SYNTHESIZING AND EXTENDING THE RESULTS OF POLICE RESEARCH STUDIES: FINAL PROJECT REPORT

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PREFACE

In May 1978 the Police Division of the National Institute of Justice (NIJ) awarded Public Systems Evaluation, Inc. (PSE) a two-year grant for the purpose of analyzing and synthesizing the results of research in police field services. In particular, the study was intended to identify areas of missing knowledge and to facilitate the development of a future research agenda.

Organizing the field services research literature along functional lines (i.e., patrol, investigation, support services, etc.), PSE's research team identified a series of hypotheses whose origins are rooted in the historical assumptions which have shaped field service operations. It was from this hypothesis-based perspective that PSE reviewed a large set of research products and selectively specified a subset for further review, analysis, and synthesis.

Throughout, PSE attempted to be "fair" in its selection of research products. Where significant and relevant research activities concluded subsequent to the review stages of the project, every reasonable effort was expended to acquire such products for inclusion--or, at least, mention. In some cases PSE was unable to acquire the associated reports, but these are inevitable "gaps" which characterize efforts to synthesize broad bodies of written materials. It should be stated that PSE has strictly construed the term "research." As a result, this report disproportionately reflects the patrol discipline, which has been characterized by more formal research--i.e., experimental or quasi-experimental--activities.

Finally, the authors have attempted to be objective in their assessment of the research products by stating carefully the criteria upon which that assessment is founded. However, when strong criticism is justified--for example, in the case of widely cited major studies with serious methodological flaws--the authors have not refrained from expressing their concerns. Their purpose throughout was to expand our future research knowledge base, not to dwell on past individual efforts.

ACKNOWLEDGMENTS

This research project could not have been conceived and conducted without the active support and participation of the Police Division of the National Institute of Justice and the project subcontractors: Approach Associates and the International Association of Chiefs of Police (IACP). The NIJ officials--Messrs. Joseph T. Kochanski (Director, Police Division), David J. Farmer (former Director, Police Division) and Ms. Shirley Melnicoe (Project Monitor, Police Division)--should be acknowledged for their continuing support of efforts to identify research contributions and fill research knowledge gaps, and their patience and constructive contributions to this report; the Approach Associates personnel--Dr. Alan Kalmanoff (Project Director) and Ms. Karen Brown (Principal Research Investigator)--should be commended for their excellent research study of the interface between patrol and investigation; and the IACP personnel--Dr. Andrew Crosby and Mr. Sampson Chang--should be recognized for their assistance in identifying and acquiring relevant products.

The authors would also like to thank Dr. Kent W. Colton and Dr. James M. Tien for their technical criticism and contributions; Messrs. John G. Peters and William G. Spelman for their research support; and Ms. Jo Ann Wescott, Ms. Martha A. Cleary, Ms. Melissa A. Taggart and Ms. Phyllis deFano for their editorial and typing support.

Finally, and significantly, the authors would like to express their appreciation for the contribution of the project Advisory Panel whose participating members were: Dr. Egon Bittner (Brandeis University), Chief Anthony Bouza (Minneapolis Police Department), Col. Eugene Camp (St. Louis Metropolitan Police Department), Dr. Jan Chaiken (Rand Corporation), Chief Victor Cizanckas (Stamford, CT Police Department), Mr. Calvin Clawson (Seattle Police Department), Dr. George Kelling (Harvard University), James Parsons (former Chief, New Orleans Police Department), Mr. Theodore Schell (U.S. Department of Commerce), and Mr. Thomas Sweeney (Yonkers, NY Police Department). The Board members traveled large distances to attend project meetings and their participation helped to shape and guide our research.

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We dedicate this report to the memory of the late Victor I. Cizanckas. His contributions to the field of police administration and commitment to the conduct and assimilation of quality police research were outstanding.

I INTRODUCTION

The operations of urban police departments have been observed with interest for many years. Today this general interest in policing is accompanied by a persistent questioning of the effectiveness of police activities. Given the millions of dollars spent on police forces each year, government officials, local administrators, and citizens alike are asking whether or not the police are worth the investment that has been made.

At the center of concern with policing lies the traditional practice of police patrol. This activity has consumed a large fraction--perhaps greater than 50 percent--of all financial, personnel, and technological resources allocated to police departments over the past fifty years. However, the *effectiveness* of police patrol in preventing and deterring crime and in providing general public safety services has been difficult to establish.

It should come as no surprise, then, that police patrol has become the subject of numerous researchers. Since the 1967 Report of the Science and Technology Task Force of the President's Crime Commission (The Institute for Defense Analyses, 1967), literally hundreds of reports, articles, and books have appeared focusing on the issues, merits, and practice of police patrol. The purpose of this particular report is to synthesize the major findings of these researchers and to surface some

of the problems evident in patrol *research* as well as patrol practice.

This report is not the first attempt at summarizing what is known in the field of police patrol. In particular, the following six reports have all presented useful knowledge syntheses relative to their publication dates:*

(1) An Evaluation of Policy Related Research: Reviews and Critical Discussions of Policy Related Research in the Field of Police Protection (S. I. Gass and J. M. Dawson, 1974).

(2) National Evaluation Program (NEP) Phase I Summary Report: Traditional Preventive Patrol (T. Schell, D. Overly, S. Schack, and L. Stabile, 1976).

(3) NEP Phase I Summary Report: Neighborhood Team Policing (W. Gay, H. Day, and J. Woodward, 1976).

(4) NEP Phase I Summary Report: Specialized Patrol Projects (K. Webb, B. Sowder, A. Andrews, M. Burt, and E. Davis, 1977).

(5) Task Force Report: Science and Technology/A Report to the President's Commission on Law Enforcement and Administration of Justice (The Institute for Defense Analyses, 1967).

(6) Police (National Advisory Commission on Criminal Justice Standards and Goals, 1973).

While not deriding the efforts which resulted in the above publications, suffice it to say that the report being introduced is different. In this report we have attempted to let research *hypotheses* (as opposed to complete research studies) form our basic units of analysis. Such an approach allows one to see how the *body* of completed patrol research

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* A brief summary of each of these reports can be found in the Appendix.

responds to the dominant issues and questions raised in the study of police patrol. This approach is also useful in uniting previously disconnected literature in a coherent manner.

The report is organized along the following lines. In Part II, we begin with a discussion of the historical background of police patrol and note the simultaneous development of patrol strategies and patrol research in recent years. In doing so, we provide the reader with a brief initial tour of the patrol research literature. Part II concludes with a normative discussion of the structure of patrol research efforts. The model of research developed there provides a useful tool for use in assessing completed research studies.

From our discussion of the goals of patrol and the development of patrol research in Part II, we discern three major categories of research questions. These categories--Preventive Patrol, Response Time, and Alternative Organizational and Manpower Allocation Schemes--are comprised of a number of research hypotheses. A listing and discussion of these hypotheses is provided in Part III.

Part IV contains the results of the major effort of this report: our hypothesis-based assessment of patrol research. For each research question surfaced in Part III, we have attempted to determine both the degree to which current research supports or refutes the central idea being suggested and the credibility of each piece of reported evidence pertaining to this central idea (whether the evidence is pro or con). Our method for assessing credibility is also discussed in Part IV.

The next two sections of the report address collective findings. In Part V, synthesized methodological findings are presented. Much of this section focuses on the methodological problems currently faced by patrol

research, and several reported findings of questionable research merit are discussed. Part VI addresses synthesized substantive findings. The areas of agreement and disagreement among studies with respect to specific research questions are summarized there.

In Part VII we present our recommendations. These recommendations address both methodological concerns with patrol research and specific areas in which future research could be beneficial. The importance of developing an overall research framework by which otherwise independent studies may be related is noted.

Finally, many of the readers may find our appendices particularly useful. The annotated study bibliography briefly describes each of the studies we examined in conducting the study. The full bibliography, which we believe to be quite comprehensive, lists many patrol-related research studies which have been reviewed but are not specifically addressed in this report.

II HISTORICAL BACKGROUND

2.1 GENESIS OF THE PATROL FUNCTION

The activities of police patrol have historically accounted for the major portion of all police work. According to Manning:

> The most visible activity of the police, that for which they were conceived and by which they are best known, is preventive patrol. (Manning, 1977, p. 19)

In this brief section, we will examine the historical development of the police patrol function and identify the "stated purposes" of patrol.

Although the origins of policing may be traced as far back as the "watch-and-war" system of the thirteenth century (President's Commission on Law Enforcement and Administration of Justice, Task Force Report: The Police, 1967, p. 3), the first attempts to organize a mobile *patrol* force occurred in Britain during the mid-1700s. That patrol became a reality in eighteenth century England is not surprising given the high level of street crime existing at that time. For example:

> In 1776, the Lord Mayor of London was robbed at gun-point, and within the decade two of England's great nobles, the Duke of York and the Prince of Wales, were mugged as they walked in the city during the day. (Rubinstein, 1974, pp. 8-9)

One of the first advocates of police patrol was Henry Fielding, a London magistrate of the 1750s. Fielding argued that constables should be ". . . organized to patrol the streets rather than remain at their watch boxes" (Rubinstein, 1974, p. 9). Viewing the people of his time as in need of control, Fielding felt that a patrol oriented towards the

prevention of crime was warranted to supervise London. In this light, he constructed a mounted patrol to protect the highways leading into the city. Fielding created one of the world's first mobile patrol forces with this action.

By the late 1700s the urban crime problem in Britain was staggering, despite Fielding's initial efforts to institute police patrol. As Lee claims:

> . . . there is no exaggeration in saying that, at the dawn of the nineteenth century, England was passing through an epoch of criminality darker than any other in her annals . . . and the other lurid crimes which belong to this age, surpass in enormity anything before or since. . . . Such then was the desperate state of the society at the dawn of the century. (Lee, 1977, pp. 67-68)

In 1798, Patrick Colquhoun (also a magistrate) established a patrol force to guard the docks of the East India Company along the Thames River. However, Colquhoun was interested in the application of the patrol concept in general. In his 1796-1806 Treatise on the Police in the Metropolis, Colquhoun wrote:

> Police in this country may be considered as a *new science*; the properties of which consist . . . in the *prevention and detection of crimes*; and in those other functions which relate to the internal regulations for the well ordering and comfort of civil society. (In Manning, 1977, p. 73)

Thus, Colquhoun saw in the patrol force a means by which crimes could be deterred before-the-fact; this view of policing was markedly different from the "apprehension and punishment of criminals" model of policing popular at the time.

Though Colquhoun's thoughts on policing were made explicit through his writings, his thoughts were not permanently translated into action until England's Home Secretary Robert Peel began a concerted effort to

establish a fulltime police patrol force in the 1820s. Beginning with a limited one-year 24-man experimental patrol in 1822-23, Peel was able to sell the notion of police patrol to his peers and to the public at large. With reference to Peel, Manning states:

> He rationalized his proposal for the police in London not on the basis of control of the masses but because it would be cheap and efficient, helpful in reducing the rising crime rate, a matter of progress (he expressed the opinion that the city had 'outgrown' its police institutions), and a matter of simplification and centralization of function, as changes in enforcement capacities were to be instituted in concert with reform of the criminal law. His aim in the latter action . . . was to increase the deterrent capacity of the police and to substitute more certain enforcement and prevention for harsh penalities. (Manning, 1977, pp. 77-78)

In 1829, under Peel's patronage, England's Parliament passed an "Act for improving the Police in and near the Metropolis". With this act, the existence and functions of police patrol became formal. Peel stated:

> It should be understood, at the outset, that the principal object to be obtained is the Prevention of Crime.
>
> To this great end, every effort of the Police is to be directed. The security of person and property, the preservation of the public tranquility and all other objects of a police establishment, would thus be better effected than by the detection and punishment of the offender after he has succeeded in committing the crime. . . . Officers and police constables should endeavour to distinguish themselves by such vigilance and activity as may render it extremely difficult for anyone to commit a crime within that portion of the town under their charge. (In Chapman, 1972, p. 4)

Peel not only stated the aims of patrol, he also proposed a measure for assessing patrol performance:

> . . . when in any division offenses are frequently committed, there must be reason to suspect that the police is not in that division properly conducted. The absence of crime will be considered the best proof for the complete efficiency of the police. (In Chapman, 1972, p. 4)

Thus, it was well known after 1829 what the purposes of police patrol were. Peel's formalization of the patrol function based upon his own ideas as well as those of Fielding and Colquhoun survived unchallenged almost until the present day. However, the *strategies* employed by the police to achieve the goals of patrol have changed since Peel's time, so a brief history of patrol methods will now be presented.

