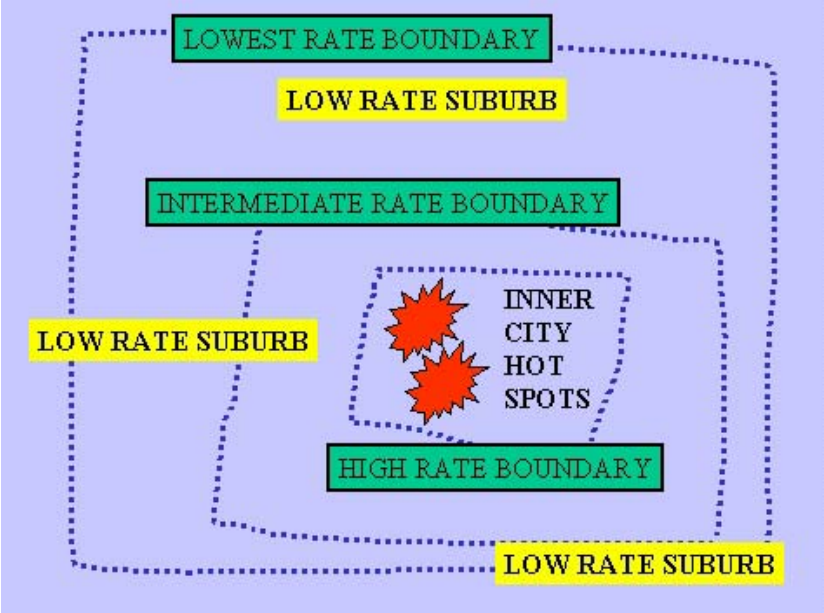

Figure 4. Within a metropolitan area, crime rates for various jurisdictions are a function of where their boundaries are located with respect to the crime production system**.** *Source*: Illustration by author.

Boundaries have other effects. Most notably they artificially partition what we might call "crime system space" – the functional realm of operation for criminals. As noted earlier, crime hot spots may be split by multiple boundaries, some of which coincide with each other, as when city, county, and state borders coincide, as they do in many places. In some cases, the nature of boundaries invites complications in the realm of law enforcement. For example, along the Potomac River between Maryland and Virginia, the state line is on the Virginia shore – all of the river is in Maryland. Historically, this led to an ingenious approach to the fact that gambling was legal in Maryland but not in Virginia. The solution was for Virginia entrepreneurs to build piers from the Virginia shore (gambling illegal) to provide access to vessels moored in the river, in Maryland (gambling legal)!

Smart criminals will "play" boundaries, operating back and forth across jurisdictions in order to avoid leaving a trail that might be picked up on if all the activities were on the same side of the boundary. In areas with political geography as complex as Los Angeles, this could be a productive approach, since it is unlikely, absent a regional criminal justice system, that jurisdictions would detect any kind of pattern. Boundaries can be abused, too. In a singularly pointless exercise in the 1980s, Washington D.C. police rounded up prostitutes and marched them across a Potomac bridge in order to make them Virginia's problem. This begs discussion of the displacement and "spillover" issues, which have been considered in some depth elsewhere (for example, Hakim and Rengert, 1981; Barnes, 1995). Suffice it to say that displacement may result in a kind of boundary ping-pong, with displacement bouncing back and forth between jurisdictions. What are the implications for crime analysts for change detection and resource allocation? The most prominent hazard may the likelihood that the analyst will be blindsided by unexpected events happening next door, or may be called on to explain events for which virtually no data are available, given that the data are "owned" by the neighbors. One of a number of possible approaches is to cultivate an awareness of the importance of

boundary issues, and to become quite well informed about what is happening "over the line." This demands efforts, both physical and intellectual, since the data necessary to understand what is going on "over there" will not necessarily be readily available. Most obvious is the possibility of liaison with counterparts in the other jurisdiction(s), and this is happening in some places.

