THE UTILIZATION OF THE FORENSIC SCIENCES IN POLICE INVESTIGATIONS: A Review of the Literature

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PREFACE

Supreme Court decisions, Presidential crime commissions, law enforcement practitioners and researchers all have urged greater reliance upon physical evidence and scientific procedures as means for upgrading the quality and effectiveness of criminal investigations and prosecutions. Accordingly, public agencies across the country have allocated funds to the expansion and improvement of forensic science laboratories. To date, however, there exists a void in the criminal justice literature addressing the costs and benefits of the "scientific approach" to the solution of crimes and the prosecution of criminal defendants.

In response to this need, the National Institute of Justice awarded a research grant to the Forensic Sciences Foundation, Inc. and the University of Illinois at Chicago Circle to assess the role and impact of scientific evidence on police investigations. This ongoing research project is gathering data in four field sites throughout the country for the purpose of determining the types, quantities and usefulness of physical evidence collected and utilized in the course of criminal investigations. The role this evidence plays in reconstructing crimes, identifying or eliminating suspects, and associating or disassociating offenders with victims and the scenes of crimes is being described. Those configurations of physical evidence and other elements of information collected by criminal investigators which lead to the arrest and charging of offenders will be identified. The outcome and final disposition of investigations employing physical evidence will be contrasted with a control sample of cases without physical evidence.

This present monograph represents the completion of the first phase of the research project in which the literature of forensic science, policing and cost-benefit analysis has been reviewed. Those publications which have addressed the utilization of scientific information in the investigation and adjudication of crimes are discussed and evaluated within the context of the goals of the present project.

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INTRODUCTION

In 1965 the President's Commission on Law Enforcement and Administration of Justice was impaneled to undertake an exhaustive inventory of the nation's criminal justice system and report its findings to the American people. During the intervening years the various operating agencies which comprise the justice process have undergone scrutiny by evaluators and social science researchers attempting to understand these agencies' respective roles and effects upon the crime problem and the justice system and to recommend changes for their greater efficacy.

Two such research foci have been the criminal investigation process and the operations of the forensic science or crime laboratory. It is the intent of this research to examine the interrelationship between scientific laboratories and police investigators, and specifically to examine the effect of forensic science on the investigation and solution of crimes. This research is long overdue. Since the publication of the President's Crime Commission Task Force Reports on *Police* and *Science and Technology* (1967) in which greater reliance on physical evidence by the criminal justice system was advocated, data have not been collected which show just what the value of forensic science services is to the system. The use of physical evidence has also been advocated by the National Advisory Commission on Criminal Justice Standards and Goals which stated:

> Every state and every police agency should acknowledge the importance of efficient identification, collection, and preservation of physical evidence; its accurate and speedy analysis; and its proper presentation in criminal court proceedings. These are essential to professional criminal investigation, increased clearance of cases, and ultimately, the reduction of crime...(1973:299).

The 1975 forensic science assessment study of the judiciary (Schroeder, 1977) reported that judges, on the whole, find physical evidence testimony most beneficial in the courtroom. Although positively in favor of forensic science, these endorsements are weak in terms of making a cost-effectiveness argument for the expansion of its services. Other research, in particular the Calspan (Rosenthal, 1974) and INSLAW (Forst, 1977) studies discussed below, have collected limited

empirical data regarding the effectiveness of scientific evidence in criminal investigations but these studies either suffered difficulties gathering sufficient data to reach statistically valid statements or inferences (CALSPAN) or treated the role of physical evidence in the prosecution of offenders in a far too cursory fashion (INSLAW). Consequently, forensic science has been relegated to a kind of nether world in the realm of federal, state and local funding priorities; administrators and scientists simply lack the data needed to compare the value of scientific means of investigation against other more traditional forms of fact-finding.

That forensic science is of some intrinsic value has never been questioned. However, an explanation of its value is usually anecdotal in nature. One often resorts to the citation of an infamous kidnapping, homicide or rape case in which physical evidence was crucial.

On the other hand, forensic scientists themselves believe their profession to have unlimited, if undeveloped, potential to aid the criminal investigative process, particularly in the apprehension and conviction of criminals. At present, however, physical evidence is not used so much to provide investigative leads to law enforcement officers as it is to either corroborate an investigator's theory, e.g., a fingerprint linking a suspect to the crime scene, or demonstrate that a crime indeed was committed, most commonly in drug possession cases and death investigations.

The public often forgets that forensic science has capabilities beyond analyzing drugs and processing fingerprints. This fact has been obscured by the inundation of narcotics cases which accompanied the "drug explosion" of the late 1960's and the long-standing if slightly romantic notions about the value of fingerprints. Drugs, however, are the main culprit. During the last decade the number of crime laboratories has doubled but mainly to accommodate the ever growing need for drug analysis. The laboratory has been forced into a reactive mode where the demands of the police and prosecutors require that most available funds be channeled to purchase more sophisticated instrumentation and hire additional scientists solely to handle drug caseloads.

Thus, to put forensic science utilization in its proper perspective, drug cases should be considered separately since they most definitely skew the picture. Several research studies have addressed or touched on the area of forensic science utilization in the criminal justice process, and all have found utilization to be extremely low. What follows is a discussion of these studies.

This examination of the literature is divided into four principal sections which may be visualized as a series of concentric circles, the core of which is a review of those writings addressing the availability and utilization of physical evidence and the operations of crime laboratories. The next ring of studies concerns those addressing the criminal

investigation process and particularly what role, if any, tangible evidence plays in solving cases. This is followed by a more general discussion of studies in police evaluation and productivity which have applicability to the issue of measuring scientific effectiveness. The outer most circle of literature addresses cost-benefit analysis in general with, again, an eye toward its application to the determination of cost and benefit of scientific modes of inquiry in law enforcement.

Physical Evidence and Crime Laboratory Operations — The vast majority of publications in the forensic sciences is devoted to scientific principles and techniques and their application to the analysis and interpretation of physical evidence. Still, a small body of literature has developed in recent years which examines the availability and collection of physical evidence from scenes of crimes and the performance and output of forensic laboratories. This section, which constitutes the major emphasis of the literature review, will discuss those significant articles, reports and monographs published over the past two decades.

Criminal Investigations — As with most of the writings in forensic science, the literature of criminal investigation has centered primarily upon professionally oriented texts, covering various tactical and rule of thumb methods for investigating crimes. Few attempts have been made to evaluate the role or effectiveness of investigation units, with perhaps the leading effort to date being the Rand Study of 1975. Those studies in this area which address the significance of physical evidence in investigations will be reviewed.

Police Productivity — There have been a number of research projects of late which have attempted to evaluate the effectiveness of police operations, in terms of their attainment of such goals as crime prevention and apprehension of offenders. An overview of primary studies in this area is included since any effort to incorporate measures of forensic science effectiveness into a police operation must be integrated with overall agency goals and evaluation procedures.

Cost-Benefit Analysis — Because one of the primary challenges of this research is to develop the means to describe the actual benefits as well as costs of forensic science services to a police agency, the general cost-benefit literature has been reviewed in search of concepts and strategies that, although developed in the private or other public sectors, have applicability to the present problem.

PHYSICAL EVIDENCE AND CRIME LABORATORY OPERATIONS

One of the very first research studies funded by LEAA's National Institute of Law Enforcement and Criminal Justice in 1969 attempted to determine the availability and to describe the various types of physical evidence at the scenes of crimes (Parker and Peterson, 1972). This project found that physical evidence was present at most, perhaps ninety percent, of felony crime scenes investigated. The study also documented that much of this evidence was not preserved, and even less was ever analyzed by a forensic science laboratory. If the goal of the police investigative function is the solution of crimes and the apprehension of offenders, then it appears on the surface that a vast source of potentially valuable information is lost when physical evidence is ignored.

A police department, like any organization working within budget constraints, must be mindful of the benefits which accrue from any expenditure. Policy makers within an agency must have some notion of the utility of allocating funds and resources in certain areas toward the achievement of goals. It is often unclear what the true goals of an organization really are (i.e., what the organization is actually trying to achieve, rather than what it might publicly state it is seeking). However, for police investigators, it is possible to posit two goals: First, is the goal of solving crimes, which does not always include the apprehension of the offender, or a conviction for an offense. It may mean simply identifying the offender responsible for the commission of an offense with some level of certainty. Second, an investigator is concerned with the public relations value of giving the crime victims a sense of confidence in the police and their crime solving efforts.

In his article "The Scientific Assessment of Physical Evidence from Criminal Conduct," Brian Parker (1974) examined the history of forensic science and its literature, beginning with the assumption of all criminal investigation that "physical changes necessarily accompany each human act" (Parker, 1974:505) and that the conduct can be reconstructed. He cited the Parker and Peterson (1972) study results to counter investigators' claims that physical evidence is an uncommon occurrence at the scenes of crimes. He then goes on to cite four modes of behavior investigators commonly employ to explain their treatment of such evidence, the first being a legal requirement.

Although in the majority of cases laboratory evidence is not necessary to show that a crime has been committed, a laboratory analysis is absolutely essential in drug possession cases. The laboratory must

show that the contraband is in fact the substance which is restricted or controlled through statute.

The second factor is the community requirement. A particularly abhorred or heinous offense demands (at least the appearance of) total investigation and utilization of all police resources. Physical evidence must be collected although it may serve only to enhance public relations.

Third is the availability of investigative personnel, and their ability to make decisions based on more or less rudimentary knowledge. Fourth is the investigator's awareness of the laboratory caseload and the investigator's intuitive prediction of laboratory results. If the investigator does not think the evidence will be helpful, he will probably not bother to preserve it for analysis. Because an investigator often has so little experience with the laboratory, he may be ill-prepared to distinguish the useless evidence from that which is important. Parker's major conclusion is that physical evidence must be evaluated against *all* types of investigative information if a rational allocation of resources is to be made.

Beginning with Parker's survey of forensic laboratories in 1963, several efforts at measuring the actual utilization of laboratory services have been made. It was determined in this early study that less than two percent of total criminal violations at the local level received laboratory examination, and other studies have confirmed the low utilization statistics. Joseph (1963), Rosenthal (1969), and Parker and Peterson (1972) found that the crime laboratory is used in from only one-half of one percent to six percent of all criminal cases.

Measuring and contrasting the actual amount of physical evidence that enters the laboratory with the potential amount was the subject of the study by Parker and Peterson in 1972. The authors rejected laboratory receipts and offense reports as measures of physical evidence, arguing that both of these sources are biased by the decision criteria employed by field officers in selecting evidence for laboratory analysis. Their "ideal" measure would be "an independent measure of all physical characteristics at a site of criminal activity" (515). This ideal was approximated by the use of observers, knowledgeable in forensic science, who visited and recorded more than 750 major felony crime scenes in Berkeley, California over a three month period in 1969.

The ultimate objective of this study was to determine if criminalistics could become a regular aid to the investigation process, and not be used just as a last resort when all other methods fail. While that question is not answered, it is clear that utilization of physical evidence is very low. Only 4 out of 3,303 Part I crimes during that period involved laboratory examination of physical evidence, although the potential for utilization is very high. Physical evidence was present in

about 9 out of every 10 crime scenes visited.

As each crime scene was investigated, the observer noted all physical objects that could be used as evidence, and they were classified into 23 categories. In some cases no physical evidence was found because the crime scene had been cleaned up by the time the observer arrived. Other times, the scene was inaccessible to the observer and no record of physical evidence could be made. In some cases, minimal site disturbance by the criminal occurred when, for example, a burglar entered through an unlocked door and left with a portable item such as a television. These three reasons: cleaned up scene, inaccessible scene, and minimal disturbance, accounted for most of the cases in which no physical evidence was found.

Parker and Peterson found that 88% of burglary scenes had physical evidence, yet in less than 5% of those crimes was there any request for laboratory service. During the observation period, 92% of the cases which were analyzed by the crime laboratory involved drugs and narcotics. Usually more than one form of physical evidence existed at a crime scene, although many investigators often confine their search to only one type of physical evidence—fingerprints.

In Peterson's 1974 monograph "The Utilization of Criminalistics Services by the Police" an attempt was made to account for the reasons why evidence is collected and analyzed by the laboratory in such a small proportion of cases. Peterson developed an "evidence screening model" (Figure 1) in which eight levels of decision making were identified between the time of initial police involvement with a crime and the submission of physical evidence to the laboratory. At any level evidence could be ignored, screened out or discarded.

The first level is the decision made by the patrol officer to intervene in a suspected criminal violation. The decision will depend upon the perceived seriousness of the event in question, the policies of the police department, as well as the prior experiences of the officer in handling similar incidents. The second level concerns the question of whether a case should be dealt with informally or whether a patrol officer should record the alleged crime in a formal report and process it through official channels. This, of course, is a function of the police officer's interpretation of criminal codes and the matching of the incident with the appropriate definiton. The presence of physical evidence at the scene which tended to corroborate the victim's or witness's account of the incident often tipped the balance in favor of the officer's decision to handle the case through formal channels.

Only if the case is to receive formal treatment will a patrol officer, detective, or field sergeant decide to call for the services of a crime scene search officer or evidence technician. If the technician is notified, he must decide when he will respond, because he usually has a backlog of cases awaiting processing. Oftentimes a technician's sub-

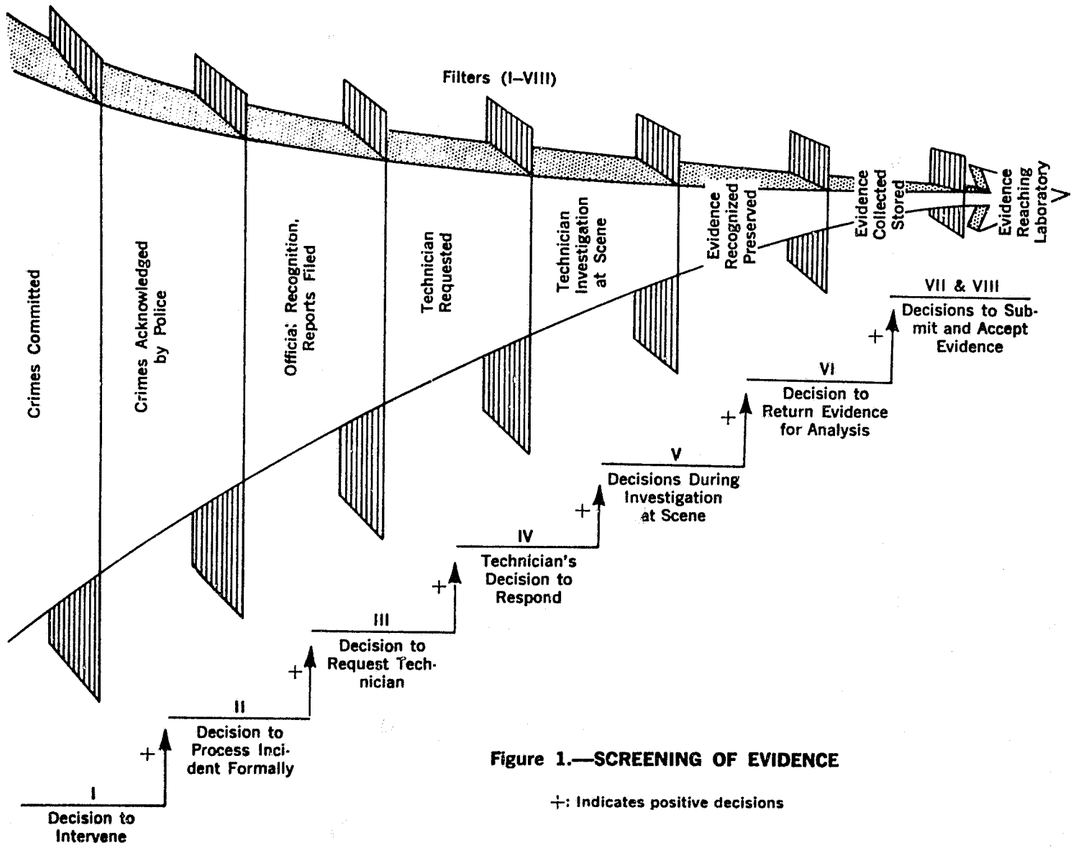


Figure 1.—SCREENING OF EVIDENCE

+: Indicates positive decisions

jective evaluations enter into this decision, particularily when he is averse to travelling to that area of the city or when he has poor relations with the requesting officer. Other factors may influence his decision, such as his perceived urgency of the request, his involvement in another, more serious incident, the rank of the officer requesting his services, and his past success with similar crime or similar physical environments.