The oldest patrol mode is foot patrol. It has already been mentioned that Robert Peel's foot patrolmen (the "Bobbies") constituted the first formal police department. Foot patrol as initially practiced was scheduled along *fixed routes* in assigned territories called beats. Patrolmen would walk singly or in pairs, communicating with each other by blowing whistles or pounding the streets with their batons in time of need. Since each patrol officer had a schedule to maintain, patrol supervisors knew where their officers were. Unfortunately, it was also possible for thieves and other ruffians to learn the patrol routes; this allowed for the occurrence of "well-timed" crimes.

Mounted patrol is probably as old a patrol mode as foot patrol; indeed, Fielding's mounted highway patrol, although shortlived, was established well before the end of the eighteenth century. However, mounted patrol was not suitable for regular street patrol in the city, so most urban patrol forces remained on foot.

From the 1830s onwards, many of the major innovations in police patrol were technological in nature. For example, the establishment of telegraph call boxes in the 1850s and telephone call boxes in 1880 greatly improved the communcations between patrol officers in the field and administrative personnel in the station houses. The invention of the bicycle allowed patrol officers to cover greater territory during their tours of duty.

1 PATROL

by

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However, the invention of the automobile coupled with the development of two-way radio systems in all likelihood had the greatest impact upon police patrol. The first fully-motorized police force was fielded by August Vollmer of the Berkeley, California, Police Department in the 1920s, while two-way radios were successfully initiated into motorized police patrol in 1929. In 1930, Vollmer declared:

> . . . with the advent of the radio-equipped car a new era has come. . . . Districts of many square miles . . . are now covered by the roving patrol car, fast, efficient, stealthy, having no regular beat to patrol, just as liable to be within 60 feet as 3 miles of the crook plying his trade--the very enigma of this specialized fellow who is coming to realize now that a few moments may bring them down about him like a swarm of bees--this lightning swift 'angel of death.' (In Rubinstein, 1974, pp. 20-21)

Recently, a new wave of technological developments has served to further advance the state of police patrol. Some American cities have installed Computer-Aided Dispatch (CAD) systems; others are experimenting with Automatic Vehicle Monitoring (AVM) systems. The potential usefulness of these new technologies is only beginning to surface.

As mentioned earlier, the basic functions of police patrol have remained unchanged over the last 150 years. For example, O. W. Wilson and R. C. McClaren in their book Police Administration state that:

> The elimination of the actual opportunity, or the belief in the opportunity, for successful misconduct is the basic purpose of patrol. A thief's desire to steal is not diminished by the presence of a patrolman, but the opportunity for successful theft is. (Wilson and McClaren, 1972, p. 320)

In the final report of the President's Commission on Law Enforcement and Administration of Justice (1967) the principal patrol function is said to be deterrence: ". . .. discouraging people who are inclined to commit crimes from following their inclinations" (President's Commission on Law

Enforcement and Administration of Justice, 1967, p. 95). Similar statements may be found in any current reference stating the primary functions of patrol.

While deterrence is seen as the basic goal, other functions such as the *apprehension of offenders*, the *recovery of stolen property*, and the *provision of public services* have been attributed to the patrol force. These stated purposes of patrol have given rise to several intuitive patrol strategies. For example, if patrol does deter crime, then it seems correct to reason that more patrol deters more crime; hence the argument by some for high visibility saturation patrol. Or, if the apprehension of criminals by the patrol force appears to vary inversely with response time, then response time minimization is arguable as an appropriate strategy in light of the apprehension function of patrol.

For many years theories linking patrol strategies to achievement of patrol objectives have remained unchallenged. However, in recent years some have begun to query the wisdom of conventional police patrol as a means for achieving patrol objectives. It was this initial questioning of police patrol's "sacred cows" which has led to the past decade of patrol research. The evolution of patrol research is the topic of our next section.

2.2 EVOLUTION OF PATROL RESEARCH

Though the police have formally existed for over 150 years, *independent* research in police patrol is a relatively recent phenomenon. Indeed, prior to 1967 "research" in patrol was usually an in-house enterprise conducted by police departments for their internal use. For the first half of this century, research in patrol and "doing something new in patrol" were practically synonymous.

It is important to realize that the police community and the academic community held (and to some degree still hold) different views as to what constitutes research. The Webster's New Collegiate Dictionary (1974, p. 984) provides the following definition of research:

> . . . investigation or experimentation aimed at the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts, or practical application of such new or revised theories or laws.

Academics are primarily concerned with the first part of this definition, i.e., the discovery of facts and the revision of theories. On the other hand, police officials are most concerned with the practical application of new knowledge. In the patrol area, this has often amounted to the introduction of new organizational strategies or new technologies into policing, and those responsible for the innovations have become respected as police researchers.

Among the most well known of these early researchers/innovators was Berkeley's Chief of Police August Vollmer. His initial work involved the fielding of a complete bicycle patrol force and the installation of an electronic alarm system in 1905-06. Vollmer's force was also the first to become completely motorized; this occurred during the 1920s.

Quite often, observations accompanying the introduction of new technologies into patrol constituted research. With respect to motorized patrol, O. W. Wilson, a former student of Vollmer, reported in 1929 that:

> . . . an effort has been made to render adequate patrol service to outlying business and residential sections by increasing the strength of the mounted [in automobiles!] patrol. On a basis of arrests made for all thefts, the mounted officer is six times as effective as a foot patrolman, and instead of protecting two to four blocks, he covers an area of over three square miles. (In Chapman, 1972, pp. 322-323)

Thus, new knowledge emerged as a byproduct of technological innovations in policing.

New hardware was not the only police research item in the first part of this century; the police were also concerned with the efficiency of their service. August Vollmer was particularly interested in efficient procedures for the deployemnt of his officers, and in 1933 he stated how such procedures could be derived:

> If the assumption is made that patrol work is important and that the patrolmen should be distributed by areas in proportion to the amount of work to be done, it should be possible to state a universal hypothesis. This hypothesis is that the normal expectation of police duties on any beat can be indicated with a reasonable degree of certainty because of the regularity in the occurrence of crimes and of other police duties. The further hypothesis is necessary that time units can be discovered for the routine operations of patrol. If the normal number of operations to be performed and the average time required for each can be determined, the amount of time required to cover a given territory can then be calculated. In other words, it should be possible on this hypothesis to allocate patrol duty so that no patrolman will have an impossible task to perform and all patrolmen will have definite minimum duty requirements. (In Chapman, 1972, p. 317)

Similarly, O. W. Wilson's development of hazard formulas provided the police with a technique for allocating patrol units to beats. Wilson, building on the earlier work of Vollmer, attempted to state explicitly the relative amounts of time required for certain patrol activities compared to others. The end result was a weighting formula which determined the amount of "work" required in each beat; patrol units could then be allocated in proportion to beat workloads.

With the exception of Vollmer, Wilson, and a few others, research of any form was notably absent from most police departments. The majority of American police officials accepted both the traditional functions and strategies of patrol. For example, the common argument that "more patrol

deters more crimes" assumed that police patrol does deter crime even though such a relationship between police patrol and crime deterrence had never been shown to exist.

In the 1960s urban America faced violent times. The rising crime rate led President Johnson to establish a Presidential Commission on Law Enforcement and Administration of Justice in 1965. The Commission's final report, The Challenge of Crime in a Free Society, appeared in 1967, and a telltale research-related finding emerged:

> The Commission found that little research is being conducted into such matters as . . . possible methods for improving the effectiveness of various procedures of the police . . . the criminal justice agencies should welcome the efforts of scholars and other independent experts to understand their problems and operations. These agencies cannot undertake needed research on their own; they urgently need the help of outsiders. (President's Commission on Law Enforcement and Administration of Justice, 1967, p. x)

With respect to police patrol, the Commission's Science and Technology Task Force presented a challenge to conventional thinking about patrol. The usefulness of standard preventive patrol was directly questioned by the Task Force:

> Police on 'preventive patrol' cruise the streets to look for crimes in progress. Presumably, this activity prevents crime because it poses a threat of detection and immediate apprehension. However, there is little evidence on how much crime is thereby prevented or on how much would be prevented with alternative patrol tactics. (The Institute for Defense Analyses, 1967, p. 12)

The Task Force researchers estimated that the probability of detecting a crime such as robbery via preventive patrol was so low that an individual patrol officer could expect an *opportunity* to detect a robbery about once every 14 years (The Institute for Defense Analyses, 1967).

Another conventional patrol practice questioned by the Task Force was the equal manning of patrol shifts in large police departments. Such time-independent manpower allocation schemes do not reflect the time-*dependent* nature of demands for police service, nor do they reflect relative spatial needs for patrol service (e.g., per capita level of crime in different areas). The Task Force outlined some crude yet indicative statistical procedures to deal with this problem.

Limited evidence presented suggested that apprehension probabilities were inversely related to response time; hence, response time minimization on calls for service was seen as a useful goal. However, the Task Force stated that the effects of response time on arrests need to be studied in more detail.

Other suggestions presented in the Task Force report called for the implementation of Automatic Vehicle Monitoring (AVM) systems and the establishment of criteria for priority dispatching of patrol cars. Perhaps the most important contribution of the Task Force Report was not its substantive queries into patrol operations but rather its seed effect on other research. Some of the major patrol-related Task Force recommendations were:

(1) Undertake studies in large police departments of crimes, arrests and operations;

(2) Develop computer-assisted command-and-control systems;

(3) Undertake experiments to improve statistical procedures for manpower allocation.

(The Institute for Defense Analyses, 1967, p. xiv)

Throughout the body of the Task Force report emphasis was placed on the need for *controlled experimentation*. Many of the questions raised by the

Task Force could not be conclusively answered due to lack of available data. It was hoped that through experimentation enough valid data could be generated to answer these questions.

Other relevant Task Forces of the President's Commission on Law Enforcement and Administration of Justice included the Task Force on Police and the Task Force on the Assessment of Crime. Though the Police Task Force did not concentrate on patrol operations as extensively as the Science and Technology Task Force, one key recommendation was that:

> Police departments should commence experimentation with a team policing concept that envisions these with patrol and investigative duties combining under unified command with flexible assignments to deal with the crime problems in a defined sector. (President's Commission on Law Enforcement and Administration of Justice, 1967, p.118)

The major contribution of the Task Force on the Assessment of Crime was the finding that reported crime comprises only a fraction of all crime, that fraction being as low as 35 percent. If the goal of the patrol force is to deter crime, this finding suggests that the use of *reported* crime rates to judge patrol activity is in itself inappropriate. The use of victimization surveys to probe true levels of crime was presented as a statistically more reliable but expensive alternative.

The final reports of the Commission and its Task Forces marked the beginning of a new wave of patrol-related research. Patrol operations, though accepted by the police, became the subject of major inquiry. The little patrol research completed to this point was basically the product of in-house police department studies; the new era of research was to be conducted largely by independent consultants or academics with federal- or state-level funding.

Indeed, with increasing pressure to keep municipal spending down, the concern over the effectiveness of costly patrol operations has resulted in numerous studies of traditional patrol and other alternatives to crime deterrence. Much of this research has taken the form of *program evaluation*, where specific proposals in patrol are empirically tested in an experimental or quasi-experimental setting. A smaller number of studies have concentrated on *operations research*, where police patrol is characterized and analyzed with the aid of mathematical models. It appears that the Commission's suggestion to incorporate "outside" people into police research has been implemented.

When examining the evolution of research in any field, it is interesting to observe the *timing* of relevant studies and the *interrelationships* between studies that develop over time. For example, one may hypothesize a general pattern for the timing of research into any specific issue as follows.

Initially, a few pathbreaking "seed" studies of the issue will be published. After a short time period, the interest generated by these studies will lead to a growth of research in the area. Finally, a small number of *definitive* studies, building on the results of past research, will effectively answer the original research questions and hence end the debate.

There are two pictures associated with this conjecture. First, one may imagine a unimodal frequency curve of completed studies over time as shown in Figure 1. Secondly, an S-shaped cumulative frequency (or "Ogive") curve will result from this theory of the timing of research, as shown in Figure 2.