4. Detection of Demographic Change and its Implications

A key to understanding how crime patterns may change involves monitoring demographic trends. As noted earlier, areas with high levels of both poverty and female-headed households with children present are frequently at risk. If proportions of population in these categories show a tendency to increase in certain neighborhoods, it can be assumed that community risk will increase. A community that has developed the risk concept and made it a focus of departmental policy is Redlands, CA, where risk has been formalized into the expression "Risk Focused Policing" (RFP), described as a process that is "data and results- driven." For additional information, see: http://www.ci.redlands.ca.us/207.html.

But demographic change informs much more than risks of serious violence. Is population increasing? Raw population totals provide some indication of crime levels, and these probabilities can be refined on the basis of what is known about the socioeconomic status of the additional people. Those numbers, in turn can be translated into demand for resources. How many new households (generally the same as the number of new housing units) are there? What is the population density? Does the history of the relationship between population size and characteristics and calls for service in the community help inform predictions of additional resources needed for patrol purposes? Does demographic change in adjacent communities suggest future developments that may place demands on local police resources? These are some of the ways that demographic change can be used to refine planning for change and resource allocation in law enforcement.

5. Need for Data Integration

It becomes apparent that change detection and resource allocation place heavy demands on data, much of which is in reality missing or inadequate, such as census data in the second half of any decade or crime data for an adjacent jurisdiction(s). Frequently, when the "real" data are missing, it becomes necessary to fall back on surrogates, such as substituting building permits or utility hook-ups for counts of households or indications of neighborhood population turnover. Since such data are not normally part of the police department repertoire, integration across local government departments is called for, and is happening more and more. Thus we see a need for integration that can be described as both *horizontal* (same variables, such as crime data or building code violations, across communities A, B, C . . .) and *vertical* (drill down through the levels of the criminal justice system, so that data are freely available for policing, courts, and corrections). For additional discussion, see Harries, 1999:148).

Conclusion:

This paper has explored some of the issues surrounding change detection and resource allocation, as influenced by the fragmentation of local governments and concomitant boundary and demographic conditions. Unfortunately, the data that analysts need to best do their jobs are frequently incomplete, unavailable, or out-of-date. Data availability problems are compounded by local government fragmentation, the traditional reluctance of departments within local governments to share data among themselves, and the infrequency of censuses of population. "Community-centric" databases blind us to changes in neighboring places that may impact our own situations. Fragmented local government is attractive to citizens and

employees alike, since it provides local autonomy as well as a proliferation of jobs as bureaucracies are duplicated. These perceived benefits are counteracted by inefficiencies, such as difficulties detecting crime patterns across political boundaries and general lack of coordination among neighboring agencies.

Recent trends provide some basis for optimism. One is seen in the form of regional initiatives such as RCAGIS, the Regional Crime Analysis GIS in the Baltimore-Washington region (http://www.usdoj.gov/criminal/gis/rcagishome.htm), and SanGIS in San Diego City and County. The latter has the following stated objective: "To maintain and promote the use of a regional geographic data warehouse for the San Diego area and to facilitate the development of shared geographic data and automated systems which use that data.." (For additional information, see: http://www.sangis.org/sangis/about.html). Such initiatives provide some capacity to cut across local government boundaries, detect change more effectively, and, in theory at least, utilize resources in a more optimal manner. Another initiative that will provide an important supplement to the decennial census is the new American Community Survey developed by the U.S. Bureau of the Census. Their documentation notes that full implementation of the survey would begin in 2003 in every county of the United States. The survey would include three million households. Data are collected by mail and Census Bureau staff follow up those who do not respond. The American Community Survey will provide estimates of demographic, housing, social, and economic characteristics every year for all states, as well as for all cities, counties, metropolitan areas, and population groups of 65,000 people or more. (For further detail, see: http://www.census.gov/acs/www/index_main.htm.)

Improved change detection and more optimal resource allocation are on the horizon, if not yet reality in many places. If current trends toward limited regionalization and improved timeliness of demographic data continue, analysts' tasks will be made a little easier.

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