When the technician responds to the crime scene, his retrieval of evidence will be influenced by the amount of time he chooses to devote to the particular incident, the equipment and supplies he has with him at that time, and of course, how well the scene has been preserved. The collection of certain evidence may also be dictated by detectives or superior officers at the scene. Technicians may also gather evidence if they feel it will create favorable public relations with the victim of the crime.

Although evidence is gathered, it may not be examined in the laboratory. In many cases, evidence is stored in a property room until the detective, or prosecuting attorney, in charge of that case decides to request an analysis. Often this request is made only after all other avenues of the investigation fail, or, if an arrest is made, a decision is made to prosecute. The Peterson model explains why only a small proportion of evidence available in the field ever reaches the laboratory for analysis. The "filters" erected by patrol, detective and technical field personnel in some police departments screen out most of the available evidence.

The *Task Force Report on Science and Technology* of the President's Crime Commission (1967), advocated greater reliance on physical evidence by the criminal justice system. The Task Force was mainly concerned with what science and technology could contribute to the police operations of controlling crime by apprehension of criminals and deterring criminals with the threat of apprehension. They observed that the most significant factor affecting clearance of cases is the naming of a suspect in the crime report. The Task Force recommended, therefore, more intense preliminary investigation at the crime scene to produce more leads for fruitful follow-up by detectives.

Major attention was not devoted to criminalistics. However, the report did recommend the establishment of regional crime laboratories to serve the combined needs of police departments in metropolitan areas, and it recommended the expansion of forensic science research activities.

Several "systems analyses" of crime laboratory operations and the role of physical evidence have been conducted. A John Jay College study by Alexander Joseph (1968) involved a national survey of crime laboratories. Based on 140 replies to a questionnaire and field visits to 18 sites representing a cross section of laboratories nationwide, Joseph

found that poor facilities, low salaries, and inadequate education and training of laboratory personnel were the norm rather than the exception. Few non-federal laboratories were "fully equipped," and many laboratories could perform only elementary analyses. Joseph called for the use of a standardized management reporting form, and proposed a college curriculum for aspiring criminalists.

This study included data on the then existing facilities and manpower, and presented recommendations for a system of regional laboratories and other improvements. Joseph's survey of directors of laboratories revealed that, in their opinion:

> the number of crimes committed in their jurisdictions that should have been serviced by the laboratory was six to twelve times greater than the number of cases submitted...(Joseph, 1968:11).

Finally, the report concluded with a list of "research needs," or areas of forensic science that deserve emphasis and priority in research.

In 1970 the Midwest Research Institute, with the assistance of an LEAA grant, issued a report, "Systems Analysis of Criminalistics Operations," by Benson et al. The primary aim of the study "was to recommend systems of criminalistics operations that would meet cost/benefit criteria while serving the needs of local communities, regional areas, and the nation" (Benson et al., 1970:111). The value of criminalistics itself was assumed, and no attempt was made to measure its effectiveness. The study was concerned only with making an analysis of the role that criminalistics plays in the criminal justice system, and to define factors that influence size and location of criminalistics operations (4).

Benson et al. began their report by noting some facts about the state of crime laboratories nationwide in 1970. Although the number of laboratories engaged in some aspect of forensic science was greater than one hundred, fewer than ten could be called "full service." The national FBI laboratory, which could provide the most comprehensive and up-to-date forensic service at no charge, was used in only about .1% of all criminal cases.

The study sought to determine what arrangement of local, state, regional and national laboratories would provide the best service and what sort of crime laboratory system would be the most cost effective.

Before outlining a form for the most effective criminalistics operation, the report presented several minor findings. It mentioned the infrequent involvement of the crime laboratory in the total body of crime, and hence the difficulty in assessing its impact on the whole criminal justice system. It recommended training in evidence preservation for all law enforcement officers, and the use of skilled evidence

technicians for the collection of evidence. It estimated that if crime laboratory involvement were increased to only 4% of all reported crime, a fourfold increase in the number of practicing criminalists would be necessary to handle the load.

The Midwest Research Institute Report was one of the first to document the huge burden of drug cases in crime laboratories. In a survey of ten jurisdictions, 54% of the cases submitted to crime laboratories involved drugs and narcotics. For the cities of Berkeley, Buffalo and Portland, the mean drug submission rates were 92%, 72% and 67% respectively (19-20). The development of automated analyses for commonly recurring substances was recommended, as was the acceptance of laboratory reports at lower court hearings in lieu of the appearance and testimony of the analyst.

The crime laboratory is generally an isolated element in the criminal justice system, subject (usually) to the management and budget constraints of a police department, yet not wholly a part of it. Benson recommends emphatically that:

> The laboratory should be situated in the organization where it has some voice in its budget, personnel policies and other management decisions...In addition to involvement in funding decisions, the laboratory needs to have a strong voice in assessing the amount, type and quality of evidence that it receives (9).

If the crime laboratory is to reach maximum effectiveness, it must, according to Benson, have some autonomy, some self-determination concerning budget and personnel, and a voice in its role in the criminal justice process. Under the control of a police department bureaucracy which may or may not fully understand and appreciate its abilities, the criminalistics operation cannot flourish.

Benson concluded that crime laboratories must be located where the crime is. The utilization of criminalistics services is a function of the distance between the submitting officers and the crime laboratory. If the laboratory is not within reasonable driving distance of the evidence, there is a reduced likelihood the officer will bother with packaging and sending the evidence in for analysis. Benson also recommended that crime laboratories serve an entire Standard Metropolitan Statistical Area.

After the report of its nationwide criminalistics systems analysis, the Midwest Research Institute was contracted to undertake several smaller scale studies in such jurisdictions as Massachusetts and in New York's Mid-Hudson River region. The main question in the Massachusetts study (1971) was: What should be the organization of the state

criminalistics system? It concluded that the Boston Police Laboratory should be left alone, and a separate state system should be developed into a network of regional laboratories. That conclusion was based upon one interesting observation: Although centralization—consolidation of the existing Boston and state laboratories—can be cheaper and allow for greater sophistication of services offered:

> ...experience has shown that a crime laboratory does not necessarily grow more efficient with increased size. (T)he mere fact of existence of even the more sophisticated crime laboratory does not guarantee that it will be used to its full potential (6,8).

The argument in both the Massachusetts and New York reports is that a crime laboratory is primarily a service venture and to be successful it needs customers. In order to reach its potential, it relies on a comprehensive system of support from patrol officers, evidence collectors, investigators, and prosecutors. The laboratory obviously cannot help in clearing cases and prosecuting offenders unless it is utilized by these other system components. The MRI report concluded that consolidation and centralization (of Boston and state services) had a higher potential for raising organizational barriers between itself and its customers. The degree to which a laboratory is used depends mainly on police/investigator attitudes, and these are shaped in large part by the convenience (or inconvenience) of bringing the evidence to the laboratory and the laboratory's ability to produce timely and useful results. A statewide network of regional laboratories, with the Boston laboratory remaining independent, was suggested as the best way to achieve maximum criminalistics services.

Both the Massachusetts and New York studies suggested a crime scene search training program for law enforcement personnel, and found the creation of an evidence transport system advisable. An evidence transport system would securely deliver evidence from the crime scene to the laboratory, thus relieving patrol officers and investigators of this major inconvenience. Another suggestion urged that routine drug, narcotic, blood and urine analyses be completed, as much as possible, outside the criminalistics laboratory. A laboratory's productivity is often measured in terms of the number of cases it handles, and drug and blood cases certainly add to that number. However, too much emphasis on routine analyses detracts from the laboratory's ability to aid in more serious criminal investigations.

That existing facilities, equipment and personnel were not adequate to meet the needs of law enforcement was determined in another study of the state of Massachusetts. Published in the same volume

as Joseph, and drawing extensively from the findings of Joseph and the President's Commission, the report stated that:

> Equipment is either totally absent or obsolete, facilities are crowded, staffs are too small and underpaid, and many police officers throughout the state are not adequately trained in crime scene search and preservation of physical evidence (98).

The study made several recommendations relating specifically to the problems of Massachusetts. One recommendation, contrary to the MRI report, suggested that the state chemistry laboratory should be expanded to provide essential services to *all* public law enforcement agencies in the state. It urged that a single administration should direct all of the state's police laboratories.

The Alabama State Department of Toxicology and Criminal Investigation reported on its own in-house study of forensic needs in 1973. Although "sufficient data on the present effect of the laboratory system on crimes could not be generated" (Rehling, 1973:2) a number of issues relating to effective crime laboratory systems were explored, including a very detailed examination of the effects of the distance of the laboratory from the crime scene.

That the distance of a laboratory from a crime scene has a very important effect on the amount of physical evidence submitted is discussed in a number of studies (e.g., Benson, 1970). Alabama found, for example, that of homicides occuring within 20 miles of a laboratory, an average of 6 percent of all physical evidence identified in the investigator's report was not submitted. For homicides occurring 60 or more miles from a laboratory, 32 percent of the identified evidence was not submitted. For the crimes of arson, burglary, robbery and suicide, the evidence not submitted for crimes within 20 miles of a laboratory was 25, 27, 36 and 40 percent, respectively. For the same crimes occurring more than 60 miles from a laboratory, the amount of evidence not submitted increases to 41, 55, 53 and, 93 percent, respectively. These statistics reveal, according to the report, "a very serious need for training of officers throughout the state on the benefits of proper evaluation of physical evidence" (32).

In terms of cases per officer and cases per 1,000 population, the data revealed that a very significant drop in the ratio of cases submitted to the laboratory occurs as the distance from the incident to the laboratory increases from 0 to 25 miles. When the laboratory is more than 25 miles from the crime scene, the percentage of cases in which evidence is submitted is fairly constant, albeit at a level of less than one percent. One recommendation of the Alabama study was the creation of a system of regional and satellite laboratories which would more

effectively serve the state by positioning laboratories nearer to the submitting police agency.

In the Alabama study, the percentage of evidence not submitted is based on information contained in the investigator's crime scene reports. Parker and Peterson (1972) found that there is usually more than one type of evidence available at a crime scene. It cannot be assumed that Alabama investigators found only one type of physical evidence per scene. Therefore, no comparisons can be made between the Alabama statistics, measured in terms of "evidence submitted"/"evidence identified by investigators at the crime scene" and the statistics of other studies in which percentages of evidence submitted are measured by "evidence submitted"/"number of crime scenes."

Forensic science services are so difficult to evaluate because these services are rarely used; the potential of physical evidence is generally untested. In "The Role of Criminalistics in the World of the Future," Parker and Gurgin (1972) asked what the character and nature of social benefit would be if criminalistics services were increased. These authors found no reason to devote additional funds to crime laboratories, given the present bureaucratic constraints placed on these facilities.

Employing a case-study methodology, Parker and Gurgin focused on the Santa Clara County (California) Crime Laboratory. They examined records of laboratory utilization in the county for the last twenty-five years, and official crime data from the county and the nation, and interviewed users of the laboratory, laboratory personnel, and county administrators. Observations and findings from the county were compared with other findings in the field of criminalistics, and the authors (along with their panel of expert consultants) concluded that the results of their work were representative of the current "state of criminalistics" (5).

Among the results of this study are many that appear throughout the literature on investigation evaluation. Criminalistics is disproportionally utilized in drug cases. When other types of physical evidence are gathered, it may be primarily for public relations purposes. However, this study looked at criminalistics from a "social institutional" perspective, as a component in a large organizational bureaucracy. It did not provide a cost/benefit analysis, but it examined the interests and aims of laboratory professionals and how their goals contrast with the goals of other members of the bureaucratic hierarchy.

As a professional, the criminalist is concerned with matters of science and law. In practice, the criminalist has little to say about what evidence is gathered at crime scenes, or which of his or her analyses are used in the courts. Evidence submitted to the crime laboratory is largely determined by factors other than the professional aims of the criminalists. Typically, it is the law enforcement officer who decides

what physical evidence will be taken to the laboratory; however, evidence may be filtered out at other levels (cf. Peterson, 1974). Parker and Gurgin conclude that evidence is gathered and used only to the extent it is deemed necessary by the bureaucracy.

The authors suggest that criminalistics be disassociated from law enforcement agencies to pursue its own scientific goals. Currently, most laboratories are under the control and within the budget of the police or the district attorney. It is recommended that research centers for evidentiary science be established which are independent of police or prosecutorial interference. They also recommend that scientific personnel be given the authority to determine when criminalistics services should be initiated, not leaving this critical decision to law enforcement or other, perhaps, politically motivated authorities.

Another study carried out at the Stanford Research Institute (Greenberg et al., 1973) focused exclusively on the investigation of the crime of burglary. In the report "Enhancement of the Investigative Function," Greenberg noted that burglaries account for the largest number of crimes committed in the United States. Burglary also has the lowest clearance rate of property crime, including larceny and auto theft (1). These facts made burglary investigation particularly ripe for suggested improvements.

Six Alameda County, California police agencies participated in the Greenberg study, and 2,000 burglary reports over a three month period were examined. The objective of the study was to develop guidelines for burglary investigation, and determine a way to decide which cases should receive follow-up investigation. Burglaries usualiy involve few clues, and the cost of a full investigation often exceeds the value of the property lost. Therefore, it was important to determine which cases to investigate, and which to close early.

The SRI study sought to dissect the fundamentals of the investigative function by a systems analysis. From computer analysis of burglary reports:

> The primary objective was to ascertain those informational elements that are *essential to the investigation* of burglary cases and to rely upon statistical analysis techniques to evolve those elements that are *critical* to the successful "closure" of cases, in effect, the Essential Elements of Information (EEI's) (5).

From the burglary reports, 170 separate elements of information were identified, and these were reduced to five categories of information for which a relative numerical weighting scale was devised. These five factors are: estimated range of time of occurrence, witness reporting of offense, "on view" reports of offense, usable fingerprints, and suspect

described or named (20). Based on these five categories, it was possible to predict with 80% certainty whether a given case would or would not be cleared.

Greenberg concluded that inadequacies in the handling of information and physical evidence were primarily responsible for the low success rates achieved by police in burglary investigations. Great concern was expressed throughout the report for improving information systems in general, including a suggestion that a computerized regional information retrieval system be developed, with participation from local, state and federal agencies.

Latent fingerprints, toolmarks, and footprints are generally the types of physical evidence found at burglary scenes. However, only fingerprints were useful in verifying the identity of suspects, and no mention was made of using them to develop suspects. Increased use of physical evidence is called "essential," yet the study reported that witnesses provide the best aid to investigators, and that steps should be taken to encourage witnesses to report their observations since this would most effectively improve the investigative function.

Finally, citing Ward's study of specialist and generalist investigators, the SRI report recommended that patrol officers be granted greater investigative responsibility. Also, improved communication among the patrol, detective and other police functions and greater utilization of fingerprints and other physical evidence, were thought to be the best ways to enhance investigative success.

In another "systems" study, Krendel and Dummer (1971) evaluated the forensic science component of the Philadelphia Police Department. The authors reiterated common systems notions, including the idea that a system must be looked at as a whole to best evaluate the performance of a single component. They also pointed out the important role of politics in the analysis of social systems.

The major product of the Krendel and Dummer article is a queueing model which illustrates the sequence of service facilities (i.e., types of analyses) performed by the forensic science component. Like Peterson (1974), the authors discuss the filtering process that determines what evidence is collected and what is analyzed. Probability density functions of such variables as the time required for completion of laboratory reports were developed, and a model for determining optimal budgeting decisions in a static (i.e., non-growing) laboratory was created.