Now, *patrol research* is a relatively recent endeavor, as mentioned earlier. In Figure 3 the publication dates for patrol-related studies obtained from our bibliography have been used to construct a pair of frequency curves for patrol research. From a rather humble start in 1967,

Figure 1

Timing of Research

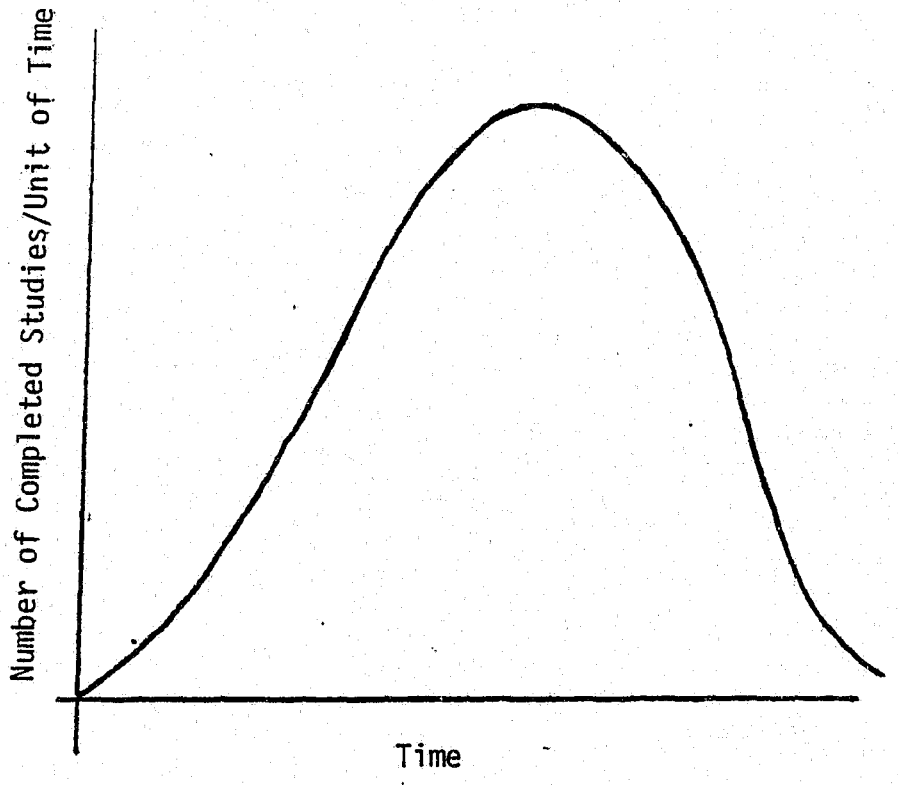


Figure 2

Timing of Research

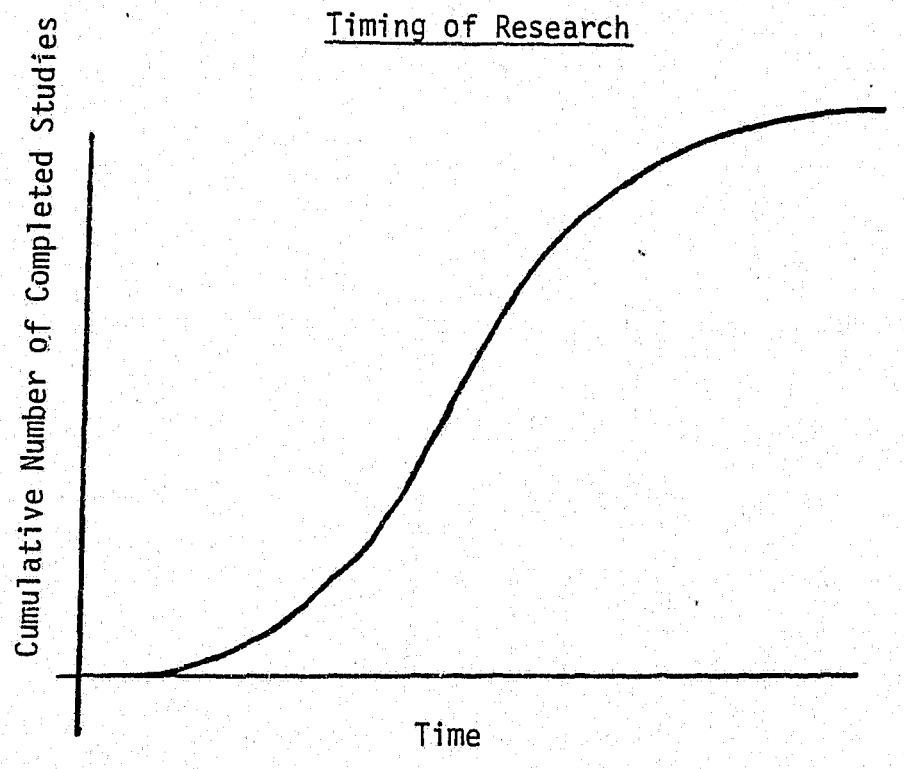
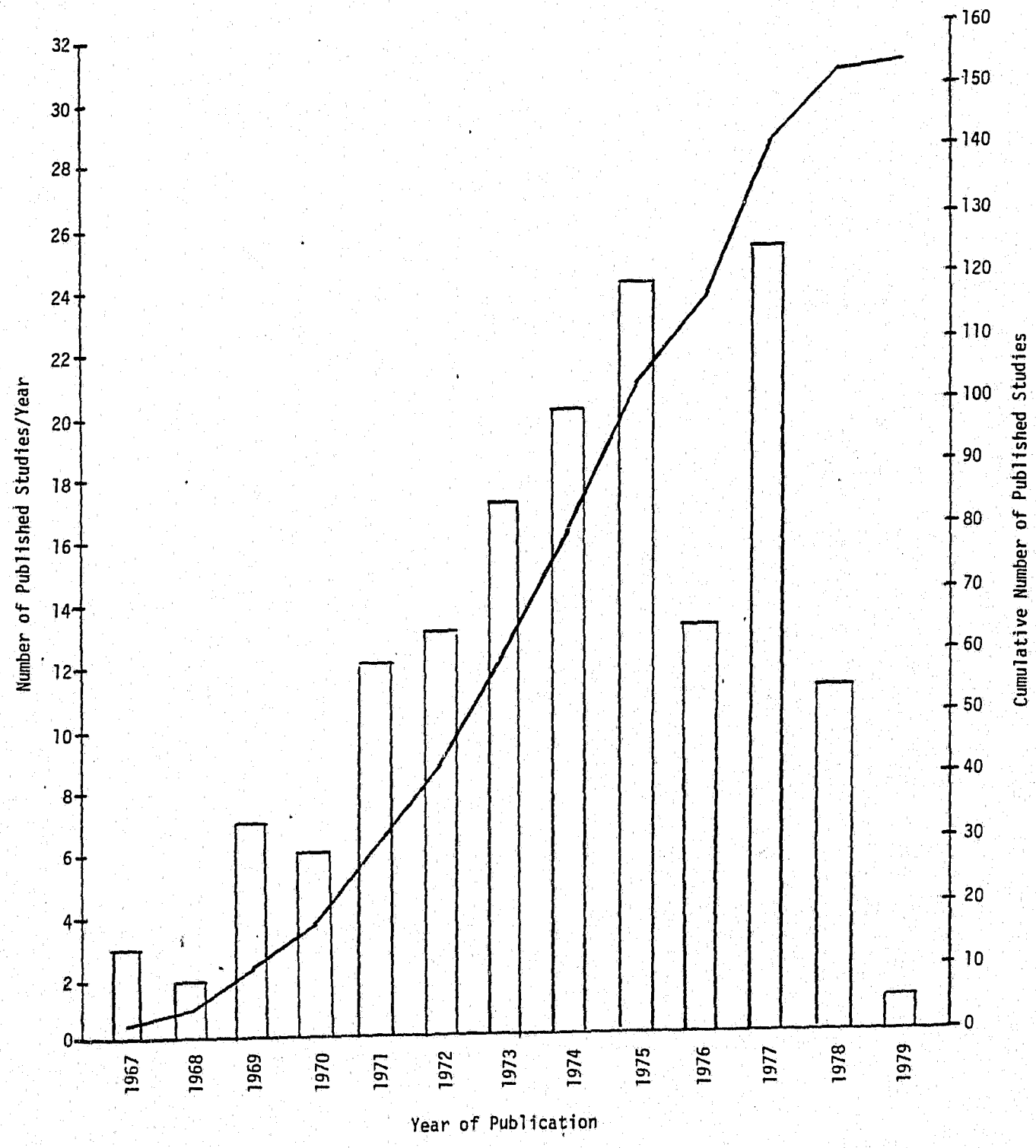


Figure 3

Evolution of Patrol Research

Timing of Research Studies



the "modal" or peak stage of patrol research appears to have been reached. Though our observed frequencies for completed studies in 1978 and 1979 have tapered off, this is more likely due to our lack of knowledge of the existence of such studies than to the true nonexistence of such studies. Thus, the state of patrol research at present corresponds roughly to the left halves of Figures 1 and 2, indicating that research in police patrol may be expected to continue, though perhaps at lesser intensity, for some time to come.

With respect to the interrelationships between pieces of research, it should be possible to determine the degree to which certain studies have influenced (or motivated) other studies. In our ideal model, we expect studies to build on the knowledge gained from prior research. In the area of patrol this is not always the case.

As a specific example, consider Figure 4. Here we have attempted to present the interrelationships (or linkages) between representative studies which have examined, among other topics, issues of police response time. The arrows connecting studies indicate that the earlier study was referenced (in a footnote or in the bibliography) by the later study. Table I presents this same information in the form of a *connectivity matrix*. It is particularly interesting to examine the row and column totals in Table I. Two studies, the Science and Technology Task Force Report (The Institute for Defense Analyses, 1967) and Urban Police Patrol Analysis (Larson, 1972b), appear to have been the most influential "seed" studies in this area, at least in the sense that these two studies were referenced more often than all of the others combined. A lesser seed study was the Kansas City Preventive Patrol Experiment's analysis of response time data (See Kelling, Pate, Dieckman, and Brown, 1974).