In "Management Planning for Forensic Science Laboratories," Krendel and Dummer (1976) stated the research problem as one of finding the optimal forensic science service given a particular criminal justice organization and crime pattern in a given area (4). The goal of the study was to find methods for determining what forensic science service is best for a particular area.

Data were gathered from an in-depth survey of three crime laboratories: City of Philadelphia, State of Pennsylvania and State of New Jersey. In addition, a general questionnaire was mailed to a cross section of laboratories throughout the country. These data led to the development of a two stage "queueing model," which purported to explain the filtering process by which physical evidence is screened out, beginning at the point of the crime scene and leading up to laboratory analysis.

In addition to the queueing model, a computer simulation program was written to evaluate various laboratory configurations in terms of total cost. Using results of the simulation, a "dynamic programming model" was constructed which makes capital equipment decisions, and funding and grant decisions, on the basis of cost effectiveness. The program can be used to determine the "best" laboratory arrangement.

A number of recommendations were made in the study conclusion. The first was a call for better communication, which is heard in much of the literature. It is pointed out that, "laboratory analyses and work by other police investigators occur almost independently of each other" (26). To cure this, use of a standard form for the recording of all evidence submitted to the laboratory was suggested. These forms would require the submitting agencies to supply some information about the particular case and about the circumstances of the evidence submitted.

Another recommendation involved the assignment of weights to evidence to determine priority of collection and analyses. If a particular piece of evidence had very low weight on the scale, it need not be bothered with. This recommendation builds on the assumption (well-documented) that there is a large quantity of physical evidence material available, giving considerable leeway for choice of which evidence is used.

While the problem of the vast amount of drug evidence processed by crime laboratories is mentioned, and the report recommended finding more efficient tests for handling it, it also warned laboratory directors not to overemphasize the problem. The build up of a large and efficient but inflexible drug unit might prove wasteful in the event of falling requests for drug analysis in the future. It pointed out that while the Philadelphia City Police Laboratory once handled mainly alcohol analyses (during prohibition), alcohol is very rarely dealt with now. A similar reduction in drug analysis would result if certain drugs are decriminalized or law enforcement priorities are shifted. The final recommendation of the report was a call for development of a national data base on procedures and performance times with which to make the simulation and budgeting models more generally applicable. It pointed to the National Institute of Law Enforcement and Criminal Justice as the appropriate agency to gather and disseminate such

information.

In 1969, Paul Rosenthal (who later co-directed the Calspan study) prepared a plan for a pilot study whose objective was to find ways to quantitatively evaluate the benefits of forensic science. While none of the experiments developed in this planning study was implemented, it has several points worthy of notice.

The study centered around three counties in the Niagara Falls area of New York State. The area was thought to be somewhat representative since it includes everything from rural areas to a large city (Buffalo). To answer the question of the pilot study, i.e., how to quantitatively evaluate the benefits of modernized and more available forensic science services, certain measures had to be developed. Through a set of three surveys, suggestions for measures were obtained.

The first survey sought the role of physical evidence as perceived by law enforcement and criminal justice personnel in the tri-county area. The second survey was administered to area crime laboratories, seeking information on their current practices. The final survey collected data on such variables as the number of crimes in the area and the fraction of those crimes in which physical evidence was utilized. One of the principal findings of the third survey was that vastly better record keeping is needed in order to record such evidence utilization data.

Rosenthal found measures of effectiveness for several aspects of forensic laboratory practice, including resources, activities, output and costs (60). For example, measures of the physical plant include age of equipment, work area per analyst, and number of mobile units. For scope of laboratory effort, a measure is the number of cases analyzed/number of crimes reported containing physical evidence. Measures of output include the ratio of accuracy obtained to accuracy obtainable, time per analysis, and significant aid to investigation per analysis.

The planning study recommended the creation of a forensic science laboratory for the tri-county area which could be experimented with by researchers. Rosenthal proposed a number of experiments to be conducted at the new laboratory which could indicate what changes in forensic services would result in improvements. For example, the first study recommended would concentrate on burglaries. Since there is a fairly high number of burglaries committed, experimental treatment of burglary procedures could produce statistically significant results. Rosenthal proposed that laboratory services in burglary investigations be augmented; the costs and benefits of the augmented services could then be evaluated. Another proposed experiment involved the utilization of a mobile laboratory unit at crime scenes.

The essence of this planning study was that a pilot forensic science laboratory should be created, for service to the tri-county area, but especially for research. Experimentation with the facility could produce information and have important implications for the operation of

other laboratories across the country.

An unpublished study by Calspan (Rosenthal and Travnicek, 1974) developed several measures of the effectiveness of criminalistics operations. Rosenthal and Travnicek, co-authors of the LEAA funded Calspan report, stated that their goal was to develop means to improve utilization of physical evidence in the investigation and adjudication of felony crimes. The study was prompted by four major problems:

1. The low percentage of reported crimes in which physical evidence examination plays any role;

2. the diversion of criminalistics activity to dangerous drug and sobriety-related analyses;

3. lack of user motivation toward increasing utilization of criminalistics;

4. the need for systematic investigation of the use and effectiveness of criminalistics in criminal justice operations (Vol. IV, 1).

Tacit throughout the study was "effectiveness" as a measure of criminalistics operations. Effectiveness was defined as, "the frequency of use and the value of information on physical evidence examination in obtaining investigative resolution and/or adjudicatory disposition of a reported offense" (Vol. IV, 2).

A rather parochial use of the concept "criminal justice system" was employed by Rosenthal and Travnicek. The authors took this to mean all actual and potential uses of criminalistics; functions normally associated with criminal justice but unrelated to criminalistics, such as detention or parole, were not included. Thus, the criminal justice system is reduced to four stages: crime scene search, criminalistics operations (analysis), investigation, and adjudication. Three study sites were selected (Contra Costa, California; Columbus, Ohio; and Dade County, Florida), and data were collected for each of the four criminal justice stages, by field observers, during an eight-month period.

One of the major findings of the Calspan study concerned the fragmented and non-systematic practice of record keeping, and the lack of communication among system stages. Each of the study sites employed separate case numbering systems, making it difficult to track cases and categorically analyze physical evidence use. Also, police offense reports were often found to contain no reference to physical evidence. The authors called this symptomatic of a lack of physical evidence orientation by administrators. Lack of adequate record

keeping, they pointed out, can only hinder effective management and supervision of the criminalistics operations.

In Volume I of the Calspan report, Rosenthal and Travnicek followed the steps of investigation, described what criminalistics services were available at each step, and then analyzed their use by case observations. They found, among other things, that the capacity and potential of criminalistics services are greatly underutilized. While eyewitnesses and informers are frequently used, physical evidence rarely is. Generally, physical evidence is used only to corroborate conclusions (i.e., to confirm a suspicion or eliminate a doubtful suspect), and not to develop suspects. Finally, the use of fingerprints varied among the departments, although it was underutilized at each site.

Volume II of Calspan focused on the use of criminalistics in the courtroom. It reported that very few offenses which go to trial involve physical evidence. However, in several crime categories, the use of physical evidence increased the ratio of pleas of guilty as charged to pleas of guilty to a reduced charge. This suggests that physical evidence can substantially "strengthen" the prosecution's case, making it unnecessary to bargain for a plea to a lesser charge.

Volume III, in which measures of the effectiveness of criminalistics are developed, is perhaps the most relevant to this review. In all, 35 potential measures are examined, most of which were formulated after statistical analysis of the collected data. Other measures were based on field observations, or else on "potential observations," areas in which currently unrecorded data could be collected.

Examples of measures of effectiveness include, at the search stage, the percentage of crime scenes actually searched. At the analysis stage, classification of laboratory service requests by evidence type and crime category is seen as the most basic measure; another is the number of contacts between a criminalist and an investigator. In investigations, the ratio of resolved investigations with physical evidence to all resolved investigations is, perhaps, most important. The ratio of convictions in cases with physical evidence to all convictions may be a useful measure in the adjudication stage.

Although Calspan dealt with only three study sites, and thus a limited amount of data, the results appear to be generalizable to criminalistics operations nationwide. The findings of low utilization of criminalistics services, but better ability to prosecute when the services are applied, are consistent with findings of both earlier and later studies. The Calspan report concluded with a series of recommendations for improving the utilization of physical evidence in the investigation and adjudication of crimes.

The first of these recommendations involved communication, training, and control. It was suggested that periodic case review meetings be held between representatives of crime scene search, criminal-

istics, investigative and adjudicatory operations. The meetings would explore how the selection, quantity, quality and potential of evidence submitted could be balanced against their contribution to case outcome, establishment of priorities, workload and desirable turnaround time (Vol. IV, 25).

A close record of all contacts and communications between criminalists and laboratory users was considered very important. Also, through continuing education, a program of acquainting patrol, investigative and management level police personnel with criminalistics capabilities and requirements was highly recommended. In regard to the 35 candidate measures of effectiveness, a trial introduction was suggested in which inadequate measures could be weeded out, and an "effectiveness equation" could be developed.

As a companion project to the Calspan study, the LEAA also funded research in 1974 to develop measures of *performance* for crime laboratories. Whereas the goal of the Calspan research was to develop measures of the *impact* and *uses* of scientific evidence by police investigators and legal fact finders, the intent of the Planning Research Corporation project (Bradford, 1974) was to examine the laboratory as a discrete entity and to develop internal performance standards.

The PRC study team was headed up by an experienced crime laboratory director. PRC developed a conceptual model of a full-service crime laboratory, which represented the "achievable state-of-the-art as it should be practiced now and in the near future." Using this model, estimated requirements for staffing, floor space and scientific equipment were formulated as a function of demand; i.e., the types of physical evidence which would result from major cases. The study defined the four major caseload areas as drunken driving, narcotics and dangerous drugs, major cases (murder, rape, robbery, burglary) and toxicology.

Measures developed addressed the quantity and quality of evidence examined as well as the time required by the laboratory to examine the evidence and return scientific results to the submitting agent. The issue of quality received great emphasis and addressed both the physical security of the scientific operation as well as the quality control measures employed by the laboratory to insure results were valid and reliable. Other projected measures included the quantity of cases processed by individual units in the laboratory and the outcome of the case.

A scoring system was devised (Crime Laboratory Performance Index Rating-CLPIR) into which numerical assignments of laboratory resources, service characteristics and quality were introduced. Laboratory resources focused on laboratory policies, personnel, equipment, facilities and management. Service ratings were controlled by the availability, quantity and timeliness of service offered. Quality

addressed both the security and analytical quality provisions of the laboratory operation. The intent of this CLPIR system was to give management a device to evaluate a particular criminalistics operation. The final report contained a number of useful strategies for investigating laboratory performance. While not directly focusing on the issue of the value of results to police investigators, a number of useful insights and strategies were contained in the PRC study which should be of interest to the research community.

In 1973, the St. Louis Police Department experimented with an expanded Evidence Technician Unit (ETU) (Taylor et al., 1973). Through a 40 hour training session emphasizing crime scene photography, selected officers were trained in evidence collection procedures and then augmented the regular evidence technician unit. This increased the number of trained evidence specialists and enabled a greater percentage of crime scenes to be searched.

Although the overall number of reported crimes decreased in St. Louis from 1972 to 1973, the number of crime scenes searched increased by 31 percent. The increase in collected evidence centered on fingerprints and photographs, but there was actually a decrease in the amount of other types of physical evidence gathered. The response time of evidence technicians to the crime scenes was also reduced significantly.

Results of the experiment showed that of crime scenes processed by ETU personnel compared to those handled by others, there is a higher proportion of arrests (by 9%), there is less time from offense to trial (by 1.5 months), there is a higher proportion of guilty pleas (67% vs. 43%), and there is a higher conviction rate (72% vs. 51%). While these results suggest that use of evidence technicians certainly aids the investigative process, they must be considered with some caution. The authors of this report warn:

> While there is certainly no question that the evidence services provided by the ETU contributes significantly to the achievement of these results, the procedures by which crime scenes are selected for ETU investigation tend to screen out incidents for which favorable results (i.e., arrests, convictions, etc.) are less likely. Therefore, comparisons between ETU-processed incidents and incidents not so processed may be biased in favor of successful outcomes for the ETU-processed cases (24).

This is an important point from an evaluation standpoint since the ETU may be called in only to those crime scenes where a suspect is in custody or where there appears to be a good chance of locating a

suspect. In the large number of cases that, from the outset, are seen as unsolvable, the ETU may not be contacted. Therefore, an examination of these gross statistics may make the ETU appear to have greater impact than it really does.

A recent article by Serrill (1979) highlighted the preliminary findings of the Peoria Physical Evidence Project which had the primary goal of reducing residential burglaries in that city. One component of the project was to increase the number of searches for physical evidence at the scene of burglaries and another was to automate the storage and search of fingerprint files. The percentage of burglary scenes searched by evidence technicians was doubled (from 30 percent of burglaries reported to 60 percent). Even with the magnitude of this increase, the ratio of scenes at which latent prints were developed remained almost constant (at about the 30% level). The number of "hits," where a latent print was found to match that of a suspect, increased by 40 percent.

A primary finding of this phase of the project was that police officers are not qualified to make the decision whether the scene does or does not have physical evidence worthy of analysis. Chief Al Andrews of Peoria stated "...policemen cannot tell, and there is no substitute for an examination of the crime scene" (29).

In 1977 the Institute for Law and Social Research (INSLAW) published its report, *What Happens After Arrest?,* which dealt with the problem of securing the conviction of a suspect after his or her arrest. Forst, Lucianovic and Cox, authors of the report,investigated the Washington, D.C. criminal justice system. They began their study with the observation that more than 70% of all arrests for felonies and serious misdemeanors brought to the Superior Court (in Washington) in 1974 did not lead to conviction. This leads to the questions of whether it was necessary for all of those arrests to have been made, and whether more of the persons arrested should have been convicted. The purpose of their study, said the authors, was to provide insight into why so many arrests fail in court. Although not addressing explicitly the criminalistics operation or its role in the adjudication process, some of the study's findings are relevant.

Five major crime groups were examined: robbery, all other violent crimes (including homicide, rape, and assault), nonviolent property crimes (including burglary and larceny), victimless crimes (including drug offenses, prostitution, and gambling), and other crimes. In each category the percentage of convictions was greater when tangible evidence was recovered than when there was none. Although this indicates that tangible evidence is of importance, what constitutes "tangible evidence" is never clearly defined. It is impossible to determine the role of criminalistics service because it is unknown what portion of this tangible evidence was laboratory-analyzed. Nevertheless,

this report supplies strong data in support of physical evidence utilization.

Another of INSLAW'S findings dealt with the elapsed time from offense to arrest of a suspect, and its effect on the gathering of tangible evidence, witnesses, and eventual conviction. While there is no simple relationship between elapsed time and conviction rate over all types of offenses, the chance of recovering tangible evidence clearly decreased as elapsed time increased.

In the case of robbery, it was found that if the robbery were committed by a stranger to the victim, conviction rates steadily decreased as time from offense to arrest increased. If, however, the crime were committed by someone known to the victim, there was no clear relationship between elapsed time and conviction rate. Tangible evidence was recovered in about two-thirds of the cases when an arrest was made within thirty minutes of the offense. However, it was found in less than one-third of cases with arrest occurring after 24 hours. For violent crimes between strangers (other than robbery), the conviction rate increased somewhat as elapsed time increased. These are just a few examples of numerous analyses presented in the INSLAW report.

An article published by Lassers in 1967 discussed an examination of capital cases that came before the Illinois Supreme Court since 1950 and those reviewed by state or federal appellate courts in 1963, 1964 and 1965.

> We think our study shows an incredible lag in the employment of modern methods. The prosecution does use scientific evidence in upwards of 25% of all cases, but it relies almost exclusively on three forms of such evidence, the newest of which is 40 years old: firearms identification (so-called "ballistics"), blood typing, and fingerprint comparison (Lassers, 1967: 310).