Figure 4

Linkages Between Response Time Studies

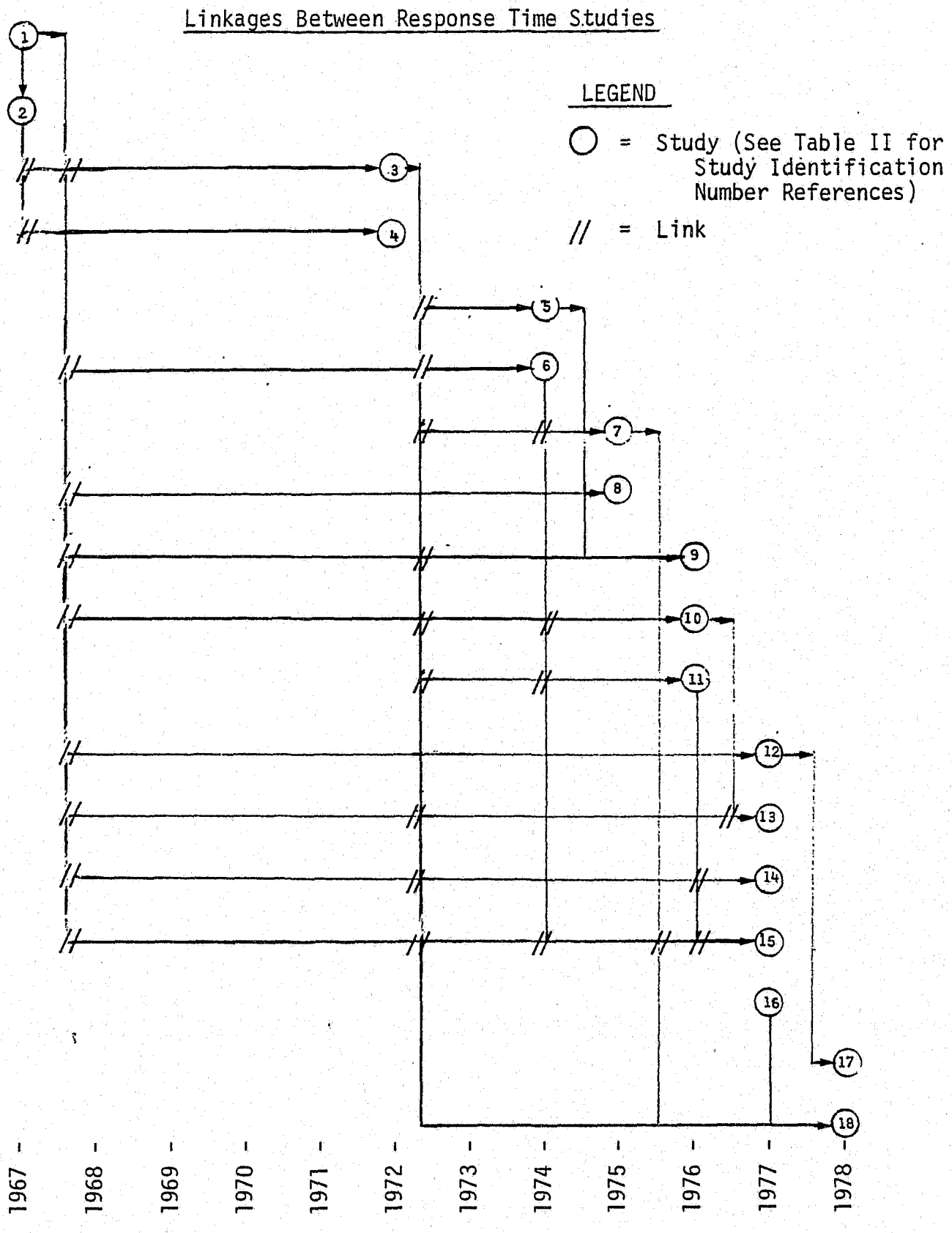


Table I

Linkages Between Response Time Studies*

Referencing Study

Study Referenced	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
1	-	1	1	0	0	1	0	1	1	1	0	1	1	1	1	0	0	0	10
2		-	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
3			-	1	1	1	1	0	1	1	1	0	1	1	1	0	0	1	11
4				-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5					-	0	0	0	1	0	0	0	0	0	0	0	0	0	1
6						-	1	0	0	1	1	0	0	0	1	0	0	1	5
7							-	0	0	0	0	0	0	0	1	0	0	1	2
8								-	0	0	0	0	0	0	1	0	0	0	1
9									-	0	0	0	0	0	0	0	0	0	0
10										-	0	0	1	0	0	0	0	0	1
11											-	0	0	1	1	0	0	0	2
12												-	0	0	0	0	1	0	1
13													-	0	0	0	0	0	0
14														-	0	0	0	0	0
15															-	0	0	0	0
16																-	0	1	1
17																	-	0	0
18																		-	-
Total:	-	1	2	2	1	2	2	1	3	3	2	1	3	3	6	0	1	4	37

LEGEND

1 = Column study referenced
Row study

0 = No reference

* See Table II for Study Identification Number References

Table II

A Sample Family of Response Time Related Studies*

(1) Institute for Defense Analyses, Task Force Report: Science and Technology (A Report to the President's Commission on Law Enforcement and Administration of Justice).

(2) Larson, R. C., Operational Study of the Police Response System.

(3) Larson, R. C., Urban Police Patrol Analysis.

(4) Larson, R. C., "Improving the Effectiveness of the New York City 911 System."

(5) Lipsett, F. R. and Arnold, J. G., "Computer Simulation of Patrol Operations of a Semi-Rural Police Force."

(6) Kelling, G., Pate, T., Dieckman, D., and Brown, C., The Kansas City Preventive Patrol Experiment: A Technical Report.

(7) Larson, R. C., "What Happened to Patrol Operations in Kansas City?"

(8) Tien, J. M. and Larson, R. C., *et al.*, An Evaluation Report: Worcester Crime Impact Program.

(9) Brown, W. J., "Response Speeds and Response Times of Urban Police Patrol Cars in Ottawa, Canada."

(10) Larson, R. C., *et al.*, Evaluation of an Implemented AVM System: Phase I.

(11) Pate, Tony, *et al.*, Police Response Time: Its Determinants and Effects.

(12) Clawson, C. and Chang, S., "Relationship of Response Delays and Arrest Rates."

(13) Reichart, Otto, The Effect of Automatic Vehicle Location on Police Patrol Efficiency.

(14) Kansas City Police Department, Response Time Analysis.

(15) Tien, J. M., *et al.*, An Evaluation Report: Wilmington Split-Force Patrol Program.

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* For full citations, see bibliography.

Table II

(Page 2 of 2)

(16) Boydstun, John, *et al.*, Patrol Staffing in San Diego: One- or Two-Officer Units.

(17) Tarr, Dianne, "Analysis of Response Delays and Arrest Rates."

(18) Kaplan, E., "Evaluating the Effectiveness of One-Officer versus Two-Officer Patrol Units."

One would expect that with the passage of time and the completion of research projects the number of referenced studies per new study would increase. This figure, given by the column totals in Table I, has begun to increase, though it has remained fairly stable over time. The Wilmington Split-Force Experiment acknowledged a larger number of studies than other research projects, though some of these linkages could be related to issues other than response time. Given the low rate of past referencing, it seems that research in response time, like patrol research in general, is far from being complete.

With the arrival of independent scholars on the patrol scene has come a change in the scope and methods of patrol research. The emphasis has been changed from low-key, in-house analysis of police records data to large-scale social experimentation in patrol. Though these experimental studies have encountered certain methodological problems,* they have also served to surface several issues in the patrol area.

Concrete examples of patrol experimentation serve to illustrate the types of methods, hypotheses, and problems encountered in patrol research. Thus, in the following paragraphs, we briefly review eight selected studies which are representative of state-of-the-art patrol research. The intent here is to familiarize the reader with some of the substantive hypotheses which occur frequently in patrol research and the types of conclusions reached by this research. While this quick review does not exhaust the number of studies performed since 1967, the findings presented are indicative of what has been learned from patrol research. A much more detailed assessment of patrol research is presented in Part IV.

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* The methodological problems with patrol research will be examined in depth in Part V.

The Crime Control Team Experiment (Elliott and Sardino, 1971)

Beginning in July 1968, an experiment involving an organizational restructuring of the police department was conducted for a one-year period in Syracuse, New York. This project, a joint effort of General Electric's Syracuse Electronics Laboratory and the Syracuse Police Department, utilized various patrol strategies such as:

(1) The use of one-officer patrol cars;

(2) The use of time-*dependent* manpower allocation schemes; and

(3) The use of a mathematical model in an attempt to increase the detection probability of patrol.

The Crime Control Team Experiment was evaluated, and the results of the research included several interesting findings:

(1) The substitution of two one-officer units for one two-officer unit was shown to increase the apprehension capability of the patrol force.

(2) The use of systematic patrol procedures (as determined via the use of models and statistics) increased the crime interception rate to about six times the pre-experimental level.

(3) The new patrol strategies implemented were viewed favorably by citizens of the local community.

The purpose of this experiment was to demonstrate that an alternative (namely, Team Policing) to the traditional organizational structure of the police could be effectively used to combat crime. Although the Crime Control Team Experiment was not able to show conclusively that the program strategies reduced crime rates, it did demonstrate that organizational structures other than those normally associated with traditional police departments could effectively control crime in an urban area.

The Kansas City Preventive Patrol Experiment (Kelling, Pate, Dieckman, and Brown, 1974)

The results of the Crime Control Team Experiment were available in book form in 1971. While this book was generating interest among police researchers and practitioners, the groundwork was being laid for the most elaborate and well-known police study to date. The intent of the Police Foundation's Kansas City Preventive Patrol Experiment was to determine the effect of varying levels of routine preventive patrol on outcome measures such as the crime rate and citizen satisfaction with the police. Beginning in October 1972, 15 Kansas City police beats were divided into three groups of five beats. Each group of five beats was to receive one of the following three levels of patrol activity for a one-year period:

(1) Reactive Beats - no preventive patrol was to be performed in these areas.

(2) Control Beats - preventive patrol was to be carried out as usual.

(3) Proactive Beats - two to three times the normal level of patrol was to be implemented.

The general finding of this study was that variations in the level of preventive patrol had no measurable effect on the relevant outcome measures. Stated differently, the crime rates and levels of citizen satisfaction found in reactive, control, and proactive beats were not significantly different from each other at the end of the one-year experimental period.

The implication of these results could be far-reaching. Indeed, if it really is true that routine preventive patrol has little influence on the incidence of crime (this was suggested by the Science and Technology

Task Force Report discussed earlier), then perhaps the amount of resources allocated to the patrol function should be seriously questioned. While some took the Kansas City results as an indication that patrol forces could be vastly reduced in number without a concurrent degradation in service, other researchers questioned the experimental methodology and, hence, the validity of the stated results (See Larson, 1976; Davis and Knowles, 1975; Fienberg, Larntz, and Reiss, 1976; and Zimring, 1976).

While the emphasis of the Kansas City Preventive Patrol Experiment was on the relationship between patrol and the crime rate, some positive "side effects" in the area of manpower allocation have emerged. For example, R. C. Larson presents a case for "fluid patrol":

> . . . if conditions warrant a change in the spatial deployment of units within a confined region (say a 'precinct', 'district', or 'division'), then if procedures are followed such as those used in Kansas City, such redeployments can be made without suffering marked degradations in either actual or perceived service in the depleted regions. (Larson, 1976, p. 291)

Without doubt, the Kansas City Preventive Patrol Experiment remains one of the most significant pieces of patrol research performed to date. While the experiment did not prove conclusively that preventive patrol does not influence crime rates, the experiment did demonstrate that the relationships between patrol and crime may be much weaker than had been assumed. Further investigation of the relationship between preventive patrol and crime has been a major concern for subsequent research.

Police Response Time: Its Determinants and Effects (Pate, Ferrara, Bowers, and Lorence, 1976)

The Kansas City Preventive Patrol Experiment generated large amounts of data useful for the testing of hypotheses other than those central to the relationship between patrol and crime. In particular, data on response

time and related outcome measures such as arrest rates and citizen satisfaction were collected. A detailed analysis of these data was released by the Police Foundation in 1976, in a study entitled Police Response Time: Its Determinants and Effects.

While the small samples involved in this study render its findings somewhat weak, three separate surveys indicated that there was no relationship between response time and arrest rates (contrary to the results of the 1967 Science and Technology Task Force). Similarly, when examining the impact of rapid police response on citizen satisfaction with the police, researchers found that citizen satisfaction with response time remained at a (high) constant level over a large range of response times, thus demonstrating that citizen satisfaction apparently does not depend on rapid police response.

Instead, the researchers found that citizen satisfaction with the police depended upon the *difference between* observed and expected response times, a difference that was previously not given much thought. If the police were able to respond more quickly than expected, the citizen involved was more likely to be satisfied than if the police responded more slowly than expected.

Kansas City Response Time Analysis (Kansas City Police Department, 1977)

Another major study which examined the merits of rapid police response was also undertaken in Kansas City when, in 1973, the Law Enforcement Assistance Administration (LEAA) awarded a grant to the Kansas City Police Department. Published in 1977, the report Response Time Analysis examined several hypotheses similar to those scrutinized by the Police Foundation's response time study just discussed. With respect to arrests, response

time was shown to be inversely related to apprehension probability, but only marginally so. Also, surveys confirmed the earlier result that most of the population was satisfied with response time regardless of the actual response time involved, though the difference between observed and expected response time was again shown to be a determinant of citizen satisfaction with the police.

This study is important for another reason; it was one of the few studies which attempted to determine the length of the delay associated with citizens' reporting of crimes to the police. This delay was shown at times to be larger than typical response times (including dispatch delays). Based on this finding and the results discussed earlier, the researchers concluded that the minimization of response time is not an empirically justifiable goal.

Unfortunately, some of the analysis upon which these conclusions are based is demonstrably weak. In fact, several of the assertions made by this study are open to question. In Part V we will critically review this study as an example of troubled methodology in patrol research.

The St. Louis AVM Experiment (Larson, Colton, and Larson, 1977; Larson and Simon, 1978)

While studies examining the effects of response time on various outcome variables were being undertaken in Kansas City, other researchers were focusing on the application of modern technology to police patrol using response time as a performance measure. In July 1974, Public Systems Evaluation, Inc. began an 18-month study of an Automatic Vehicle Monitoring (AVM) system in conjunction with the St. Louis Police Department. The potential gain in efficiency achievable via AVM was expected

to arise from the practice of closest car dispatching, a practice not possible without exact car location information.

A somewhat surprising result of the initial 16-beat Phase I study was the finding that the use of an AVM system did not reduce response time, despite the expected benefits of closest car dispatching. This finding was confirmed in a citywide Phase II effort involving all 135 beat cars.