Lassers determined scientific evidence was not only normally neglected at the court level but throughout the entire investigative and prosecution process, with an inordinate reliance upon confessions and witness testimony.

In March of 1978, the National Institute of Law Enforcement and Criminal Justice sponsored a workshop on "Forensic Science Services and the Administration of Justice." In this workshop, views from various components of the criminal justice system were sought in order to guide the improvement of forensic science services. From the perspective of the police, E. Wilson Purdy observed that "there is a general lack of understanding among police executives as to what the forensic sciences can do for them." Purdy attributes this, in large part,

to the fact that today's police executives performed in their patrol officer/investigator function at a time when the forensic sciences were relatively undeveloped. Today's executive learned in an environment without the prevalence of full service crime laboratories, and so has learned to operate without that service. To combat the problem of underutilization in the "fragmented" forensic science delivery system, Purdy proposed a two-pronged attack:

> First, agencies using the services of the forensic sciences must be informed of the capabilities of the various disciplines which comprise the forensic sciences; secondly, through minimum standards (certification) and resource utilization, the forensic sciences must be brought up to their full potential (27).

This concludes the review of that literature which focuses on physical evidence: its presence at crime scenes, its collection and analysis in the crime laboratory, and its ultimate use in the investigation and adjudication of crimes. The next chapter will expand the search of the literature to include studies of the criminal investigation process and their treatment of the utility of physical evidence.

CRIMINAL INVESTIGATION PROCESS

In his analysis of the investigative function in United States police departments, Ward (1971) dealt with many topics of importance in evaluating the effectiveness of that function. Ward began with "clearance" as his measure of detective efficiency, stating that this was the only universally accepted measure (110). A crime is said to be cleared when the police have enough evidence to arrest and charge a person, even if the suspect is not apprehended or officially charged with the crime. Although the use of the clearance rate as an indicator of investigative performance had received much deserved criticism, Ward argues that its use for this study was warranted.

Perhaps the most important problem with clearance rates is the ability of police agencies to "doctor" their statistics. While Ward found no significant correlation between clearance and arrest rates, there was a significant relationship between rates of clearance and rates of reported crime.

> The fact that clearance rates for both robbery and burglary are related significantly to the number of crimes reported, and number of arrests in these categories has no influence on clearances, tends to negate the value of clearance rates as an adequate measure of effectiveness... (There is) strong evidence to indicate that cities "adjust" their clearances to the number of reported crimes (219-220).

What this means is that there appears to be a "norm" for clearance rates from which individual departments try not to deviate.

The null hypothesis of Ward's study was that specialization of the investigative function is no more effective than generalization. That is, in police departments where detectives are organized by the specific crime (or category of crimes) that they investigate, the clearance rates will be no higher than in departments where detectives are not assigned to a particular crime category. Ward closely examined the police departments of New York (generalized) and San Francisco (specialized investigation), and also looked at data from twenty-one departments who responded to a questionnaire mailed to police agencies nationwide. His general conclusion was that there is strong evidence to indicate that specialists *do not* perform more effectively than generalists. However, more study is necessary before drawing the conclusion that

generalist detectives are more effective than specialists. Also, Ward added, clearance rates are inadequate criteria for judging investigative effectiveness.

Except in narcotics cases (where laboratory analysis is essential), and in homicides and other cases that receive a great deal of publicity, the use of scientific investigative tools was found to be very rare. Often, especially in dealing with victims from lower socioeconomic classes, the investigator performs a perfunctory search of the crime scene to satisfy the victim. It is merely a public relations tool. Although Ward's questionnaire data indicated that 66% of felony crime scenes (in the responding cities with evidence technicians) were visited by evidence technicians, there is no indication of how much evidence was actually collected, or whether it was of any subsequent value in the investigation or prosecution. The major problem Ward identified was the great influx of narcotics cases, draining the resources of the forensic science laboratories and actually displacing the evidence that routinely was gathered from Part I crime investigations.

There have been several reports published which reveal that detectives are most successful in clearing crimes when a suspect has been named in the offense report. The *Science and Technology Task Force Report* (1967) reported on a study in which it was determined that in cases having detective follow-up reports, almost two-thirds had a suspect named in the initial offense report. Most cases had no suspects named in the beat officer's report (82 percent), and of these, 88% remained unsolved.

A study by the New York City Rand Institute in 1970 found:

> The few arrests that do occur as a result of a detective's investigation usually result from the complainant's being able to give the exact identity or residence of the suspect because they were acquaintances before the crime. It is a rare event when a property crime is solved through the clever piecing together of a fragile chain of evidence (Greenwood, 1970: 26).

Moreover, this research concluded that the solution of crimes, especially those involving property, were "chance events" with little or no relation to the effort exerted by the police investigators. Even the crimes which received highest priority by the department had solution rates which were no better than low priority investigations. Data were not compiled in this study which distinguished investigations involving evidence retrieval from all others, so essentially no conclusions could be drawn concerning the impact of such scientific efforts.

The Rand Corporation conducted what is probably the most comprehensive evaluation of the investigative function to date (Greenwood, Chaiken and Petersilia, 1975). From 153 of the largest police departments in the country which were surveyed, twenty-five departments were chosen for detailed study, including participant observation, and interviews with officers. The scope of the study was limited to the investigation of serious crimes (i.e., homicide, rape, assault, robbery, burglary, and theft), and its objectives included assessing the contribution of such investigations to criminal justice goals, and finding the relationship of investigative effectiveness to differences of organizational structure, staffing, and procedures.

One problem with the Rand study is that of physical evidence. It considered only fingerprints. It found, for example, that physical evidence is available in most cases, and fingerprints in over half. However, such evidence is rarely used except to confirm a suspect. The use of technicians can increase the recovery of physical evidence (i.e., fingerprints), but that does not increase the small (about 1%) number of cases in which the evidence gets matched to a suspect. The report states that simply collecting more evidence does not result in more suspect identifications. While money spent to increase evidence processing capabilities can increase suspect identifications, Rand concluded that at the present time more evidence than can be effectively utilized is currently being collected from the field.

Twelve major findings are presented in the summary volume of the Rand report. These findings bring into question many common beliefs about the value of criminal investigation. Most notable among these is the assumption that investigation actually leads to the solution of crimes.

First, Greenwood and Petersilia (co-authors of the Rand summary) report that differences in investigative training, staffing, workload, and procedures had no appreciable effect on investigative effectiveness. Effectiveness was measured in terms of crime, arrest and clearance rates. Also, the method by which investigators are organized (such as specialist versus generalist) was not related to variations in crime, arrest or clearance rates.

Probably the most interesting finding was that very few cases are actually solved by "investigation" in the popular sense of the term.

> The single most important determinant of whether or not a case will be solved is the information the victim supplies to the immediately responding patrol officer. If information that uniquely identifies the perpetrator is not presented at the time the crime is reported, the perpetrator, by and large, will not be subsequently identified (Vol. I, vi).

If the offender is not arrested at the scene, if he or she is not identified by the victim or an eyewitness, or if some uniquely identifying feature (such as a license plate number) is not obtained, there is little chance the case will be cleared.

Of cases that are ultimately cleared without having the perpetrator identified at the crime scene, "almost all are cleared as a result of routine police procedures" (Vol. I, vii). These routine procedures include fingerprint searches, informant tips, mug shot showups, and stolen property recovery. It appears, then, that classical detective work does not live up to its reputation as an effective way to solve crime. The investigator's time is largely consumed in administrative duties (such as paper work and interviewing victims) in cases that experience shows will never be solved. Although serious cases like homicide, rape and suicide invariably receive investigative treatment, less than half of all felonies can be said to be truly "investigated." Of those that are, few receive more than superficial treatment from the investigator.

The essence of the Rand report is that classical investigation does little to solve crimes. If enough information to identify the offender is not supplied to the immediately responding patrol officer, the crime most likely will not be solved. "(I)n more than half of the cleared cases, the identity of the perpetrator is known or readily determinable at the time the crime report is made" (Vol. I, vii). While physical evidence in the form of fingerprints is available in most cases, it is rarely used except to confirm a suspect. Fingerprints rarely provide the only basis for identifying a suspect. One policy recommendation drawn from the report is that increasing resources spent in the processing of physical evidence (i.e., fingerprints) could provide more identifications than by spending the resources in other investigative actions. For example, "cold" searches of latent fingerprints were found to be far more effective in increasing the apprehension rate than were routine follow-up investigations. The Rand report recommends that fingerprint processing capabilities be increased by creating a network of better trained, highly motivated, and better utilized fingerprint specialists nationwide.

In a subsequent critique of the Rand study, Gates and Knowles (1976) attacked the study's methods and data bases as well as its conclusions. Writing from the perspective of police administrators, the evaluators admitted that the investigative function is in need of improvement. However, they claim, the recommendations of the Rand report are not the proper steps to take to improve the function. One conclusion in particular drew the ire of Gates and Knowles,

> ...our study findings suggest that the effectiveness of criminal investigation would not be unduly lessened if approximately half of the investigative efforts were

> eliminated or shifted to more productive uses (Rand 1975, Vol. I, p. x).

The major thrust of this critique is that Rand's findings and proposed solutions are not consistent with the data gathered. As well as going beyond the limited data, Gales and Knowles argue, much of the study relies on data of questionable reliability and validity. Although the Rand authors themselves had recognized this problem, according to Gates and Knowles, they continued to use the data and draw policy implications from them.

One particular criticism worth mentioning is that the majority of Rand's major findings are based on data from as few as six cities, and some are based on data from Kansas City alone. Rand sent questionnaires to three hundred of the nation's largest police departments, and received responses from 153. Of the respondents, "more than twenty-five" were selected for individual on-site research. However, supporting the most important conclusion of the study, that there should be a reduction in the investigative effort, are data from just six cities.

In short, the evaluators question the worth of the LEAA financed study and say it fails because it,

1. contains procedural errors that erase almost all hope of accuracy;

2. has a fatally limited data base; and

3. presents conclusions that do not follow from the data presented and that ignore a host of important related issues.

In a response to the evaluation of Gates and Knowles, the authors of Rand replied that it is absurd to expect research studies to be fully self-contained and not incorporate past findings in their reports. Greenwood, et al. stated:

> Our conclusions and especially our policy recommendations should not be judged alone by whether they flow inevitably and exclusively from the data collected in our study. Instead, they should be appraised in terms of whether they are, within reason, correct or incorrect as cast against a full backdrop of what is known about the criminal investigative process (Greenwood et al., 1976).

Gates and Knowles attacked the Rand sample as being "miniscule,"

and thus not generalizable. The Rand authors replied that,

> Many of our findings have been previously reported by other researchers in studies of single departments. These studies could have been individually questioned on the grounds that the department studies might have been unique in some critical respect. But when, in our work, similar results emerge from several departments located in divergent parts of the country and having different organizations and procedures, they take on greater generality of interpretations.

Finally, Greenwood et al. stated that the evaluators failed to bring forth any evidence contradictory to the Rand findings. Citing studies by the Police Foundation (Bloch and Bell, 1976) and the Stanford Research Institute (Greenberg et al., 1975) as directly supporting some of their major conclusions, they claim that there are as yet no reasons to reject their basic findings.

In 1971, the Rochester, New York, Police Department began an experiment called Coordinated Team Patrol (CTP). Under the old system, patrol officers were organized into three units of approximately 95 officers each, and detectives were assigned to a separate, centralized division. By 1970, it had become apparent that this arrangement was inadequate, and so the CTP method was introduced in two of the city's three patrol districts.

The CTP method featured teams of approximately 36 members—about 30 uniformed patrol officers and six detectives and plain-clothes investigators per team. Whereas in the old system responsibility for patrol operations rested with the unit captain, under the CTP format responsibility for both patrol and investigation was in the hands of team commanders. Two commanders, drawn from patrol lieutenants, were assigned to each team. Each commander was responsible for the team's effectiveness and both had the authority to structure the team for maximum efficiency.

Perhaps the most important innovation in the Rochester experiment involved the "early closing" of unpromising cases. Several studies, the most notable of which has been Rand (1975), reported that very few crimes are solved by "investigation" in the popular sense of the term. If the offender is not arrested at the crime scene, or if he or she is not identified by the victim or witness, there is very little chance that he or she will ever be apprehended for that crime. If the offender is eventually caught, it will most likely occur through routine police procedures and not through the efforts of investigators (Rand 1975, Vol. I, vii). Recognizing that investigation succeeds in so few cases, the Rochester experiment allowed team commanders to officially close

robbery and burglary cases that there appeared little chance to solve. With unpromising cases put aside before too much time was wasted on them, effort could be concentrated on "solvable" crimes.

(Such early closure of unpromising cases runs contrary to most forensic science literature which suggests that practically *all* felony scenes should receive a search for physical evidence. If the search for physical evidence is considered to be part of the investigative follow-up, then a decision to close a case, because there are no suspects, for example, would preclude a search for evidence which conceivable could have led to the identification of a suspect.)

Another important innovation of CTP was that investigative tasks were assigned by a team commander who was able to supervise all investigations. In the typical department, each case is assigned to an individual investigator. If the investigator is ill or on vacation, the case receives no attention. By this procedure of "centralized case management," the team commander is given the responsibility for developing innovative methods to meet team objectives (i.e., arrests).

> (T)he department's administrators moved away from a rigid chain of command toward a more flexible, more effective arrangement of personnel. While team commanders (mid-level management personnel) remained strictly accountable to higher management, they also were given the opportunity to design their own approach to problems (11-12).

The supervising commander, having the whole team at his or her disposal, is thus able to keep an investigation in progress and on the right track.

The CTP experiment focused on three types of crime: robbery, burglary, and larceny. Its goal was to determine whether the CTP system could improve the department's investigative and apprehension operations for these crimes. The measure of performance for team effectiveness was arrests, and, to a large extent, the experiment proved a success.

Teams, as opposed to non-teams, were almost 50 percent more likely to make an arrest as the result of a burglary investigation, three times as likely to make an arrest through a robbery investigation, and twice as likely to make an arrest from a larceny investigation. As far as on-scene arrests are concerned, team members were more than twice as likely to make them for robbery and larceny, although they made about the same amount of on-scene burglary arrests as non-team personnel. It must be noted that "arrest" in these cases is not the same as "clearance." Arrest means simply the number of arrests. Clearance measures the total number of crimes attributed to apprehended

suspects. Bloch and Bell, authors of the Rochester report, place more emphasis on the arrest statistics, feeling that they are "operationally more important and less subject to manipulation and distortion than clearance statistics" (7). But the team personnel came out ahead when performance was evaluated by arrest or clearance. One factor contributing to this, according to the authors, was the high team emphasis on arrests as an indication of success.

Both teams and non-teams used technicians to collect physical evidence, and they gathered evidence in a similar proportion of cases. However, this physical evidence was apparently used successfully by only one team. In that team, physical evidence was indicated in their preliminary reports in 61 percent of the cases that were eventually solved by follow-up arrests. Of other teams and non-teams, in only about one-quarter of their follow-up arrests had physical evidence been mentioned in the early reports. Two factors were seen as contributing to the successful use of physical evidence by this team: first, it had a detective specializing in physical evidence; and second, its centralized case management resulted in better identification of cases in which physical evidence might produce an arrest (75).

While the Rochester experiment appeared to be a success, and the Rochester Police Department reorganized its entire force into the CTP concept in 1975, there was one somewhat disconcerting feature. Although the rate of prosecutions of offenders arrested through investigation was similar for both teams and non-teams, on-scene arrests made by team personnel failed in court in a much higher percentage of cases. The factors responsible for this lack of "quality" of team arrests were not determined.

The specific problems involved in managing criminal investigations were examined in a "Prescriptive Package" published by the LEAA in 1975. This package discussed new methods to increase investigative success, and also described past experiences with investigative innovations. The major source of information for this report was data gathered from field visits to six city police departments. Also, a review of available literature was conducted and a panel of experienced police officials interested in investigative management was consulted.