However, as in the Kansas City Preventive Patrol Experiment, a positive "side effect" was noticed, again in the area of manpower allocation. It was suggested that appreciable improvements in patrol productivity may be obtainable by exercising the potential for improved supervision of the patrol force using AVM. Such a supervisory capability could greatly enhance the possibility of establishing a "fluid patrol" like that suggested by Larson in his review of the Kansas City Preventive Patrol Experiment presented earlier.

The Worcester Crime Impact Program (Tien, Larson, Green, Williamson, Dunlap, and Simon, 1975)

Fluid patrol may be viewed as one alternative to traditional deployment and allocation schemes. A quite different alternative could entail a change in the role played by police officers with respect to the call-for-service response function. In particular, the use of *civilians* to respond to noncrime calls for service offers the opportunity for both a departure from traditional patrol staffing and an improvement in the productivity of the police.

In March 1974, Public Systems Evaluation, Inc. undertook a six-month after-the-fact evaluation of the Worcester Crime Impact Program, whose

main innovative feature was the use of some 41 Police Service Aides. This study demonstrated that for many police calls, a trained civilian can handle the work required at a lower cost without compromising the quality of service provided. In fact, the number of calls handled by a civilian can approach the number of calls handled by a uniformed police officer.

As part of the evaluation effort, researchers were interested in whether or not the response times of Police Service Aides were acceptable to the public. As in the two Kansas City studies discussed earlier, citizen satisfaction with response time was consistently high despite wide variations in response time. While this indicates that Worcester residents were happy with the attention they received, it also indicates that citizen satisfaction is not too dependent on response time.

The Wilmington Split-Force Patrol Experiment (Tien, Simon, and Larson, 1977)

Yet another approach to the utilization of police resources was tested in Wilmington, Delaware. The concept of split-force, which involves separating the preventive patrol and call-for-service response functions of the patrol force, was first tried in St. Louis in 1966 and then in Chicago in 1971. An LEAA-funded test of the split-force approach was conducted in Wilmington in 1975, and Public Systems Evaluation, Inc. performed the evaluation of this program.

The results of this study showed that split-force patrol does increase the efficiency of the patrol force in both the call-for-service response function and the preventive patrol function. This improvement was achieved without decreased effectiveness on the part of the patrol force. Thus, this program was able to demonstrate the feasibility of

split-force patrol as a cost-effective alternative to traditional patrol strategies.

Another interesting result from this study was in the area of response time, where it was *again* found that response time had no effect on citizen satisfaction. In addition to this, a limited number of citizens were formally told that a response delay would occur, and 45 percent of these citizens responded that they "couldn't care less"! Hence, the Wilmington study supports the contention that police response time, when averaged over all types of calls for police service, is *not* an important factor contributing to citizen satisfaction with the police.*

Patrol Staffing in San Diego: One- or Two-Officer Units (Boydstun, Sherry, and Moelter, 1977)

When considering the allocation and deployment of police resources, a seemingly simple decision such as whether to staff a patrol unit with one or two officers can give rise to rather complex implications. Traditionally, many police departments have staffed their cars with two officers, primarily for reasons of safety. Those departments which have used one-officer patrol (such as the Crime Control Team in Syracuse) have usually exchanged two one-officer units for each two-officer unit.

In October 1975, the Police Foundation began an experiment in San Diego where only one one-officer unit was substituted for each two-officer unit. It was found that in terms of response time, on-scene arrests, officer injuries, and other performance measures one-officer units performed at a satisfactory level of efficiency and effectiveness. The cost

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* As we will argue later, however, rapid response to certain types of priority calls is very important.

implications of this drastic reduction in manpower are clear; if one wished to retain equal-cost staffing options, the potential for increased productivity through the use of one-officer patrol is very great (Kaplan, 1979). Thus, a simple switch in staffing policy may have significant implications towards patrol productivity.

As can be seen from this brief review of eight studies, there are a number of important issues being addressed by patrol research. The main body of this report will examine in depth the substantive and methodological sides of these issues. However, it is first necessary to understand the structure of the typical patrol research effort, as we will be drawing generic research conclusions which in some cases rely on this structure. It is to the mechanisms of patrol research that the next section is devoted.

2.3 THE STRUCTURE OF A TYPICAL PATROL RESEARCH EFFORT

Patrol research may be performed in a variety of modes. For example, research may take the form of a *narrative case study* where certain aspects of patrol activity are observed and described in detail. A *demonstration project* could be undertaken to see if a particular concept in patrol is viable. At the other end of the spectrum, *mathematical models* of operating police patrol systems may be constructed, and suggestions for improvement may stem from insights provided by the models.

Recently, the *social experiment* has become the dominant paradigm adhered to in the patrol area. In general, experiments may be thought of as consisting of the following five steps:

(1) Selection of *hypotheses* to be tested;

(2) Selection of *performance criteria* by which to test the stated hypotheses;

(3) Design of an experimental procedure for testing purposes;

(4) Execution of the experimental procedure; and

(5) Evaluation of the experimental results.

Since most of the studies to be reviewed in Part IV are of this type, it is useful to examine the ideal structure of this style of analysis as it applies to police patrol research.

SELECTION OF HYPOTHESES

The relevance of a particular piece of patrol research is to a large extent determined by the hypotheses underlying the research. In selecting hypotheses for research investigation, it is important to keep in mind the potential value that confirming or rejecting the proposed hypotheses holds for police decision makers.

As mentioned previously, many research hypotheses have stemmed from a questioning of the standard methods of patrol as a means for accomplishing patrol objectives. The 1967 Science and Technology Task Force Report was a catalyst in this regard. Also, the Kansas City Preventive Patrol Experiment was designed to test one of the most basic and traditional modes of policing--routine preventive patrol.

Direct questioning of traditional police practice has not been the only forum leading to the formulation of research hypotheses. Recently, we have witnessed research based on emerging themes in the patrol area. One such theme is the utilization of civilians in patrol; the evaluation of Police Service Aides in Worcester serves as an example. Another emerging theme centers around the creative use of technology in the

patrol area; the Phase II evaluation of the St. Louis AVM system may be viewed in this light. In Part III, the major hypotheses which have been researched over the past ten years will be discussed in detail.

We should note at this early stage that the hypothesis-based research approach is not without its problems. For example, the dominant hypothesis-based approach focuses on a so-called "null hypothesis" which is an hypothesis that conjectures that the particular program being studied has no effect. As an illustration, if an innovative police patrolling program is instituted for one year in a particular area of the city, the null hypothesis would be that that program had no effect compared to status quo or traditional policies. The problem with this approach is that the resulting experimental design tends to be conservative in nature and biased toward the null hypothesis. That is, to prove that the new program has a measurable effect, the researchers must disprove the null hypothesis. Such disproving at scientifically acceptable levels of significance (which are typically .05 or less) is difficult to do in many police patrol experiments because of limited time and budgets which in turn limit the sample sizes involved. With small sample sizes it is often very difficult to disprove a null hypothesis of no effect. With the hypothesis-based approach, one should also bear in mind that one never proves an hypothesis; one only fails to disprove it or succeeds at disproving it at particular levels of significance. Surviving or dominant or popular hypotheses are those that have not been disproved in repeated attempts by different researchers in similarly focused studies. An additional concern with the hypothesis-based approach is that it is subject to a subtle form of abuse in that a researcher with preconceptions about patrol can hide his or her own biases by the selection of his

or her own null hypotheses; a set of null hypotheses which reflects preconceived biases may be hard to disprove in a study with limited sample size and then can be disseminated as supporting "scientific" evidence that the researchers' initial idea has been validated. Examples of these difficulties exist in the patrol research literature, but clearly they are not unique to that field and virtually any area of social science inquiry is subject to similar concerns.

SELECTION OF PERFORMANCE MEASURES

Hypotheses are often stated broadly (such as "routine preventive patrol represents an ineffective use of patrol officers", or "team policing is better than standard patrol organizational modes"). In designing an experiment to test the validity of such broadly stated hypotheses, one must reduce the broad hypothesis to a set a of more focused and measurable specific hypotheses that to the extent possible reflect the true character of the more broadly stated hypothesis. These more narrowly focused hypotheses must be stated in terms of measurable quantities whose values can be obtained and compared both before, during, and after the experiment. These quantities are called experimental *performance measures*. The attitudinal and operational performance measures that are selected should satisfy certain criteria:

(1) They should truly represent the broader hypothesis or hypotheses being tested and not be subject to deliberate manipulations by those who may want to subvert the experiment.

(2) The measures should be based on available or collectable data.

(3) The measures should be understandable to the police, the public, and researchers alike.

Any particular performance measure is subject to its own limitations. As an example, one may pose as a measure of preventive patrol activity the number of patrol miles driven on an eight-hour tour of duty; we have seen instances in which this measure can be perverted by driving the patrol car at relatively high speeds for, say, one hour from 4 to 5 a.m. in a public park and performing virtually no patrol during the remaining seven hours on duty. Thus, to limit the vulnerability of a study to weaknesses in performance measures, one usually wants to select a family of performance measures and to collect data from a wide variety of sources. This usually implies the collection of qualitative, process-oriented data in addition to more "scientifically rigorous" statistical data. These issues will be further discussed in conjunction with experimental conduct and evaluation.

The measures which are chosen for a given patrol research study are of course dependent on the hypotheses being examined. However, for any given class of studies, these same measures almost always appear to surface. Some examples are presented in Table III. It is not clear whether the measures that surface repeatedly do so because of their quality or because of their ease of measurement.

EXPERIMENTAL DESIGN

The key concern with the design of patrol experiments rests with the formation of "experimental" and "control" groups (e.g., beats, squads, districts, staffing rules, etc.). Theoretically, both experimental and control groups should be identical in character. However, while nothing changes from the usual mode of police operation in the control group, an experimental mode of police operation is implemented in the experimental

Table III

Common Performance Measures Found in Police Patrol Research

Type of Study	Associated Measures
Crime Prevention	Uniform Crime Report (UCR) Index Locally, reported crime rates Victimization rates (survey) Probability of crime interception Citizen-perceived fear of crime Citizen-perceived level of safety
Police Response Time	Travel time (with/without dispatch time) Travel distance Dispatch delay Citizen reporting delay Apprehension probability Citizen satisfaction with response time
Patrol Productivity/ Manpower Allocation	Patrol officer workload Patrol officer safety (injuries) Crime/Victimization rates Travel time Frequency of preventive patrol passings Citizen complaints Officer complaints

group. The experimental mode of police operation should be the *only* difference between experimental and control groups. The levels of predetermined performance measures are monitored over the experimental period (typical experiments in patrol have had durations of about one year), and at the end of the experimental period, the control and experimental groups are compared statistically (this will be further discussed under the evaluation of experimental results).

In many experiments, it has not proved possible to obtain a controlled situation of the type described above. These quasi-experiments rely on less powerful comparison groups and/or before-and-after observations. Some quasi-experiments have managed to incorporate models of the relevant performance measures into the experimental design (e.g., time series models). These models are able to predict levels of the performance measures that would have occurred in the absence of the experimental treatment, and hence serve the same function as that of a control group. Of course, the strength of such designs is largely dependent upon the accuracy of the models involved.

EXPERIMENTAL CONDUCT

In the previous section on experimental design, the importance of obtaining good experimental and control groups was stressed. While actually conducting an experiment, the emphasis shifts towards the *maintenance* of the experimental design, which includes careful monitoring of the experimental and control groups.

While the laboratories of the physicist or chemist allow desired conditions to be prolonged almost indefinitely, the urban environments of police patrol experiments do not even approximate these laboratories. Hence, there is good reason to be concerned about technical problems such

as the contamination of the experimental and/or control groups. The conduct of a successful experiment requires that the general conditions in the control and experimental groups remain the same throughout the course of the experiment. To achieve this, it is necessary to monitor continuously the experiment for the entirety of its duration. This type of process montioring may take the form of on-site observation, periodic interviews with involved personnel, routine statistical checks on various measures (e.g., number of cars in patrol areas, surveyed crime levels), or continuous time observation (e.g., use of AVM, Tachographs).

The above comments are even more important when the program is of the quasi-experimental type. Without controls, one has an accountability problem with respect to the true determinants of program outcomes: Was it the program or some other environmental condition that caused the observed results? The collection of process information will not guarantee an answer to this question, but such information may surely provide clues not available elsewhere.

Continuous time observation is clearly the most powerful method for ensuring that the conditions demanded by the experimental design are maintained; in particular, the use of AVM technology is promising in the patrol research area. Most studies have utilized routine statistical checks combined with interviews and/or on-site observation.