The "Managing Criminal Investigations" study (Block and Weidman, 1975) found that many innovations have been tried nationwide, and many of them have worked with varying degrees of success under different circumstances. While a particular method may prove helpful in Rochester or Cincinnati, for example, there is no guarantee that it will work in New York City. However, the report contains a number of ideas for innovation and experiment that police managers and local government officials should find applicable to their own jurisdictions.

A common theme throughout the recommendations (or ideas) presented in the report is that "the entire police department contrib-

utes to the success of criminal investigations" (1). While talented detectives are essential, police supervisors and high-level officials are often in a better position to improve the investigative process than are the investigators themselves. Cooperation is a crucial feature. Between supervisors and detectives, between detectives and patrol officers, and between detectives themselves; cooperation, communication and sharing of information are necessary for the most effective investigation of crimes. The report recommends policies that do not put detectives in competition with each other, or with patrol personnel.

> (R)ating officers on the number of arrests they have made fosters an unwillingness to share information or to help out someone else's case; similarly, rating detective units on clearance rates can cause them to spend too much time trying to tie-in suspects to additional crimes (3).

The point is that detectives should be encouraged to contribute to the department's overall effectiveness. Methods used to encourage cooperation included promising department-wide pay raises for increased effectiveness, and providing a single shared work table for detectives (allowing no private desks or private file drawers).

This report also concluded that such unusual policies as paying crime witnesses for their help, and using civilian detectives, can result in investigative benefits. Decentralization of the investigative component, and movement away from specialization of the detective function have also proved effective in some cases. Finally, early closing of cases seen from the outset as unlikely to be solved has worked in at least two cities, and appears to be generally applicable.

Little attention was placed on the role of physical evidence in investigation. However, it was pointed out that departments vary a great deal in their method of collecting physical evidence (either by the use of evidence technicians or by patrol officers), and the results do not clearly support either alternative. Since physical evidence is so rarely used in the identification of suspects the report suggested that:

> ...departments might enjoy a significant saving in time and expense, without adversely affecting their investigative success, by carefully limiting the evidence that is collected in all but the most serious cases (4).

While the underutilization of forensic science services has been frequently discussed, the problem of quality of scientific services was discussed in the article by Serrill (1979) in *Police Magazine* cited

earlier. Four reasons (excuses) are generally given by police for not using the laboratory: inaccessibility (especially in sparsely populated areas with no nearby facilities), long turnaround time for evidence analysis, the fact that laboratory work rarely helps solve cases, and lack of confidence in the abilities of laboratory personnel. In regard to the first reason, although the number of laboratories in the United States increased two and one-half times between 1968 and 1978 (from 100 to about 240), there are still large regions (such as the entire state of Wyoming) with no facilities for the analysis of physical evidence. Police agencies in such regions usually will package and mail the evidence to the FBI Laboratory in Washington, D.C. in major cases. However, recent guidelines and policy statements issued by the FBI indicate they wish to play a diminished role in handling evidence from state and local agents and instead, will concentrate on serving as a research and training facility for the nation's forensic personnel.

The claim that laboratory work rarely helps solve cases must be examined in some detail. From the perspective of the patrol officer or detective, a case is considered "solved" when a suspect is identified and arrested. Actually, arrest is not even necessary in some cases, such as when the victim decides not to press charges, or in other situations where police have information (evidence) that other crimes were committed by such persons. The point is, conviction is *not* necessarily the goal of the investigator, although identification and apprehension usually are. As numerous studies have shown, laboratory analysis of physical evidence is not normally employed to develop suspects. Its importance is in scientifically demonstrating a link between a given suspect and the crime scene. As Serrill says, "solid scientific evidence presented properly in court makes conviction almost a certainty." The criminalistics laboratory is frequently an aid to conviction, but not often used as an aid to investigation.

As for the problem of qualifications of laboratory personnel, Serrill argued that there may be some substance to the charge. Salaries for technicians are too low, generally $8,000 to $20,000, to attract qualified people. Budgets for laboratories are small, leaving many with outmoded equipment. And, although LEAA has contributed over $60 million since 1968 to the creation and expansion of forensic science laboratories, much of the increase was absorbed in the burgeoning demand for drug analyses.

Serrill also discusses the results of the Forensic Sciences Foundation's Proficiency Testing Research Program (Peterson et al., 1978). The objectives of this study were to determine the feasibility of establishing a nationwide testing program for the nation's criminalistics laboratories in which samples, closely approximating typical evidence types encountered in the laboratory, were mailed to the laboratories for analysis. This was a totally voluntary project with all test results

treated confidentially. On a nationwide aggregate basis, however, the results indicated a wide range of proficiency levels among laboratories with serious problems evident in selected evidence categories (such as blood, hair, and paint). Serrill suggests that, in the eyes of the police investigator, uncertainty over the qualifications of laboratory personnel and the validity of test results serves as a deterrent to greater reliance on scientific procedures.

In the first half of this literature review, emphasis has been placed on the use of physical evidence, evaluation of that use, and an examination of the investigative function in general. This review has not sought to be normative; it is not its purpose to say that the role of forensic science must be expanded. Numerous studies have shown that physical evidence is used in only a very small fraction (perhaps 1 or 2 percent) of all criminal cases. However, there is as yet no compelling evidence that gathering and analyzing more (or less) physical evidence *per se* will increase the effectiveness of police investigations.

When the subject of investigative effectiveness, or police effectiveness in general, is brought up, more questions are raised than there are answers given. This portion of the review has examined some of the work in investigation management and its evaluation. The next section will deal more extensively with evaluation of police performance, and consider the wider literature of cost/benefit analysis.

While the laboratory can perform a vital function, at least in terms of goals of prosecutors (i.e., in securing convictions), it still lacks the resources and technology in many cases to aid in achievement of investigator's goals (i.e., development of suspects, arrest, and clearance). The future of the forensic science laboratory may very well hinge upon what goals take precedence in the overall criminal justice system. If it is merely the arrest of suspects, resources might best be spent on such things as informants, payment of witnesses for testimony, or increased patrols (to lower response times). If a goal of the system is the arrest *and the conviction* of offenders, increased use of forensic sciences seems imperative. If police agencies do begin to place greater emphasis on the *quality of arrests* (those which result in prosecution and conviction) then it may be prudent for investigators to consider seriously the added value of investing time and resources in the recovery of physical evidence. In any case, while the potential capabilities of forensic science appear unlimited, its actual utility in the investigative function is as yet undetermined.

ISSUES OF POLICE EVALUATION AND PRODUCTIVITY

Historically, the practice of forensic science has been closely aligned with the overall police function and as such is deeply imbedded in the organization of the police agency. In large measure, for the forensic science laboratory to be viewed as successful, the police must be satisfied with the results produced. That the results are produced rapidly and definitively is extremely important, as the laboratory must convince the police administration of its capability and its worth, thereby securing for itself an adequate share of the total budget.

However, as noted in earlier sections of this review, only a very small percentage of investigations actually make use of the laboratory facilities. Many reasons for this can be suggested, not the least of which is the level of financial support presently provided. This translates into inferior salary structures and an inability to attract the best qualified personnel, insufficient numbers of personnel to handle the caseload in a timely fashion, and inferior equipment and instruments which prevent the laboratory from deriving the maximum information from the evidence examined. There are also other reasons for the low usage of physical evidence in criminal investigations, including poorly trained patrol officers and evidence technicians whose function it often is to collect physical evidence from crime scenes. The preservation of crime scenes and collection of the evidence are absolutely crucial to the subsequent analysis phase:

> The initial steps in the investigation of a suspected criminal violation can easily nullify any possible help by scientific personnel (Parker, 1968: 10).

It has been suggested that if the full potential of forensic science were exploited, the solution of the crime problem would be greatly enhanced, and would yield a strong social benefit. As yet there are no reliable cost-benefit indicators which can demonstrate how much evidence ought to be collected. It is the aim and intention of this study to provide them, and in so doing, it has been considered helpful to turn attention to studies of performance in other areas of police work.

Need for Accountability of Police Performance

In this present decade of hovering economic instability and severe

cutbacks in public spending (witness Proposition 13 in California, 1978, and President Reagan's efforts to slash federal spending), there is much concern over the public sector and a clear need to account for their activities. Government, as well as society at large, wants to determine concise cost-effectiveness measures so that they can develop an appro-private guideline to the proper allocation of federal funds (Parker, Gurgin; 1972). However, with the present difficulties in developing accurate measurement tools to determine the value of police activities, accountability is severely impaired. As the American Justice Institute study (1978:3) states:

> This nation's political system demands that police remain accountable....Because (they) do not measure effectiveness and productivity adequately, they cannot satisy their legal and moral obligation to remain accountable for this aspect of performance. Transcending the legal and moral obligation....is that of municipal governments to hold police accountable. Because effectiveness and productivity is not being measured adequately, local governments are similarly failing to satisfy obligations and commitments to represent government.

The study then goes on to say:

> Public and governmental mistrust of the police is not uncommon. Much of this mistrust is nurtured by a belief that police perpetuate a professional mystique, which, among other values, enables police to resist measurement and evaluation of their performance(3).

It concludes by stating:

> ... a 'measurement problem' is far more than a 'measurement problem'. It is a political problem because accountability is impaired. It is a management problem because the management function is impaired. It is more important to recognize the many specific dimensions of consequences than to regard the measurement problem in a generic sense...one which causes 'damaging consequences'(5).

Therefore, at the root of the police accountability issue is the dual problem of *definition* of productivity and effectiveness, and the *measurement* of these components. It is to the comprehension of these two

terms that the next section is devoted.

Definitions of Productivity and Effectiveness

The literature is by no means consistent in defining these terms. The Joint Federal Productivity Project (1973) (reprinted in Holzer: 1976) prefers to state what productivity *is* and what it *is not*. Productivity is an after-the-fact "scorekeeping" technique to show what actually occurred and to enable managers to explain past trends. It is also a resource tool for examining causes of changes, and it is a prediction device to gauge future trends. It is *not,* they clearly state, a measure of effectiveness or public benefit, and can only be adjusted to demonstrate these by a correlation with other performance data. Further, they say that no normative statements should be derived and contrasted with the productivity series.

Harry Hatry (1975), on the other hand, simply defines productivity as the amount of output per given amount of input, wherein police may include such elements as a reduction in crime, the maintenance of security, the apprehension of criminals, and responses to traffic or non-emergency situations.

The American Justice Institute's (1978) study elaborately defines and differentiates between productivity and effectiveness. "Effectiveness" they define as the successful achievement of objectives, and "productivity" as the costs incurred in the attainment of those objectives. The study then disaggregates the objectives into two kinds: outcome and process. Outcome objectives are the ends which the police desire, whereas process objectives are the means as represented by police functions to achieve those ends. Effectiveness and productivity measures, therefore, are concerned only with outcome objectives since these yield data on final products.

What is of particular interest in our study is that the practice of forensic science is a *means* and not an end in itself. In other words, the results of forensic science analysis will provide additional input data, or clues to the final solution of the crime, but will not in themselves directly satisfy an outcome objective such as arrest, clearance, conviction or exoneration.

However, it is still of great importance for us to study the productivity of forensic science laboratories, by looking at the information they yield and the decision-network of investigators who decide whether or not to use that information in their endeavors to solve crimes.

Finally, Zedlewski (1978) reporting on the progress of criminal justice performance definition and measures, says that the last ten years has been a period of "informed ignorance," in which the problem of conflicting goals, and activities geared to fulfill many purposes

has compounded the difficulty.

It seems necessary, in an evaluation of police performance in criminal investigations, to determine the specific contribution of all the actors responsible in the decision-making process.

Decision-Making Models Showing The Principal Actors In Criminal Investigations

Greenberg, Yu and Lang (1972) produced a model of the investigative procedure carried out in burglary cases (17) which divides the process of investigation into four main stages; the burglary detection and suspect apprehension stage; the information collection stage; the information processing stage and the case closure stage. Through these stages, the role played by different branches of the police force is demonstrated.

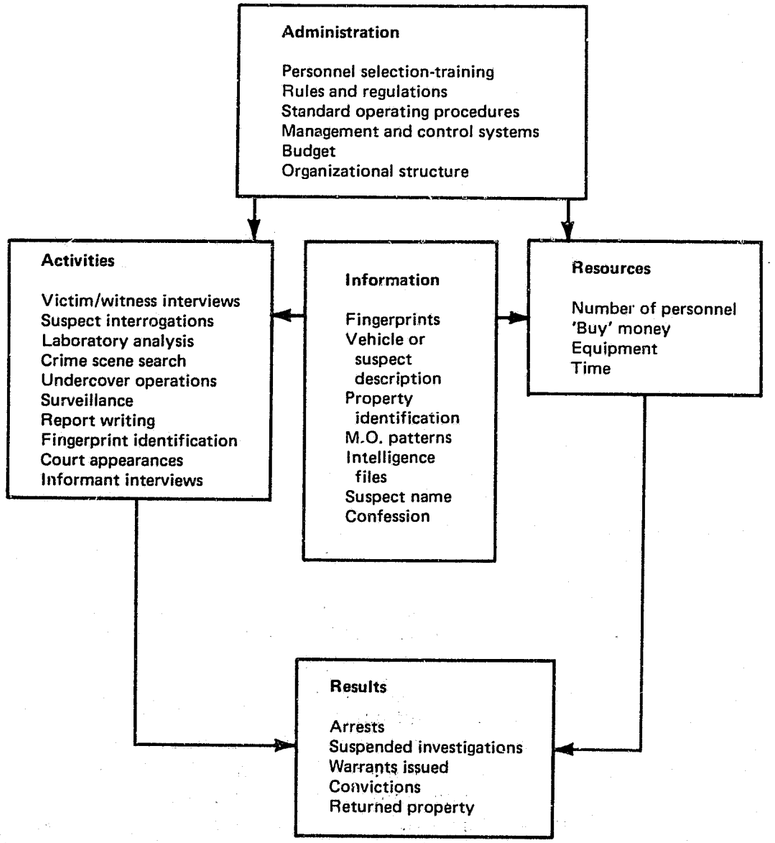
John Eck (1979), basing his study on the findings of the Greenberg et al model, developed a different framework for analyzing the investigative function, in which he sought the relationships among administration, activities, resources, information and results (See Figure 2). This model shows that administrative decisions on personnel such as selection and training, rules and regulations and so on, affect the activities performed by the investigators as well as the resources available to them to conduct their investigations. Through their activities and the resources used, information will be derived which will then spur further investigative activities. By iterations of the model, the results will finally be obtained such as an arrest, a conviction, or the return of stolen property.

Having shown the relationship of the use of physical evidence to other police functions through two different models documenting the investigative function, attention can now be turned to recent efforts made on the part of the government to lay down performance standards and goals for criminal investigations.

Standards and Goals of the Criminal Justice System

In 1971 the Law Enforcement Assistance Administration appointed the National Advisory Commission (1973) to "formulate for the first time national criminal justice standards and goals for crime reduction and prevention at the state and local levels" (Foreword). Because of the well recognized need for solid analytical principles and empirical research, the Commission came into existence with the aim to define performance; establish a relationship between activities and goals; determine the factors which impede goal achievement; select fiscal measures and assess the sensitivity of these measures. They felt, as a committee, that most police agencies were incapable of artic-

Figure 2: Framework for Analyzing the Investigative Function (Eck, 1979:74)



ulating their assessment of performance except by the most parochial means (Zedlewski, 1978).

The Commission addressed themselves to every aspect of police work, but of relevance to us will be the role of the patrol officer, the recommended procedures for criminal investigations, the role of the evidence technician and the function of the crime laboratory. In terms of the patrol officer (Standard 8.1), the Standards and Goals manual acknowledges this role as being the agency's primary element for the delivery of police services and prevention of criminal activity. The report also recommends that to maximize efficiency of patrol services, policies should be spelled out to ensure that patrol officers engage in police functions and respond immediately to a threat, a crime in progress or a crime committed. Further, the policy should stress the preventative role of the patrol. Every police chief executive should develop an ordering system to determine priorities of requests for service, and a police information system should be established to provide more knowledge to the public thereby heightening citizens' awareness.

For enhancing the patrol function (Standard 8.2), they recognize that this role is, perhaps, the most important element of the agency, and as such want to attract and retain highly qualified personnel. They suggest opportunities for advancement and salary increases, as well as providing status and recognition from the agency and community at large. They stress the patrol officers need for maximum cooperation and assistance from all elements within the agency and they recommend comprehensive training both initially and while in service. The implementation of procedures whereby patrolmen performing at consistently high levels are recognized is also suggested as are procdures for allowing patrol to conduct the complete investigation of crimes which do not require extensive follow-up work.

Standard 9.7 refers to criminal investigations, and recommends that written policies be developed to emphasize the importance of the patrol officers as preliminary investigators, with particular emphasis on their role as evidence gatherers. However, should the crime be of a very serious or complex nature, the investigative specialists should be called in. It should, though, be borne in mind that every police agency establish only as many specialized investigative units as necessary. With an impeccable preliminary investigation on the part of the patrol, the need for follow-up investigations should be lessened.

These follow-up investigations should be given a priority according to the seriouseness of the crime, the elapsed time between commission and report to the police, the quantity of information, the availability of agency resources, and the attitudes of the community.

The existence of full-time specialized criminal investigators depends on the size of the police agency. Any agency of fewer than 75 personnel should not assign specialists of this nature unless it can be

determined that this will improve overall efficiency.

Quality control procedures should be established to ensure that every reported crime receives the necessary investigation. These would include a follow-up report every 10 days for each open investigation, with command approval for the continuance of the investigation past 30 days; a constant inspection and review of all criminal investigation reports along with investigator activity summaries; and individual, team and unit performance measures based on arrests and dispositions, crimes cleared, property recovered, and caseload. It seems interesting that no further refinement on the performance measure was made, nor were suggestions put forward as to carrying the case until the first judicial screening.

The report also has much to say on the use of physical evidence. Every agency with greater than 75 personnel should consider using a case preparation officer to ensure that all evidence which could lead to a conviction or acquittal of defendants is prepared and presented in a systematic manner to be reviewed by the prosecuting authority. If the quality of the case preparation can be improved by calling in an evidence technician, the report recommends this should be done as long as the cost of the investigation is not increased. (This is a curious recommendation, inasmuch as the calling in of allied personnel carries with it a certain cost.) Policies and procedures should be developed in cooperation with the local prosecutorial and judicial systems requesting information, and all information should be documented to include copies of the incident report, the follow-up report, identification and laboratory reports, and any other reports necessary to the investigation. Every case should also include written documentation of all case disposition information and notification records.

Every effort should be made to facilitate and improve coordination between the police agency and all other concerned operations. This should be supported by well-recognized procedures for the exchange of information among investigative specialists and between them and patrol officers. There should also be systematic rotation of generalists into the role of investigative specialist and the efforts of all elements of the agency should receive equal publicity.

The role of the evidence technician and the crime laboratory were also given careful consideration in the Standards and Goals Report (Standards 12.1 and 12.2). As far as the evidence technician was concerned, the Commission recommended that every agency should employ specially trained personnel to gather physical evidence 24 hours a day. A thorough search of all crime scenes was recommended. This would propagate efficient identification, collection, and preservation of physical evidence, performed with the accuracy and speed essential to a proper criminal investigation.

In a small agency of less than 75 personnel, it would be unlikely that the budget could be stretched to finance a full-time evidence technician, so they recommended that patrol officers should be specially trained in evidence collection and should function in this capacity 25% of the time they are on duty. The Commission felt this was particularly favorable since response time would be decreased as technicians would already be out in the field; it would prepare the patrol for investigative work; and it would promote a good public image.

In larger police agencies, with over 75 personnel, a full-time evidence technician could be afforded, and there should be extensive training of a sufficient number of technicians to ensure their 24 hour coverage.

Furthermore, all incoming police personnel should receive formal basic training in evidence collection so that all patrol could be of assistance if the evidence technician or the special patrol officer was unavailable. There should be centralized regional training centers in every state to ensure consistency of performance and state-wide proficiency, and these should provide special training in photography, latent prints, trace evidence, firearms, and report writing.

As for the standards of the crime laboratory, the Commission recommended that by 1982, every state should have a system of laboratories (local, regional and state levels) capable of providing the most advanced forensic science services to police agencies. The laboratories should be managed such that the local laboratory performs the high volume, routine analyses, such as narcotics, alcohol and urine testing. Processing of evidence of this type should take less than 24 hours.

The regional laboratories should be located at least 50 miles away from any local laboratory, and would be more sophisticated in their analyses. The centralized state laboratory would handle examinations of a highly technical nature and would also engage in a limited amount of research.

Besides the three tiered system of laboratories, the Commission recommended that each crime laboratory within a police agency should be aware that it is part of the organizational entity and as such remains accountable to the chief executive over matters of policy and budget.

The amount of funds received by each laboratory is usually calculated so as to be proportional to the number of sworn personnel in the police agency. However, some police agencies are reluctant to allocate adequate funds to the laboratory, as they remain unconvinced of its merit.

Further recommendations on staffing were put forward including such policies as each employee performing scientific analyses should be degreed and preferably a civilian, and that there should be a sufficient working staff to meet the caseload.

The Commission also recommended that each laboratory director

should document the number of crimes reported and investigated; suspects identified, cleared and charged; prosecutions; acquittals and convictions. Finally, it was recommended that each laboratory maintain a close liaison with all elements of the criminal justice system, as well as with the scientific and academic communities to keep abreast of the latest techniques and developments.

Despite the very elaborate recommendations of the Commission, these findings were spurious due to the absence of a clear understanding as to what constituted an important goal. In addition to this was the problem that many goals lack any operational meaning and carry no notion of whether they are achievable. For example, it seems unlikely, given present circumstances, that a laboratory would receive sufficient funding to support a working staff and new equipment sufficient to analyze *all* the physical evidence which *should* be collected (as stated under Standard 12.1). As such the goals were often just the articulation of a problem rather than an indication of the desired direction of change. Further, the system was inflexible in that it did not allow for a modification of goals with changing external conditions (Zedlewski, 1978).

In general, the Standards and Goals Commission seemed to have a very limited impact on the field. It was criticized for publishing objectives having questionable validity; fostering changes which necessitated excessive costs to implement; recommending standards that were not empirically grounded and could not fit well into the individual problems of each state; and finally suggesting that there were right answers where no right answer could be found (Zedlewski, 1978).

Furthermore, when Greenberg, Yu and Lang (1972) collected field observations from thirty-nine police agencies and local governments in 1975, they found that measurement practices were still unorganized, the range of measurement was limited, and the grasp of concepts was inadequate. Measurement systems were conducted in a random manner and "often only because of situational demands such as budget preparation" (22), or the measures were originally collected for other purposes. Attempts to discuss measurement during their field investigations were "frustrated by (a) universal inability of practitioners to communicate reasonably satisfactorily on the subject" (23), and 80% of the police and city management personnel interviewed said that they remained dissatisfied with their current measures and indicators.

Since it is vital to give clear quantitative indications of productivity, many studies have now been initiated. However, some police leaders are very concerned that their priorities will be distorted "by a mindless attempt to maximize some sterile number (e.g. the arrest rate) regardless of operational consequences" (Hamilton, 1975). Furthermore, police are often concerned that a quantification of their efforts will

lead to the:

> ...widespread tendency to relate police performance to some cosmic measure of final output (e.g., a reduced crime rate) which is affected by so many other social phenomena that the most creative and professional police work may produce no measurable improvement whatever (29).

They then go on to say:

> Unfortunately, recent experience has given substance to both of these concerns, much to the detriment of attempts to advance the state of the productivity monitoring art (29).

The importance of the second objection cannot be overstressed; the police do not operate in a "ceteris paribus" situation, but are subjected to external variables relating to the socio-economic and political climate which are beyond their control.

Police might also object to measurement of their productivity since they may find it threatening to be thus exposed, and demeaning to have their activities represented by numbers (29). However, despite their objections, many recent attempts to quantify productivity have been executed, and it is to these that we now turn.

Studies of Police Productivity

There are many possible approaches to measurements of productivity. First, there is a choice between the inductive or deductive approach. Whereas the inductive approach would look at successful attempts at performance measurement, and collect additional information on this basis, the deductive approach would start with a conceptual model of how the criminal justice system should operate, and then develop a series of measures which could then be tested against real-world situations (NILECJ Memorandum, 1977).

However, in most cases there is not such a dramatic difference between the inductive and deductive methods, and indeed there is usually a blend between the two. This is called "inductive systematization", and involves initially the inductive stage of data gathering followed by the deductive stage of hypothesis-building based on the suggestions of the initial data, and finally an inductive stage of additional data-gathering to prove or disprove the hypotheses.

It seems likely that the present study of the use of scientific evidence by the police will be conducted more in the nature of inductive system-

atization. Data will initially be collected on physical evidence gathering procedures and the corresponding scientific output from the crime laboratory. Based on this information, indicators will then be evolved which can express both the costs and the benefits of the present state of forensic science and the benefits derived from the collection and examination of evidence. This particular stage of the analysis will be the deductive state.

With this thorough knowledge of the existing situation, alternative models for improvements will then be proposed. For example, if funds were injected into the system they could be used in various ways, including the purchase of new equipment, advanced training of scientific personnel or an improved fingerprint storage and retrieval system. Also, besides upgrading the capabilities of the laboratory in the ways just outlined, added resources could be focused on specific crime categories; for example, on homicide investigations, or the solution of residential and commercial burglaries. This, then, would provide the basis for evolving alternative models for making improvements on the present real-world situation.

Next follows the deductive stage of establishing hypotheses. Basically, the hypothesis for each of the alternative models proposed in "Do the benefits exceed the costs?" If so, then this could provide a potential model of improvement, and the actual model chosen among all the alternatives will be that one which yields the greatest benefits. (See the following discussion on Cost-Benefit Analysis).

The hypothetical costs and benefits from each alternative model can be deduced, knowing the present situation and the indicators of costs and benefits, by projecting into the future against a thorough knowledge of demographic, economic and forensic science trends. The most favored alternative can then be implemented if funding is available.

Another difference in the approach to measuring productivity is between the single versus the multiple perspective of performance. Obviously, the single perspective would concentrate on one aspect only of performance, whereas the multiple approach would try to incorporate the political and institutional pressures omitted from most models. Although this latter approach would be more complex an undertaking, it would provide a truer picture of reality, besides answering the common police objections referred to by Hamilton (1975) above.

Attention will now be turned to several different models that have evolved. One very interesting recent model was that put forward by the American Justice Institute (1978) in their study on Police Effectiveness and Productivity Measurement.

With the warning in mind that any *process* of measurement must always remain subordinate to the *purpose* of measurement, the study then proceeds in four stages: selection of the objectives, measurement

of these objectives, interpretation, and then improvement. As such, it is an inductive model: its aim is to measure reality and explain it as it is, rather than to build hypotheses about the real world. They wish only to concentrate on outcome objectives, since these will yield a measurable data series of effectiveness (the successful achievement of the objective) and productivity (the cost of this achievement).Since their range of outcome objectives is extremely large, the study obviously has adopted the multiple as opposed to the single perspective approach. Measurements are to be made according to a specific instruction as to their computation, and are to be equitable, valid and definitive. Each of these terms will now be defined.

An equitable measurement *"specifies achievement of an objective which is defined realistically and reasonably."* (34) In other words, this would make it logically or structurally achievable. Any objective which is defined in *relative* as opposed to *absolute* terms would thus answer the need for equitability, since it is both logically and structurally feasible to achieve the objective "to *minimize* crime", whereas the absolutist version "to *prevent* crime", is unfortunately an unachievable objective. The study found that only 3% of the police departments they studied had achievable objectives (36).

Their second requirement of the selected measure was that it should be valid. This is taken to mean that the measure should be able to specify the achievement of the objective *precisely and fully*; in other words, it should have the attribute of fidelity. To attain validity, the measure should have three dimensions: it should be *elemental*, it should have a *sound quality*, and it should be *reliable*. Elementalism implies that the measure is disaggregated into exacting detail so that it is precise and unambiguous. An example of such measures would be:

> To minimize the number of verified violations of
> constitutional safeguards such as, but not limited to:
> unlawful arrest, illegal stop, search and seizure,
> violation of right against self-incrimination

rather than merely and collectively to state: "To protect constitutional guarantees" (39).

The dimension of quality is included in measures of validity to ensure that police do not only attempt to increase the quantity of their performance, but are also careful as to *how well* they conduct their duties. For example, the objective should be "to serve all citizen requests for information and/or assistance," with the qualitative additions of "in an *accurate, courteous, and timely* manner".

The attribute of reliability ensures that the instruction used to compute the measure should do so "completely and with precision," (41) and should account fully for the entire content of the measure.

In other words, it should produce all the relevant significant data and exclude the possibility of extraneous information.

Finally are the definitive measures, whereby police ought to be able to specify their performance in conclusive terms such as superior, good, bad, average, and so on. Any performance standards which merely assign a relative label such as "better than", "worse than" do not convey with finality whether performance should be judged acceptable or not acceptable. (45) Standards of comparison could either be internal, showing a single police department's records through time, or could be external, whereby performance records of police departments with similar characteristics could be contrasted.

With these considerations in mind, The American Justice Institute (AJI, 1978) then evolved the Police Program Performance Measures (PPPM), which supplied the complete department-level outcome objectives (Final Report of the National Project to Develop PPPM: 3). These were divided into four main sets to measure effectiveness of 46 contemporary categories of crime prevention: crime control, conflict resolution, services and administration. Because of space limitations, these cannot all be listed here, but some of the measures more relevant to this study will be mentioned. For example, subsumed under crime control, is the objective concerned with crime case closures (Figure 3). This format could also be applicable to major crimes against property such as burglary, larceny and vehicle theft and also to lesser personal and property crimes including arson, vandalism, drunkeness, prostitution, and so on.

Also included under Administration is the objective "coordination with other agencies" which could be relevant if taken to mean using forensic science laboratories. (16-17) (Figure 4). In conclusion, the PPPM package is extremely comprehensive and breaks away from the more frequently used, yet limited, attempts to measure productivity as numbers of crimes and clearances. However, this subject is very complex and "because of the confusion which exists, agencies are generally not fit to diagnose the nature of their measurement malaise and extricate themselves from it" (32).

Two other attempts at measuring productivity were reviewed by Harry Hatry (1975). These were the report of the National Commission on Productivity (1973) and the Urban Institute's report (1972). Both of these models were inductive in their approach, and both took multiple (though less extensive than the AJI report) perspectives. The measurements developed by the National Commission on Productivity were as follows.