EVALUATION OF EXPERIMENTAL RESULTS

The evaluation of experimental results in police patrol has relied heavily upon the use of classical statistical procedures. The use of such procedures is predicated on the control group/experimental group design discussed earlier. If it is in fact true that the sole difference between experimental and control groups rests with the presence of an

experimental treatment in the experimental group, then observed differences in the levels of performance measures between the two groups may be attributed to one of two sources:

(1) Chance; or

(2) The experimental treatment.

Statistical procedures along the lines of hypothesis testing check to see if observed differences can be plausibly attributed to chance. If plausible attribution to chance cannot be established, then the experimental treatment is assumed to be responsible for the observed differences through the logic of elimination.

Similarly, quasi-experimental procedures utilize statistical routines to compare program performance in the light of comparison groups, "before-and-after" periods, or a reasonable model as discussed earlier. However, as the design of a test program deviates from that of the classic experiment, the rationale behind the use of statistical evaluation devices is weakened. In such cases (which constitute the majority of police patrol research efforts), the collection of process data is extremely important, as such information aids in determining whether or not it was the experimental innovation or some other combination of factors which was responsible for observed outcomes.

This description of social experimentation as applied to police patrol has been the model for the bulk of police patrol research that has been attempted in recent years. While the presentation here has been somewhat normative, this is not meant to imply that patrol research has been problem free. Indeed, the patrol research area as a whole has been fraught with difficulties. Some of these difficulties stem from misapplications of the methods associated with the experimental model, other

difficulties arise from the rigidity of the experimental model, and still others arise from the urban environment itself, which is relatively hostile to the establishment and maintenance of experimental conditions. With these tempering remarks in mind, Part III proceeds to examine the results of several research studies in hypothesis-specific terms; we will return to examine the problematic aspects of patrol research in Part IV.

III PATROL HYPOTHESES

Hypotheses contained in patrol research studies are motivated by concerns for effectively achieving patrol objectives. The attainment of objectives is dependent upon the efficacy of various operational procedures that are designed and implemented in patrol operations. Thus, hypotheses focus on alternative patrol operating procedures, attempting to test their effectiveness in achieving stated goals. Recalling our earlier discussions, the three major purposes of an urban police patrol force are: (1) the prevention and deterrence of crime; (2) the apprehension of criminals; and (3) the performance of certain public services.

Operationally, almost all of these functions are carried out as a result of one of two events: (1) a call for service (CFS) can be received by the police, where the caller is reporting the need for on-scene police assistance; or (2) a patrolling police vehicle may come across the scene of a situation or incident requiring police service. In the first case, it is the police emergency response system that is activated which in turn dispatches one or more appropriate police vehicles to the scene of the reported incident. In the second case, it is the patrolling police vehicle while on preventive patrol or on some other duty that comes upon the incident requiring police service. The police patrol vehicle or unit is most often in either one of two states: either responding to a call for service emanating through the police emergency response system, or

performing some type of preventive patrol. The response state represents the reactive stance of a police patrol force; the patrolling state represents potentially a proactive or preventive stance of a patrol force. It is not unusual then that one can divide the research hypotheses pertaining to police patrol into families; the first corresponding to the merits of police preventive patrol, the second corresponding to merits of the police emergency response system, and the third--whose concerns cross both types of patrol activities, reactive and proactive--focusing on the merits of alternative organizational and manpower allocation schemes. Contained in each of these categories are several specific research questions.

In this section, we will identify the major research hypotheses found in the patrol literature. The findings related to these hypotheses will be detailed in Part IV.

3.1 RESEARCH EXAMINING THE MERITS OF POLICE PREVENTIVE PATROL

According to Larson:

> Preventive patrol constitutes touring an area, with the officer(s) checking for crime hazards (open doors and windows) and attempting to intercept any crimes while in progress. By removing opportunities for crime, preventive patrol activity is supposed *to prevent* crime. By posing the threat of apprehension, preventive patrol is supposed *to deter* criminals from committing crimes. But agreement on how to achieve the objectives of prevention and deterrence is noticably lacking in police circles. (Larson, 1972b, p. 33)

At present, researchers recognize that there is still scant evidence for linking preventive patrol (its amount and tactics) to crime prevention and crime deterrence. Most studies examining preventive patrol and crime have focused on crime deterrence rather than crime prevention. This may be due to the fact that numerous potential targets for crime exist, and

such crime prevention tactics as "target hardening" are more likely to be the responsibility of citizens-at-large (e.g., property owners) than the police. A large number of studies have attempted to answer one of the following two questions:

Does motorized preventive patrol deter crime?

Does foot preventive patrol deter crime?

Indeed, these questions have proved to be a catalyst for modern patrol research. With new studies currently underway investigating the relationships between patrol presence and crime deterrence (Public Systems Evaluation, Inc., 1980), this area of research continues to yield the most controversial results in the patrol literature.

While the police are concerned with deterring crime they are also concerned with citizen attitudes towards crime and towards police. As the police are a public agency, they are expected to maintain a service of high quality. The police have long felt that preventive patrol is an effective crime deterrent, and that patrol presence enhances citizens' feeling of security as a result; hence researchers have been led to ask:

Does motorized preventive patrol enhance citizen satisfaction or citizen sense of security?

Does foot preventive patrol enhance citizen satisfaction or citizen sense of security?

A more specific research issue deals with the interception capabilities of motorized patrol units. We already mentioned the discussion of the Science and Technology Task Force with respect to this issue (The Institute for Defense Analyses, 1967). Other studies have attempted to determine whether or not preventive patrol does pose a threat to the would-be offender through the possibility of a random interception.

These studies have asked the question:

Does preventive patrol facilitate the interception of crimes in progress?

These five questions represent the bulk of the activities of researchers in the area of preventive patrol. We have reviewed nearly 30 studies which have addressed these issues; our assessment of this research is discussed later.

3.2 RESEARCH EXAMINING THE MERITS OF THE POLICE EMERGENCY RESPONSE SYSTEM

The police emergency response system is most readily described in terms of a sequence of events that occurs following an incident that will ultimately require on-scene police service. First, the incident, such as a robbery or vehicular accident or fire, occurs. Second, the incident is detected by a person or device that will report the incident to the police. Third, the detector, say, a citizen, attempts to call the police. Fourth, usually moments later, initial contact is made with the police, usually with a police emergency telephone operator. Fifth, critical information describing the incident is communicated to the police telephone operator. Sixth, this information is converted to a patrol beat number and dispatcher identity number and assembled for communication to the dispatcher. Seventh, the information is then transmitted to the dispatcher, either by hand, conveyor belt, or via computer memory transfer (as would occur in a Computer-Aided Dispatch [CAD] system). Eighth, the incident report now enters the dispatcher queue, which, if it contains additional incident reports, may severely delay dispatch of one or more police vehicles to the scene. Ninth, ultimately a patrol unit is dispatched. Tenth, it arrives at the scene to provide required service. Finally, eleventh, that service is completed and the patrol unit reports

its availability to the dispatcher.

Such a linear sequence of activities that is initiated by an incident requiring on-scene police service lends itself to a time-oriented description. Thus, it is natural and understandable that response time, or more precisely each of the components of the response time identified above, would be used as a surrogate measure of effectiveness of the police emergency response system. This in fact has happened, as many studies have examined police response time to reported incidents. Unfortunately, many of these studies have made one or both of two errors: Error type 1 occurs when the various components of response time are lumped or aggregated together into a single response time measure; the resulting study conclusions while focusing allegedly on response time as a single entity would be more appropriately focused on the constituent components of response time such as dispatcher queuing delay or travel time, or reporting delay until an attempt is made to contact the police. The second type of error occurs when all incident types are lumped or aggregated together and treated as a homogenous pool of incidents having homogenous response needs and characteristics; since 80 to 90, or even higher, percent of calls to police are of a non-urgent nature, this grievous error of call-type aggregation results in conclusions which are dominated by a non-urgent (often service-oriented) call. The potential for erroneous research conclusions is enormous, since improper response to the small minority of highly urgent calls can yield catastrophic consequences. Each of these types of errors has occurred in police research literature. An additional error has also occurred which is related to error type 1: one researcher may label "response time" as travel time while another researcher may label response time as the sum of the internal

communications room delay and travel time, while yet a third researcher may label response time as the sum of the reporting delay plus the internal police communications delay plus the travel time; thus we have studies which allegedly yield commensurate quantities, but definitional problems preclude their contrast and comparison.

In addition to the aforementioned problems relating to the response time performance measure, it should be noted that response time is not itself a comprehensive measure of performance of the police emergency response system. Other measures include the probability of miscategorizing the call, probability of taking down an incorrect address, and the probability of dispatching a unit whose officers are inadequately trained to handle to incident. Still, almost all studies of the police emergency response system have focused solely on response time, and therefore our hypothesis-based approach will focus on this measure as well.

Intuitively, it seems that the likelihood of apprehending an offender should decrease as the amount of time taken by the police to arrive at the scene of the offense increases. Thus, considerable research has been designed around the question:

Is response time inversely related to apprehension probability?

The police have also assumed that response time correlates well with citizens' perceptions of police service. Again, it is *intuitively* plausible that a citizen's satisfaction with the police would decrease as response time to an incident reported by that citizen increases. Researchers have therefore queried:

Is response time inversely related to citizen satisfaction?

While some have questioned the validity of response time as a measure of police performance, others have accepted response time reduction as a

desirable goal. There have been several proposals suggesting how patrol forces may reduce their response times. Two hypotheses that have been empirically examined are:

Is response time inversely related to the number of units on patrol?

Do Automatic Vehicle Monitoring Systems reduce response time?

The results of 16 studies of police response time will be presented in Part IV.

3.3 RESEARCH EXAMINING THE MERITS OF ALTERNATIVE ORGANIZATIONAL AND MANPOWER ALLOCATION SCHEMES

Until recently, the manner in which police patrol was practiced remained unchanged for nearly 60 years. This situation is changing, however, with researchers investigating alternatives to the traditional modes of police patrol organization and manpower allocation. One emotional issue for patrol officers concerns the number of patrol officers in patrol cars. Since policing is a highly labor-intensive activity, the reduction (or increase) in the number of officers per car could have large cost consequences. When considering one-officer versus two-officer patrol units, the two key research questions have been:

Is one-officer patrol more efficient/effective than two-officer patrol?

Does one-officer patrol present a greater danger to officers' safety than two-officer patrol?

There have been larger scale proposals regarding the reorganization of the entire patrol force. One such proposal involves creating "teams" of generalized patrol officers who perform both patrol and investigative functions. While team policing presents one alternative, *specialized*

patrol involves a different division of labor in the patrol force. Specialized patrol schemes require officers to perform specific tasks (e.g., respond to calls for service, *period*). Forms of team policing and specialized patrol have been researched in detail, with both of these patrol alternatives being compared to routine patrol. This is evidenced in the following two research questions:

Is team policing more efficient/effective than routine patrol?

Is specialized patrol more efficient/effective than routine patrol?

One issue of special concern since the 1972 amendment of Title VII of the Civil Rights Act concerns the ability of women to perform the duties of patrol officers. Since women may not be excluded from police work solely on the basis of sex, it has become important to determine whether or not women can provide effective patrol service. Hence, researchers have attempted to answer this question:

Are women as efficient/effective on patrol as men?

We have uncovered over 20 studies which examine issues of organization and manpower allocation; the results of these studies will be presented in the next section.

These 14 research questions represent the thrust of the majority of patrol research completed to date. Having presented the major hypotheses governing patrol research, it is now time to examine the research products themselves. In Part IV, we present our assessment of patrol research in hypothesis-specific terms.

IV HYPOTHESIS-BASED ASSESSMENT

This section presents a detailed examination of the major findings of patrol research conducted over the past 30 years, with an emphasis on research completed during the last decade. Our purpose is to synthesize and assess a *body of research*. Hence, our presentation will focus on the *research question or hypothesis* as the unit of analysis as opposed to the individual research studies.

In order to convey our results in an efficient manner, we will attempt to become rather systematic in this section. First, for each of the three "families" of hypotheses identified in the last section (preventive patrol, response time, manpower organization and allocation), we will present a list of the hypotheses contained in that family. Then, for each hypothesis, we will present the findings of related studies and critically assess the merit of these research efforts. Where a sufficient number of studies permits, our analysis of research questions will conclude with a "findings/credibility" matrix such as that shown in Table IV. In this anonymous format, it is possible to summarize the extent to which patrol research has substantially confirmed or refuted a particular research hypothesis, and the validity of the research in this area.