One productivity measure was developed to indicate the extent to which patrol time in the field is being committed to patrol objectives:

Figure 3: Example of an Outcome Objective: Crime Case Closures (from A.J. I, 1978)

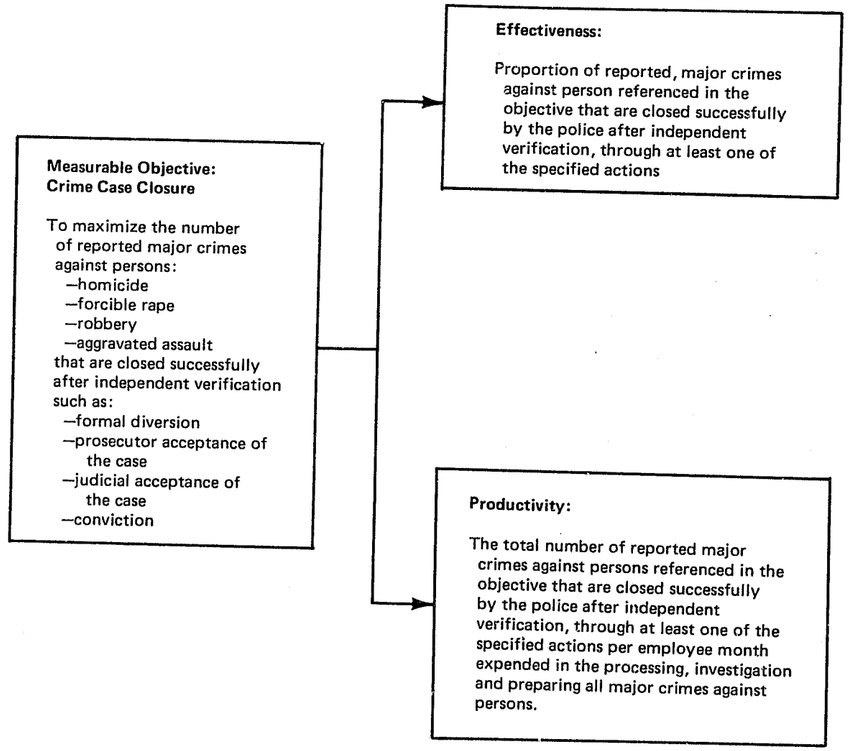
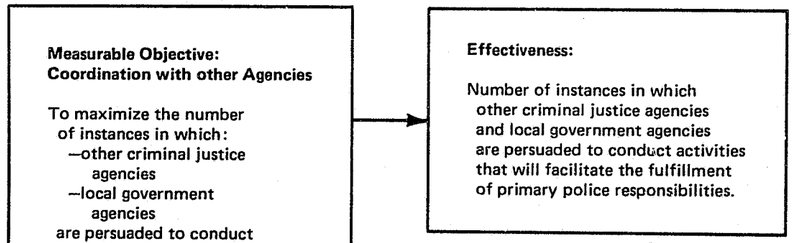


Figure 4: Example of an Outcome Objective: Coordination with other Agencies (A.J. I., 1978)



$$\frac{\text{Man-hours of patrol-time spent on activities contributing to patrol objectives}}{\text{Total patrol man-hours}}$$

This measure was considered useful as time can be 'lost' due to running errands, waiting for court appearances, and so on.

However, Hatry criticized this measure because he thought that the number of crimes committed *per capita* is more meaningful than the number of crimes committed *per patrol man-hour*. This is because a 10% improvement in both numerator and denominator would leave the ratio the same as before the improvements. Also, the ratio as expressed in man-years is confusing since, if it were large, would it imply worsening conditions such as an increase in crime, or improving conditions such as an increase in efficiency brought about by a reduction in employees?

Another productivity measure that was developed was to gauge the apprehension of criminal offenders. This was:

$$\frac{\text{Felony arrests resulting from patrol surviving the first judicial screening}}{\text{Total patrol man-years}}$$

and it could be modified to consider different kinds of arrests, including misdemeanors as well as felonies.

The inclusion of the clause "surviving the first judicial screening" Hatry considered to be very important, since a simple counting of arrests per patrol man-year would be unable to provide any indication of the *quality* of the arrests. However, Hatry did criticize this measure too in that, as it stands, it gives no *reasons* for the dropping of charges. He feels that it is important to distinguish the reasons which are partly controllable by the police from those which are not. Another objection against using the arrest rate as a measure of productivity is that this will then give the police an incentive to increase this rate, often unjustifiably.

Hatry then cites the productivity measurements developed by the 1972 report of the Urban Institute (Hatry, 1975:97). For example:

1. Population served per police employee and per dollar
2. Crime rates and changes in crime rates for reported crimes (relative to dollars or employees per capita)
3. Clearance rates of reported crimes (relative to dollars or employees per capita)

4. Arrests per police department employee and per dollar

5. Clearances per police department employee and per dollar

With the belief that productivity measurement is necessary in police management, Riccio and Heaphy (1977) set out to quantify apprehension rates. Their approach was therefore of a single perspective, inductive line of investigation. They feel that police services can be thought of as fulfilling three objectives: to deter crime, to apprehend offenders, and to provide suitable non-crime services. Of these, apprehension is thought to be the most important as it is the initial step in the process of justice, and it is thought that it might also act as a deterrent.

Riccio and Heaphy set out to measure arrests per police officer as an indicator of productivity, in much the same way as a business manager would measure output per man-year. They did this with some reservations, such as being unsure of the reliability of this measure due to external factors beyond the control of the police force.

However, they sampled 57 cities with a population greater than 250,000, and determined the number of Part I arrests per sworn officer between the years 1968-73. By collecting such a large amount of data, they could then perform both a longitudinal and interjurisdictional analysis.

Their results, though, showed great variations in the arrest rate, both from year to year, and between cities. Unfortunately, they could attribute this variation to no standard reason, other than the fact that the probability of arrests was directly proportional to the amount and quality of information concerning these crimes that was supplied to the police. They concluded by asking whether more appropriate measures of productivity could be developed, and whether apprehension productivity is either valid or useful as a management tool.

M.A.P. Willmer develops some very interesting theories of information flow to criminal investigation (Willmer, 1970:13-34). He draws an analogy between the reduction of uncertainty in attempting to solve crimes and a decrease in entropy. After stating that there are two types of information, active information whereby a suspect set is drawn up, and passive information involving an increase or decrease of suspicion of each member of the set, he then proceeds to assess the relationship of information with entropy. He defines entropy as a measure of uncertainty, or the degree of choice that exists in a situation, and he assesses the value of an item of information as the difference in the level of uncertainty before and after the receipt of that information.

Any input of information, which he terms "police units of information" (P.U.I.), can therefore have corresponding effects on the entropy

level. However, it does not follow that information will definintely decrease entropy, as there are some forms of information which are of no use in and of themselves, but which can be made actively useful if followed up on correctly. This he calls potential entropy, and he cites examples such as information on the fact that a suspect recently obtained a new car, or that he frequents certain places for entertainment. Information of this nature, which is unrelated to the specific crime itself, is called intelligence.

What Willmer sees as particularly important in criminal investigations is how this intelligence is used; in other words, whether the police adopt the correct and optimal follow-up action. Now, valuable information is that which can be used to depict a small set of suspects in which the probability that the offender is contained within that set is extremely high. However, even with valuable information, the police are not infallible and could well misinterpret the evidence. Thus the P.U.I. will become distorted by the police decision, so that the output, in terms of police activities, could generate noise, or distortions to the evidence. Willmer defines a recovery coefficient, which is the ratio between the accumulated positive differences between the output and input, divided by the average total input over time:

$$P = \frac{\Sigma [O\text{-}I]}{\text{Average } \Sigma I}$$

Thus if there is only a low difference between O and I, implying an efficient use of information, the noise level will be low and P will be correspondingly small.

Willmer feels that there are two ways in which an inefficient decision might be taken, implying that there are two ways in which noise might be generated. In the first place, noise could be caused *internally* within the police force, either by police adopting non-optimal decisions, or by information which is lost to the system. Information could be lost, he feels, by a failure of communications within the police system and he attributes this, in part, to deliberate withholding of information due to rivalry between officers. A second way by which noise can be generated is *background* effects; in other words, information is prevented from ever reaching the police. He cites an example of this as a victim cleaning up a crime scene after an incident, thus innocently destroying physical evidence.

Willmer feels that as the population size increases along with mobility of the criminal, the probability of misuse of information on the part of the police significantly increases. As a prevention to this occurence, Willmer favors the Unit Beat Policing in Britain, akin to team policing, whereby a district is divided into areas over which a constable presides. Since the constable will have closer public contact, Willmer feels that

more information will be generated, which then should be passed on to a Central Intelligence Bureau. This system improves both information flow and its use within the police system.

Skogan and Antunes (1979) acknowledged that police productivity could be enhanced if better use were made of information. By deliberating about whether an increase in the "cost of crime," defined in terms of certainty of arrest or severity of punishment, would result in a decrease in its incidence, these authors concluded that without a better information system, these factors would be rendered irrelevant. Unless the victim actually saw the offender and was capable of stating as much, the probability of his identification is extremely remote.

They were therefore in general agreement with the Rand study in that unless the victim supplies information to the police directly after the crime, the chance of catching the offender is minimal.

The 'quality' of the arrest is also a characteristic generally noted by the authors. They state that to arrive at a meaningful measure of productivity, the ratio between the number of arrests *resulting in a conviction,* to the number of crimes known by the police, should be calculated. They thus are continuing Hatry's point about following the case through at least to the first judicial screening and are adopting an inductive, single-perspective approach. For example, it was found that in Kansas City, there was only one felony conviction per patrol officer every seven work years. (230).

The authors then offered suggestions as to how productivity can be improved. Many other studies on improving police productivity have also been put forward and deserve special attention.

Suggestions for Improving Police Productivity

Skogan and Antunes propose four ways by which the apprehension rate and the resultant police productivity can be improved. The first is that citizen involvement should be increased and they should be encouraged to react by reporting crimes to the police. It has been found that a delay of only six minutes in response can make the investigation 40% less effective than if the response time were within one minute (233). However, this is a controversial point, worthy of elaboration.

It is commonly assumed in policing that a rapid response to a crime is a critical necessity, both for making an on-scene arrest, and also for appeasing the victim. But, in an innovative research study of response time in Kansas City (Response Time Analysis, 1978) it was found that the time taken to respond was unrelated to the probability of apprehension or locating a witness for most Part I crimes. Indeed they found, to their surprise, that police are often not notified, even about serious crimes, for a long time after they are committed. In such circumstances, a prompt response on the part of the police would make

very little difference. The finding also determined that citizen satisfaction with police response time was more a function of their expectations than of the actual response time itself; no amount of rapidity of response could please the over-anxious victim, nor could a slow response worry someone who had no expectations.

A second suggestion made by Skogan and Antunes to improve productivity is to train patrolmen to question victims more carefully and achieve a more thorough understanding of the incident. Thirdly, increased cooperation between patrolmen and detectives is advanced as a way to avoid hostility or duplication of functions. Finally, the authors suggest computerization of police records because of the vast amount of data that needs to be handled.

Another proposal to increase police productivity was put forward by Greenberg, Yu and Lang (1972) and the follow-up study by the Police Executive Research Forum (Eck, 1979). As noted in an earlier section of this review, their aim was to devise a model to increase the solution rate of burglaries based on statistical analyses of 2,000 burglaries in six Alameda County police agencies. Six categories of information isolated by discriminant analysis were found to be significantly related to the arrest of suspects, and these were assigned numerical weights. Using these weights, it would then be possible to make predictions as to the solvability of other burglary cases (see Figure 5). The instructions for the use of the model were for the investigator to circle the weights for each information element in the incident report, to add these weights, and then to follow up on the investigation only if the aggregate sum of the weights exceeded ten.

Despite the fact that a large proportion of cases that could be cleared by arrest would be excluded from consideration by Greenberg's model, the Police Executive Research Forum suggested that this number was small in comparison to nonstatistical screening procedures used by many departments. Furthermore, the model proved to be an accurate predictor of burglary case investigation in approximately 85% of cases reviewed. Obviously, it could be modified by allowing the police managers to select any cutoff point appropriate for their department's priorities.

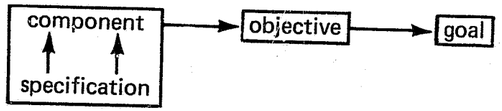
Greenberg, et al. also found that there were other variables which would have been considered relevant to burglary investigation follow-up decisions, including descriptions of property, other physical evidence besides fingerprints, casual and confidential informants, M.O., and so on, but they omitted these from the model becuase of insufficient information. The lack of consideration of other physical evidence is a sad omission as it implies that their decision model is merely presenting the status quo in terms of how investigations are conducted rather than generating a new methodology for burglary investigations.

Finally, the Urban Institute produced a working paper (Regan,

Figure 5: Greenberg et al — Burglary Decision Model (from Eck; 1979;6)

Information Elements	Weights
Estimate range of time of occurrence:	
Less than one hour	5
Between one and twelve hours	1
Between twelve and twenty-four hours	0·3
Greater than twenty-four hours	0
Witness' report of offense	7
On-view report of offense	1
Usable fingerprints	7
Suspect information developed, description or name	9
Vehicle description	0·1
Total:	

Nalley and White, 1979) containing policy proposals to improve productivity. Their approach was of a "goal achievement" nature and they considered policies dealing with: augmenting the patrol role, case screening, managing the continuing investigation, police prosecution relations, monitoring the system, and police organization and allocation of resources. As such, their model was non-active and deductive in that it made recommendations and then hypothesized about their success. Their basic model was of the style:



whereby components were listed. These included, for example under the heading "augmenting the patrol role," items which were designed to increase responsibility assigned to patrol officers. The objectives were to improve data completeness and patrol officer moral, with the ultimate goal of increasing arrests for serious, prosecutable crimes and an eventual increase in the number of convictions. These policies were evaluated in five demonstration sites: Birmingham, Montgomery County, Rochester, Santa Monica, and St. Paul.

It seems significant in this elaborate study that no direct mention is made of scientific information. It is indirectly referred to in the components 'better information collection model', 'police officer searches for solvability factors' and 'police officer decides when to call specialist' in the "augmentation of patrol role;" as a component in the "Rand checklist of needed investigative information elements" in "police prosecution relations;" and as components in "crime analysis unit" and "rape analysis, sex crime unit" leading to the objective of improving investigative efficiency, effectiveness and productivity under the policy category of "police organization and allocation of resources."

However, again the results were not particularly significant. "Augmenting the patrol role" did not substantially increase the number of clearances or arrests, and "case screening procedures," which were already practiced informally by all departments, made no impact on arrests and clearances when formally implemented.

At the time of writing, no definitive statement had been made regarding "police prosecutor relations," and "monitoring the system" proved difficult to implement. Finally, no positive correlation could be traced between the way detective functions are organized and the arrest/clearance rates.

What have all those productivity studies shown us? Generally, they have indicated that there is still much confusion in attempts to consistently understand and measure productivity, as well as implementing policy for its improvement. Many studies do not understand the behavioral dynamics of the system they are analyzing, and some

suggested measures suffer from a lack of substantial statistical evidence.

Summary of Police Productivity Literature

This section of the review has attempted to explicate the literature on police productivity by showing the ways it has been defined, the recommendations made by the Standards and Goals manual (1973) of improving police productivity, the studies which have attempted to define accurate measures of police productivity, and suggestions in the literature of introducing policies to increase the productivity of the police.

One interesting definition of police productivity and effectiveness is that used by the American Justice Institute (1978), wherein effectiveness is defined as the successful achievement of outcome objectives and productivity the cost of achieving these objectives. Other studies have defined productivity in analagous terms to a business operation, such as output for man-hours (Hatry, 1975).

The Standards and Goals manual (1973) makes recommendations on the role of patrol and criminal investigation procedures. In both cases, the emphasis is on written policies to increase efficiency and clearly establish priorities. Quality control procedures are also emphasized, along with the need to systematically collect and analyze physical evidence.

However, without clear measurements of productivity, only a limited knowledge of any improvements from these recommendations can be ascertained. Productivity has generally been thought of as the number of arrests or clearances, but more recently attempts have been introduced to refine this measure. Some interesting measurements have been proposed, including those of the American Justice Institute (1978) in which 46 contemporary, department-level outcome objectives were produced, listed under the headings of crime prevention, crime control, conflict resolution, and services and administration. The National Commission on Productivity (1973) expanded the conventional wisdom of the arrest rate to include the first judicial screening level, and obtained a much better indication of the quality of the arrest. This measurement had also been suggested at a later date by Skogan and Antunes (1979). Finally, Hatry (1975) expanded the FBI definition of clearance to more accurately account for criminal cases in which there was more than one offender.

Some researchers have been prompted to suggest improvements of police productivity. Skogan and Antunes (1979) feel that the solution of crimes can be increased by more involvement from the public, a better training scheme for patrolmen, improved cooperation between patrol and detectives, and increased computerization. Greenberg et al (1972) suggest a method whereby burglaries can be more quickly

investigated. They devise a decision model consisting of informational elements, such as the presence of a witness or the availability of suspect information and they assign weights to these elements. If the aggregated sum exceeds ten, then the case should be investigated; otherwise, the case is suspended or closed.