We will now discuss how we determine the "credibility" of a research effort. In Part II, we outlined an idealized structure for patrol research. Many of the studies we encountered were of this form, and it

Table IV

RESEARCH QUESTION: Research question of interest.

	CREDIBILITY			
	HIGH	MEDIUM	LOW	TOTAL
YES, HYPOTHESIS CONFIRMED				
INCONCLUSIVE				
NO, HYPOTHESIS REJECTED				
TOTAL				

NB: Entries in boxes will correspond to number of studies.

is thus possible to spot crucial deviations from a sound research design. For example, a study which was completely lacking in the notion of *control* (be it pure control group, comparison group, or a statistical control) will have difficulty establishing the credibility of its findings, especially if the policy implication of the study indicates any form of plan for action elsewhere. Improper use of statistical methods will serve to lower a study's credibility, as will heavy reliance on small sample sizes. Faulty or unreliable performance measures can also damage a study, as can poorly collected data. In short, research projects which suffer from serious methodological flaws will have low credibility. On the other hand, those studies which have maintained a research design of high integrity and have made proper use of research methodology will be said to be of high credibility. Unfortunately, these studies are few in number but they do provide useful examples of how one can conduct credible research in the field of police patrol. Of necessity, our assignment of credibility level is subjective in nature.

Having explained our assessment strategy, we will now proceed to examine the main body of patrol research, beginning with studies that addressed issues of preventive patrol.

4.1 RESEARCH EXAMINING THE MERITS OF POLICE PREVENTIVE PATROL

From our review of the literature, it has become obvious that the most fiercely debated issue in police research today concerns the effectivness of routine police preventive patrol. The following five questions seem to summarize the intent of researchers in this area:

(1) Does motorized routine preventive patrol deter crime?

(2) Does motorized routine preventive patrol enhance citizen satisfaction?

(3) Does foot preventive patrol deter crime?

(4) Does foot preventive patrol enhance citizen satisfaction?

(5) Does routine preventive patrol in general facilitate the interception of crimes in progress?

In Table V, we have listed those research studies which have examined at least one of the five questions posed. Our assessment of research in police preventive patrol is based upon our critical reading of these studies.

(1) *Does motorized routine preventive patrol deter crime?*

As discussed, the postulated deterrent effect of preventive patrol has provided the *raison d'être* for patrol as practiced today. We have identified 14 studies (one of which involved a bicycle patrol) which have to varying degrees examined this relationship between police patrol and crime. Though these studies are of widely different scales and have employed research methodologies ranging from the very simple to the very sophisticated, the studies are basically similar. By changing the *level* or *intensity* of patrol can one bring about a reduction in crime (measured by reported crime data or victimization survey results)?

Before discussing our findings in detail, let us briefly examine the research problems likely to surface in a study focusing on preventive patrol and its relationship to crime deterrence. First, the primary outcome variable of interest in these studies is usually crime rate. Unfortunately, crime rate as measured or as reported to the police or as reported by the police, is often quite different from crime rate as experienced by citizens; as mentioned earlier it is not unusual for only one in three serious crimes to be reported to and by police. Thus any

Table V

Research Efforts: Preventive Patrol*

(1) A Preliminary Evaluation of the Des Moines Police Department's Comprehensive Neighborhood Patrol Program.

(2) Allocations of Resources in the Chicago Police Department.

(3) An Evaluation of a Police Patrol Experiment (Alburquerque).

(4) Crime Control Team (Syracuse).

(5) Evaluating the Effectiveness of One-Officer versus Two-Officer Patrol Units.

(6) Examination of Police Patrol Effectiveness - High Impact Anti-Crime Program.

(7) Final Report - Cleveland Deterence, Detection and Apprehension Program.

(8) Final Report - Overtime Foot Patrol (St. Louis).

(9) Foot Patrols: The Fort Worth Experience.

(10) Interception Patrol.

(11) Isla Vista Foot Patrol: History, Operations and Evaluation.

(12) Operation 25 (New York City).

(13) Patrol Emphasis Evaluation (Cleveland Heights).

(14) Patrol Evaluation Research: A Multiple Baseline Analysis of Saturation Police Patrolling During Day and Night Hours.

(15) Police Tactics Against Robbery.

* Complete references may be found in the bibliography.

Table V

(Page 2 of 2)

(16) Safe Streets Evaluation Report.

(17) Science and Technology Task Force Report.

(18) Social Evaluation Research: The Evaluation of Two Patrolling Strategies.

(19) Some Effects of an Increase in Police Manpower in the 20th Precinct of New York City.

(20) Special Police Units in Michigan: An Evaluation.

(21) The Beat Patrol Experiment.

(22) The Crime-Correlated Area Model: An Application in Evaluating Intensive Police Patrol Activities.

(23) The Impact of Police Activity on Crime: Robberies on the New York City Subway System.

(24) The Kansas City Preventive Patrol Experiment.

(25) The Use of Paraprofessionals in Police Service.

(26) The Wilmington Split-Force Experiment.

(27) Urban Police Patrol Analysis.

(28) What Happened to Patrol Operations in Kansas City? A Review of the Kansas City Preventive Patrol Experiment.

program that affects crime levels is potentially plagued by an accompanying change in the probability of a crime being reported. For instance, it is entirely conceiveable that a new preventive patrol strategy could reduce actual crime rates while at the same time increasing reported crime rates; there is limited evidence in some of the studies that we have examined that this phenomenon has occurred. The major way out of this dilemma is to try to estimate true crime rates via expensive victimization surveys. Second, there is every reason to believe that crime rates should vary as the number of police patrol officers is varied; recent police strikes in various cities, and even the now infamous 1919 Boston police strike have graphically revealed that the total absence of police can in certain circumstances yield intolerably high crime levels; at the other extreme, virtual wall-to-wall police coverage essentially eliminates the opportunity for crime. The trouble is that most cities today have neither wall-to-wall police nor the total absence of police. Rather, most cities have anywhere from 50 police per square mile to 0.2 police per square mile. If the relationship between the number of crimes committed and police intensity is rather "flat" at typical levels of police coverage, then a virtual doubling or tripling of police or on the other end a halving of police presence might yield no measurable change in crime levels. This is another problem confronted by police researchers in this area. Third, the level of preventive patrol does not vary in proportion to the number of patrol units out in the field. We can see this by example. Suppose there is one patrol unit in a fixed area that spends four hours of an eight-hour tour servicing calls for service, and the remaining four hours on preventive patrol. Then, if a second car is added to the same fixed area, there is no reason to believe that the call-for-service workload

would be increased, thereby yielding an identical call-for-service workload of four hours, now shared between two vehicles. But the vehicles have available 16 total hours in an eight-hour tour, thus resulting in 12 hours of preventive patrol, up 300 percent from the four hours attributable to only one patrol unit. Here, a doubling in number of patrol cars has created a tripling in a preventive patrol level. One can think of other examples in which a doubling of patrol cars could yield a quadrupling in patrol levels or even an increase of patrol levels by a factor of five, six or ten. The amount of time that a patrol unit must spend on calls for service represents a "fixed charge" which renders the relationship between patrol intensity and the number of patrol cars not directly proportional. As obvious as this may sound, researchers have made the mistake of assuming that an increase in the number of patrol cars by x percent will increase the patrol level x percent; we have just seen that the amount of preventive patrol would be increased by greater than x percent. The fourth problem with patrol experiments of the type we are discussing here is the extreme difficulty encountered when trying to measure the intensity of preventive patrol itself. As we mentioned briefly earlier, such surrogate measures as number of miles traveled during an eight-hour tour are easily subverted. It has not been until very recently with the advent of automatic vehicle location systems that one can in fact design experiments in patrol that can be carefully monitored to ensure integrity of experimental conditions throughout the entire period of the experiments. Virtually all of the studies that we report on here did not have the benefit of such technology to assist the execution of the experiment.

In this section as well as in the following sections related to

specific hypotheses the reader is advised to consult the annotated bibliography for descriptions of the projects analyzed. Our focus in this and subsequent sections is on synthesis of results of the studies, but not on the indiosyncrasies of individual studies.

Six reports suggest that there is an inverse relationship between patrol intensity and crime occurrence. For example, the Crime Control Team (CCT) (Elliott and Sardino, 1971) in Syracuse increased the number of patrols during selected time periods by as much as a factor of four. The time-dependent manpower allocation scheme used by the Crime Control Team was determined by matching periods for intense patrol to observed high-crime periods. If the year-end summary statistics for the Crime Control Team are evaluated, it is noted that reported crime was reduced by a greater amount in the Crime Control Team beat than in the control beats.

As another example, consider the Wilmington Split-Force Experiment (Tien, Simon and Larson, 1976). Here, patrol was also allocated in a time-dependent manner with certain hours of the day receiving very intensive patrol. Wilmington also experienced a decrease in reported crime during the Split-Force study period.

Other studies which witnessed a decrease in crime rates after patrol operations were intensified include the Patrol Emphasis Project in Cleveland Heights (Gay, 1977), Budnick's evaluation of saturation patrol in Washington, D.C. (Budnick, 1972), Press's analysis of the manpower increase in New York City's 20th Precinct (Press, 1971), and Howard's study of campus bicycle patrols in Los Angeles (Howard, 1977). However, while these studies offer support to the contention that preventive patrol deters crime, there are five studies which found no evidence of the presumed effectiveness of preventive patrol.

Foremost among the studies which dispute the usefulness of preventive patrol is the famous Kansas City Preventive Patrol Experiment (KCPPE) (Kelling, Pate, Dieckman and Brown, 1974), the most elaborate police research study to date. The evaluators of this patrol project claim that during one year of marked variation in patrol intensities among three types of beat (regular intensity, high intensity, little or no intensity), no differences in the level of crime were observable between areas of intensive patrol and areas of no patrol. These results are based on statistical tests involving both reported crime indexes and victimization surveys.

Other studies have obtained the same basic results. The 1975 study by Schnelle *et al.* of saturation patrol in Nashville involved a quasi-experimental time-series design (Schnelle, Kirchner, Lawler, and McNees, 1975). Though arrest rates increased, the saturation patrol (of eight to fifteeen additional patrol officers) did not produce an appreciable change in the reported crime rate.

Similar results were obtained by Wagner with respect to the Special Operations Section of the Alburquerque Police Department (Wagner, 1978). In this program, two eight-officer teams were fielded alongside the regular patrol to create saturation conditions in various parts of Albuquerque. No changes were detected in the reported crime rates as a result of the increase in patrol intensity.

In addition to those studies already mentioned, the following two studies--Lewis *et al.*'s evaluation of saturation patrol in Michigan (Lewis, Breene and Edwards, 1977), and the Safe Streets Evaluation Report (Iutcovich, M. and Iutcovich, J., 1977)--could not detect a relationship between patrol presence and crime occurrence.

Finally, there are also those studies which produced inconclusive results. In a second carefully monitored saturation patrol experiment in Nashville, Schnelle *et al.* discovered that intensive patrol correlated with reduced crime levels only at night (Schnelle *et al.*, 1977). Daytime crime levels remained the same in spite of saturations of up to 30 times the normal patrol level. Dahman's *post hoc* examination of the High Impact Anti-Crime Program's overt patrol projects yielded mixed results, suggesting that there is no uniform relationship between crime rate and overt police patrol (Dahman, 1975). The final report of the Cleveland Deterrence, Detection, and Apprehension Program indicated that after the introduction of a high visibility patrol program, crime rates decreased, but then increased (Cleveland Impact Cities Program, 1975).

It is apparent that there is substantial disagreement among police researchers as to whether police preventive patrol deters crime. This inconclusive state of affairs is further aggravated by the sad fact that the majority of the research efforts mentioned are methodologically flawed, often because of general difficulties cited earlier for this type of research. Additional technical problems with some of these research products are serious enough to undermine their claimed findings.

For example, the results from the Crime Control Team in Syracuse do not allow one to conclude that preventive patrol deters crime for two reasons:

(1) Other beats in Syracuse not involved in the experiment experienced greater (or comparable) declines in the crime rate when compared to the experimental area; and

(2) Other factors could easily be responsible for the reduction of crime in the CCT beat, including aspects

of the CCT not related to patrol intensity, or events external to the study (which were not well controlled).

Likewise, the Wilmington project did not provide crime statistics by time of day. Since the nature of the Split-Force experiment did not call for the use of control beats, the crime decrease experienced in Wilmington cannot be attributed to preventive patrol.