It seems clear that in most of the recommendations for improving productivity, little weight is given to the role of physical evidence and scientific analysis. This is basically a reflection of the current state of the art in which physical evidence is collected and analyzed in such a small proportion of crimes. The present study, therefore sets out to assess the effectiveness of physical evidence in cases where it *is* used, and then to hypothesize the projected costs and benefits of expanding this scientific approach to a greater percentage of crime investigations.

MEASURES OF COST EFFECTIVENESS

The need for studies of cost effectiveness is clearly expressed by the Police Executive Research Forum (Eck, 1979:76):

> Cost effectiveness studies of these and traditional reactive investigations should be make in order to arrive at a more rational allocation of resources and management of investigative activities. This research eventually will lead to the development of more sophisticated performance measures for assessing the effectiveness of the different types of investigative units.

However, one of the reasons why cost effective studies have not yet been performed is that there are a great number of logical complexities in the assignment of costs. The AJI report (1978) mentions two of these. One, they say, is that police may sometimes achieve an objective by *refraining* from activity, and because no costs are directly consumed, the analysis will be inaccurate. An example of this may be in a bank raid or a hostage situation, in which the police decide to wait to see what happens rather than rushing in. In this respect, they might still be effective and prevent the occurrence of a crime. A second problem is that many police actions are so varied, diffuse and intangible that to 'cost' them is often impossible.

Related to this second point, Parker and Gurgin (1972) say that it is impossible to assign an economic, objective value to many social phenomena. They believe that this is especially true because social values are derived from institutional forms and it is only through an understanding of these that the true benefit of forensic science, for example, can be appreciated. Furthermore, they feel that there is a tension between the bureaucracy of these institutions and the professional goals of the criminal justice system, and this unfortunately lessens the effectiveness of the latter.

Another difficulty in a study of cost effectiveness is how to measure the value of time. For example, Chaiken (1975), suggested:

$$\frac{\text{The number of hours spent in identification of suspect by fingerprints}}{\text{Cost (Measured as salary of fingerprint specialist)}}$$

However, since a case that is solved more quickly would cost less, a cost-effective approach would tend to favor these as opposed to more complex cases. This, though, would produce extremely undesirable results, as the amount of time devoted to any case will depend on its seriousness, the amount of information available, and also in many cases, on its notoriety (Eck, 1979:72). Therefore, to improve fidelity, weights should be selected to determine the worth of the invested time.

Despite these difficulties, there is a clear need for a cost-effective computation of the contribution of forensic science. The best way of determining the balance between costs and benefits is to perform a cost-benefit analysis, and it is to the workings of this model that we now turn.

Construction of a Cost-Benefit Analysis Model:

Cost-benefit analysis can be defined as:

> ...a practical way of assessing the desirability of projects, where it is important to take a long view (in the sense of looking at repercussions in the further, as well as the nearer future) and a wide view (in the sense of allowing for side-effects of many kinds on many persons, industries, regions, etc.), i.e., it implies the enumeration and evaluation of all the relevant costs and benefits (Prest and Turvey, 1966: 155).

It was developed as an evaluative methodology in decision-making, so as to ensure objectivity, logic and scientific precision. Basically, it can be used to compare different policy proposals, and it follows closely the assumptions of Pareto optimality: a project will only be chosen if it makes everyone better off and none worse off.

In 1932, this assumption was extended by Pigou to include the gainers giving some compensation to the losers. In welfare economic terms, this can be expressed as:

$$x \, P \, y \text{ iff } \Sigma u(x)\, i...n > \Sigma u(y)\, i...n \text{ (Sen, 1975)}$$

where x and y are alternative policies
u are utilities
i...n are the individuals in society
P is a social preference relationship
iff (if and only if)
Σ total.

But how is the model set up and what are the stages involved in its formulation? Working on the assumption that if the input is as objective as possible, the results will be "demonstrably fair" (Self, 1974), the model's first formidable task is to define clearly the program objectives in such a way as to be translated into a systematic, analytical assessment. This generally means that all the measures of the objective are expressed in a common denominator, the dollar. Secondly, indicators have to be identified, which will show how effective the proposal is in terms of how well the objectives have been achieved. The proposal that will be selected will be the one which most closely achieves the objectives *with the least amount of resources.* However, it should not be the *average* rate of return from the project that is determined, but the *marginal* rate of return with the expansion of the program (Besen, Fechter and Fisher, 1967).

Having discussed the aim and form of the cost-benefit analysis model, we should now look at its application. There is very little evidence in the literature of its use in criminal justice, but it has been widely adopted in policy decisions ranging from locating an airport, to constructing a road, to developing a region. Some of these examples will now be more closely examined.

Besen, Fechter and Fisher (1967), for example, study the use of cost-benefit analysis in government job training programs, and they specifically looked at the Massachusetts Recruiting Program set up between 1958-1961. To determine the benefits of the program, they looked at the discounted value of post-training income differential between trainees and non-trainees (the discount rate being set at 10% over the working life of the trainee). The costs were thought to be of two types: direct costs, including education, capital, administration, and subsistence, and opportunity costs measured as the income foregone by the trainee during the training period.

Another related example of the application of cost-benefit analysis in policy decision-making is in regional development programs. Programs such as the Appalachian Regional Development Act (Besen, Fechter and Fisher: 145) are often complex in that they involve the establishment of a whole new infrastructure, including highways, health centers, public utilities and so on. Roads, for example, have two distinct benefits: they lower costs of production and distribution as they facilitate the flow of input and output materials, and thus increase their volume. They also attract new industries because of the decreased transportation time and cost.

Finally, the selection of a site for a new airport is often determined by cost-benefit analysis, as was the case in the debate over London's third airport. Such factors as decreased travel time, the loss of agriculture land, the loss of wildlife, capital construction, and revenues collected, all have to be weighted against each other to determine

the overall impact.

Despite its wide use in many cases of police decision-making, cost-benefit analysis is not without its problems. One of its major problems is that it is value-laden, yet assumes objectivity. Streeton writes:

> Cost-benefit analysis must be conducted within a framework which selects certain relations by putting them into equations, and involves moral, political and social consideration (52).

He then goes on to say that "cost-benefit analysis has a tendency to convert political, social and moral choices into pseudo-technical ones" (53). His main objection to this is that policies very often involve conflicting objectives; for example, industrial growth versus pollution, and that, therefore, someone has to *choose,* meaning that the study then becomes subjective. Furthermore, it is generally the statistical analyst, rather than the politician who makes these choices, and he might set up his studies so as to conceal his prejudices thereby assuming the appearance of scientific objectivity. This problem could also occur in attempting to fit a cost-benefit model to studies of the effectiveness of forensic science services. Since effectiveness could be increased in a number of alternative, and conflicting ways, some element of choice and subjectivity would likewise be incurred.

Similarly, the translation of everything to money as a common unit of measurement renders the study incapable of accounting for values. Stating that it is untrue that "everything has its price", Streeton goes on to say that "one of the characteristics of cost-benefit analysis is that it attaches dollar values to choices that have never been and never will be subjected to the test of the exchange situation" (53). How can the intangible social costs of being severed from a neighborhood because of road construction be assigned a dollar value? How can the aesthetic value of the natural landscape be accounted for monetarily? How, in proposals to decrease the crime rate, can fear and security be measured in dollar terms? For that matter how can the value of a fingerprint identification or the typing of a bloodstain be expressed monetarily?

Further problems arise from the use of money as the main unit of measurement. First is the problem of consumer surplus. To gauge this, consumers are often asked to state their perceived value of their property and this is then used as a determinant of the amount of compensation to give them should they in fact lose this property. However, this is often grossly inaccurate as the consumers are being plunged into the realm of the hypothetical. This would be similar to asking the public the hypothetical dollar value they assign to security from crime.

Second, by confining the analysis strictly to dollar terms, the differing marginal utilities between rich and poor are not accounted for, leading to gross injustices. This injustice is also apparent in criminal investigations which tend to make a larger commitment to solving crimes where the absolute dollar loss is high, at the expense of crimes against the very poor where the absolute dollar loss is low, yet the impact on a family may, nonetheless, be devastating. Related to this, the value of time saved (e.g., by a new highway) is usually computed in terms of hourly salary. This also unfairly penalizes the old, the sick, and lower-paid persons, and in the case of criminal investigations, the computation of value according to salary penalizes those cases which demand the most intensive amount of work from the highest paid personnel since this would incur the greatest amount of costs. In general, the excessive reliance on money leads to overlooking many factors as stated by Hatry (1974: 194):

> The caveats contained in most such studies slipped into the report somewhere to warn the reader that 'intangibles' have not been included.

Besides the problems associated with money, cost-benefit analysis also contains other difficulties. One is that since there are so many intangibles, proxy measures are often developed in their place. For example, both the National Crime Commission and the New York City Study on ambulances, to which Hatry referred (1974), used response time as a proxy measure for effectiveness. However, both studies failed to account for the *implications* of their findings; what does a savings of two minutes really *mean* to the health of an individual or in the solution of a crime?

Another problem with using cost-benefit analysis in deciding whether to choose a policy, is that often the effects of the policy will be more far-reaching than is generally accounted for. The impact of that policy might not only be confined to the area of implementation but might 'spill over' to neighboring areas (Bensen, Fechter, Fisher, 1969). This, in economics, is generally called an externality, and often is extremely hard to measure. Pollution, a result of regional growth, might be one such externality, and might be carried downstream or blown in the wind to another location. Similarly, the effects of stepping up the patrol in one neighborhood might well have an indirect impact on the incidence of crime in adjoining neighborhoods in that crime might simply be displaced from the neighborhood of high security provisions. To increase the accuracy of cost-benefit analysis, some attempt should be made to measure these factors.

Related to the fact that it is impossible to account for all aspects of a project, the government job training program can again be called to

mind (Besen, Fechter, Fisher, 1967). For example, what was omitted from their considerations was how an increase in employment could lead to a decrease in crime and consequently an overall decrease in the cost to society.

A further major criticism with the logic of cost-benefit analysis is that since it follows Paretian assumptions in considering aggregate happiness as the ultimate goal, no account is taken of the distributional implications of a project (Loodmer, 1977). Therefore, the program costs might be borne by a different group than those who receive the benefits (Hatry, 1974), and as long as the rich get richer, it would not matter if the position of the poor did not improve. This could also be the case in choosing between alternative methods to improve criminal investigations. A proposal might be chosen since it yields the highest benefits in the aggregate, but this might be just because it concentrates on solving the fewer, yet more costly, homicide cases rather than the more frequent but less costly burglaries. Therefore, a disaggregation is very important to show this.

Accompanying this problem is that of the political nature of these decisions. The political system might impose constraints on policy decisions, such as by ensuring the welfare of certain select groups in society, and this could often lead to less than optimal results.

Another problem with the cost-benefit approach is that it has to rely on forecasts and projections of data in considering the impact of the proposal in the future. This can often be very inaccurate, and there is, many times, a very inept treatment of uncertainty (Capron, 1967). In making projections from the alternative criminal investigation models that will be proposed in this study, such problems of uncertainty could also arise.

Finally, there is the problem of fragmented evidence. Individual agencies are often concerned only with their own piece of the whole system, and this therefore does not lead to a coherent view. In studying only the contribution of forensic science laboratories to the criminal investigation process as a whole, this fragmentation could also be a problem in this study. To ensure against it, every effort should be made to account for the impacts of changes in the crime laboratory on every other element in the criminal justice system (which is no small task).

However, Hatry (1974) develops an innovative cost-effective approach in which he attempts to develop measures to assess the impact of projects on *people* directly affected. In so doing, he feels that it is first necessary to define basic objectives and then to develop evaluation criteria from these. He specifically states that each program is likely to

generate many effects and so a corresponding number of evaluation criteria should be developed to measure these.

A further point he mentions is that since a program will have a different impact, either intentionally or unintentionally, on various people in society, the population should be divided into subgroups according to age, sex, geographical location and so on, to demonstrate this. By so doing, he is tackling the problem of lack of distributional considerations, which are so much a feature of cost-benefit analysis.

He then suggested that the time dimension is of great importance, a project should not be evaluated merely in the current and budget years, but projections should be made for future impacts.

In terms of measurability, Hatry thought that if some aspect could not be meaningfully quantified, then a qualitative statement should be made to justify the findings. Under no circumstances should this aspect be totally ignored since this would hinder overall comprehension. He suggested that possibly a scale ranking alternatives from one to five should be developed. He thought that this would be particularly relevant, for example, in measuring the feeling of security in crime studies. For example, questions could be asked such as "rank your feeling of security from one to five, where one implies you feel very safe, and five implies you feel very unsafe, and three is neutral."

He illustrated his point by devising a hypothetical study of an area with a higher than average infant mortality rate. With the objectives of decreasing both infant and maternal mortality and infant defects, he devised four evaluation criteria: the budget allocated to maternity hospitals, the annual maternal deaths, annual infant deaths, and annual infant defects. For his population subgroups, he divided the population into infants and mothers, blacks and whites. He then devised alternative programs and measured the hypothetical effects on each subgroup through projected time periods.

It would seem that Hatry has made a noble attempt at improving the cost-benefit model, and some of his modifications should be borne in mind as we consider this model to investigate the effectiveness of forensic science in criminal investigations. For example, it is suggested that the method used to analyze the effectiveness of forensic science in solving crimes is to disaggregate the data in two ways: first, according to the population subgroup affected, so as to account for differing marginal utilities of various victim groups, and the impact of their loss; and second, by the type of crime according to its seriousness.

Both benefits and costs should be given a very fair assessment, both quantitatively and qualitatively. Hypothetical assessments should be avoided. Also, every care should be given to speculating on and measuring any displacement effects. Although hard to assess because of the complexity of the factors, forecasts should be made of the

expected future benefits of changes in the analysis of physical evidence. Furthermore, since forensic science may very well be an integral part of the overall police function, every effort should be made to study the impact of increases in forensic science usage on police effectiveness taken as a whole.

Summary of Cost-Benefit Analysis

Undoubtedly there is a very real need for performing analyses to determine the cost-effectiveness of projects, both in the private and public sectors. In a time of economic cutbacks, a rational allocation of resources is a vital necessity. Cost-benefit analysis provides an evaluative methodology in decision-making and it lays claims for logic, objectivity, and scientific precision. As such, it expresses all measures of expected costs and benefits resulting from different project proposals in terms of a common unit, the dollar. Its function is to select, among the alternatives, that proposal wherein the greatest gain is achieved at the least cost.

Although widely used in policies involving urban and regional planning or job training programs, cost-benefit analysis has had little application in the field of criminal investigations. This seems surprising, and it is, in part, the aim of the present study to implement such an analysis to test various improvements that could be made in forensic science analyses.

However, cost-benefit analysis should not be considered as the panacea, the solution to all uncertainties. Instead it contains many problems, and these should be carefully kept in mind when applying the model to issues in the justice system, so that modifications can be made and implications drawn. Most of the problems derive from the fact that instead of being objective and scientific, it is in fact value-laden and subjective. It often involves important choices between alternative objectives and these are major political decisions. It also involves choosing how to express non-monetary values in terms of dollar units. Also, since it is only concerned with the aggregate sum of benefits as compared to costs, it does not account for the distributional implications of a proposal and this problem is exacerbated since it in no way addresses itself to the differing marginal utilities between rich and poor.

Furthermore, since cost-benefit analysis is concerned with so many intangibles which cannot be expressed monetarily, proxy measures are often developed in their place, but then are often left dangling, rather than being examined for their implications.

Not only is the model built on an unstable foundation because of the conversion of all measures to money, but also the results are even less

reliable because they are based on forecasts and projections. Added to this is the fact that data is often compartmentalized unrealistically. This is caused both by the problem of each department only analyzing that little piece of evidence with which it is directly concerned, rather than taking a holistic view, and by the problem that there are often spillover and displacement effects from the implementation of a new project.

However, with an awareness of these problems, and appropriate modifications, a cost-benefit analysis model can be built and applied to the task of improving forensic science utilization.

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