Those studies that disputed the effectiveness of preventive patrol also have their methodological weaknesses. The criticisms of the Kansas City Preventive Patrol Experiment are well known (Larson, 1975b; Fienberg, Larntz, Reiss, 1976; Davis and Knowles, 1975). Essentially, the major problem associated with this program was its inability to vary the levels of patrol to the extremes necessary for detecting the presence (or absence) of a deterrent effect upon crime. A second problem rests in the fact that the study tended to be biased in favor of the null hypothesis that varied levels of patrol will have no effect on crime (Fienberg, Larntz and Reiss, 1975). Other problems of experimental design and maintenance plagued this study, placing its controversial findings in question.

In Alburquerque, the selection of beats for the Special Operations Section program was arbitrary; this could have biased the results obtained. Also, the patrol officers participating in the study *volunteered* to take part; this could also have led to biased results.

Needless to say, there are several problems with completed research on this question. Our review of relevant research has convinced us that as of now, there are no credible, definitive studies which answer the question posed. This is reflected in Table VI which summarizes our findings on the issue.

(2) *Does motorized preventive patrol enhance citizen satisfaction?*

Present-day police departments are seen by both police

Table VI

RESEARCH QUESTION: Does motorized preventive patrol deter crime?

	CREDIBILITY			
	HIGH	MEDIUM	LOW	TOTAL
YES, HYPOTHESIS CONFIRMED	0	2	4	6
INCONCLUSIVE	1	1	1	3
NO, HYPOTHESIS REJECTED	0	2	3	5
TOTAL	1	5	8	14

administrators and the general public as the deliverers of a wide range of municipal services. When viewed from the perspective of public service delivery, client satisfaction with the mode of police service received becomes important. Of research concern is the validity of the contention that citizens are by and large satisfied with routine preventive patrol, and that increases in the level of patrol would increase the level of citizen satisfaction with the police.

This contention was addressed explicitly by the Kansas City Preventive Patrol Experiment. Through the use of survey techniques, the Kansas City researchers concluded that citizen satisfaction was unaffected by the changes in patrol associated with that experiment. However, a re-interpretation of the data provided in the final report of the Kansas City study suggests that there may be a strong relationship between citizen satisfaction and preventive patrol. On pages 331 to 351 of the KCPPE's Technical Report (Kelling, Pate, Dieckman and Brown, 1974), a wealth of information remarkable in its consistency is presented which in itself supports the idea that preventive patrol enhances citizen satisfaction. These results have apparently remained obscure; it is useful to highlight them here:

(1) Community perceived need for neighborhood police officers: the results *consistently* state that more officers are needed.

(2) Community perceived need for city police officers: again the results *consistently* state that more officers are needed in Kansas City as a whole.

(3) Community perception of time spent on patrol: when comparing *perceived* amount of patrol to *preferred* amount of patrol, the results *consistently* state that citizens feel more patrol is necessary (i.e., preferred level of patrol is greater than perceived level of patrol).

(4) Community perception of time spent on aggresive patrol: again, the results *consistently* show that citizens would *prefer* more aggressive patrol than they *perceive*.

(5) Community suggestions to reduce neighborhood crime: where suggestions are given, the modal response is *consistently* to implement more frequent police patrol.

(6) Aspect of neighborhood police service liked best: where answered, the modal response is *consistently* that police aren't patrolling enough in the neighborhood.

The Kansas City researchers realized that the above six findings did not vary in type of beat. Since patrol was presumably varied by reactive, control and proactive beats, their conclusion was that patrol intensity had no influence on citizen satisfaction with the police.

However, the consistency of the above six points is somewhat overwhelming. If the criticisms of Larson and others discussed earlier are correct, then it should come as no surprise that citizens *did not detect or perceive* different levels of patrol where the experiment would have expected these differing levels to exist. These results also seem to indicate that preventive patrol does enhance citizen satisfaction.

In Syracuse, the Crime Control Team experiment did not generate specific evidence with respect to the question under discussion. The authors of that study indicate that through discussions with business, civic, political, and religious leaders, it was apparent that citizen satisfaction with the police had increased in the experimental beat (Elliott and Sardino, 1971). However, this assertion cannot be substantiated, and even if it were true, it would be incorrect to attribute it to the increased intensity of the patrol force.

Howard's study of bicycle patrol in the Claremont Colleges also included a survey of students there. He reports that students' attitudes toward departmental effectiveness became more positive, and that students felt more secure on campus after the special program had been operative for five months (Howard, 1977). Both of these may be taken as indications of improvements in students' satisfaction with the campus police.

Thus, if we take the researchers' word on their answers to this research question, we are again left with inconclusive results as shown in Table VII. Also, we cannot ignore the methodological problems accompanying this work and these will be address later (see Part V). However, if we consider our own interpretation of the Kansas City results, then more evidence would seem to favor the argument that preventive patrol *does* enhance citizen satisfaction. At any rate, there is no conclusive piece of research at present which answers in a definitive manner the research question posed.

(3) *Does foot preventive patrol deter crime?*

Though motorized patrol currently constitutes the major activity of urban U.S. police departments, foot patrol represents the oldest mode of police deployment. There are those who feel that foot patrol has been and continues to be an effective crime deterrent, and that the merits of foot patrol should not be overlooked in favor of motorized patrol. We have uncovered nine* studies which have examined the deterrent effect of foot patrol; the results of some of these studies will now be discussed in detail.

In Isla Vista, California, a foot patrol was initiated following 18 months of community unrest (Kinney, Howlett and Harris, 1976). While serious reported crime decreased, petty reported crime increased. The Isla Vista evaluators claimed that crime itself decreased, though *reporting rates* were thought to have risen. However, there is no evidence in the report that substantiates this claim.

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* As a tenth study, we had hoped to review the Police Foundation's foot patrol experiment in Newark. Unfortunately, no documentation of this significant study exists at the time of writing.

Table VII

RESEARCH QUESTION: Does motorized preventive patrol enhance citizen satisfaction?

CREDIBILITY

	HIGH	MEDIUM	LOW	TOTAL
YES, HYPOTHESIS CONFIRMED	0	1	1	2
INCONCLUSIVE	0	0	0	0
NO, HYPOTHESIS REJECTED	0	1	1	2
TOTAL	0	2	2	4

Pendland and Gay reported that Part I crime decreased 25.4 percent in a high crime area of Fort Worth following the initiation of foot patrol (Pendland and Gay, 1972). Crime decreased by 11 percent citywide during the one-year program. The authors concluded that the foot patrol was effective in deterring crime.

An earlier study of foot patrol was conducted in New York City (New York City Police Department, 1972). On September 1, 1954, the foot patrol strength in New York's 25th precinct was increased from 188 to 440 patrol officers. This level of foot patrol was maintained for four months. Felonies and misdemeanors decreased by 55.6 percent in the precinct while arrest rates increased. These results prompted New York police officials to conclude that the foot patrol had been a success. However, the study was not controlled; there was no analysis pertaining to crime displacement and certain minor crimes were reported to have increased--prompting questions and doubts about crime categorizations by police officers.

Another New York study, this time of foot patrol in the subway system, was conducted by the New York City Rand Institute (Chaiken, Lawless, and Stevenson, 1974). Using an interrupted time series design, the Rand researchers examined eight years of subway robbery data. During this period, police presence in the subway almost tripled. Robberies apparently decreased after the increase in foot patrol and these robberies were not deferred to other hours of the day. Rather, a "phantom effect" prevailed whereby crime decreased at hours just outside of the foot patrol shifts. Unfortunately, some time after the dissemination of the results of this study, it was learned that much of the data analyzed by the researchers had been falsified during compilation by police employees. However Chaiken (1978) has reanalyzed this study considering the effects

of the data falsification, and he concluded that the earlier results are valid with the exception of their magnitudes (i.e., the deterrent effect was less than stated).

Not all foot patrol programs have demonstrated a deterrent effect. In Nashville, an additional six foot patrol officers were deployed in two target areas (Schnelle, Kirchner, Lawler and McNees, 1975). Using time-series models based upon six weeks of data, it was determined that foot patrol had no effect on the arrest rate. The number of reported offenses increased in the areas provided with foot patrol. Thus, the effectiveness of foot patrol is questioned by this study. However, here problems of random flucuations due to the small sample size, basically in favor of the null hypothesis, and change in crime reporting probabilities may all have influenced the outcomes of the study.

Another study of foot patrol was conducted in St. Louis (Walsh, 1975). From June 1972 to November 1975, overtime foot patrols were deployed in areas of the city exhibiting high crime rates. These foot patrols were reallocated quarterly. According to the project evaluation report:

> Measurable crime reduction has occurred only in isolated cases when compared to area and citywide trends. No significant geographic displacement of crime appears to have occurred. Crime appears to have been displaced to the unpatrolled hours in the experimental areas. (Walsh, 1975).

One of the more interesting studies in foot patrol was reported by Bright (1970). This one-year experiment was performed in the British cities of Cardiff, Manchester, Newcastle, and Sheffield beginning in December 1965. Each city selected one beat as a control (one foot officer/beat) and one beat as experimental (0, 2, 3, 4 foot officers/beat). Crime levels were examined as a function of the number of foot officers/beat. The results indicated that crime decreased markedly when the level of

foot patrol changed from no officers/beat to one officer/beat. Crime levels did not change with increases in foot patrol intensity above one officer/beat. Thus, it would seem that foot patrol is certainly preferable to no patrol, but that the actual level of foot patrol may not be important (within the ranges examined by this experiment).

Table VIII summarizes our assessment of studies which have examined the deterrent effect of foot preventive patrol. As is the case with motorized patrol, no easy conclusions are reachable. This is due to the conflicting results reported by different researchers, and the low technical quality of most research performed to date. Thus, our review of completed studies cannot support or refute the hypothesis that foot patrol deters crime.

(4) *Does foot preventive patrol enhance citizen satisfaction?*

As is the case with motorized patrol, police officials are concerned that citizen response to foot patrol be favorable. Indeed, it is often foot patrol that tends to be stepped up in an area in response to citizens' outcries for more "police protection." Four of the studies we reviewed surveyed citizen attitudes toward foot patrol, and all four yield similar conclusions.

In Fort Worth a survey was administered to two independently selected random samples of residents, one before foot patrol, the other after. According to the researchers, this second survey indicated ". . . a generally favorable response on the part of area residents to the Foot Patrol Unit" (Pendland and Gay, 1972).

A direct comparison of foot patrol to motorized patrol was obtained in St. Louis. As part of the evaluation of the Overtime Foot Patrol Project, a survey was administered to citizens asking them to compare the

Table VIII

RESEARCH QUESTION: Does foot preventive patrol deter crime?

CREDIBILITY

	HIGH	MEDIUM	LOW	TOTAL
YES, HYPOTHESIS CONFIRMED	0	1	3	4
INCONCLUSIVE	0	1	1	2
NO, HYPOTHESIS REJECTED	0	1	2	3
TOTAL	0	3	6	9

effectiveness of foot patrol to car patrol. Ninety-four percent said that foot patrol was as good as or better than car patrol, with 69 percent saying "better." This was taken as an indication of citizen satisfaction with foot patrol by the St. Louis evaluators.

The evaluation of foot patrol in Isla Vista included a citizen survey. This survey showed that Isla Vista residents preferred foot patrol to other types of policing. However, these findings are not entirely believable, as "The sampling techniques employed to select survey respondents were not precisely described; consequently, neither the representativeness of the sample not the levels of statistical confidence in the results could be assessed" (Kinney, Howlett and Harris, 1976). Another problematic survey is presented with the preliminary evaluation of a foot patrol program in Des Moines, Iowa (Central Iowa Crime Commission, 1977). This survey was presented in conjunction with one month of foot patrolling to small samples of citizens (20-30). Though the representativeness of this survey cannot be guaranteed, it did indicate that citizens were satisfied with foot patrol.

Thus, from the four studies we have examined on this issue, it appears that citizen satisfaction is enhanced through the use of foot patrol. Again, the technical quality of some of these reports is questionable. However, in the absence of strong counter-evidence, we conclude that completed research supports the contention that foot patrol enhances citizen satisfaction with the police.

(5) *Does preventive patrol facilitate the interception of crimes in progress?*

The interception capabilities of motorized patrol units have been analyzed from both theoretical and applied perspectives. Theoreticians

have relied on an area of operations research known as "search theory" to model the likelihood of events such as the space-time coincidence of randomly patrolling cars and randomly located crimes. Empirical estimates of these "interception probabilities" have been obtained by computing the fraction of crimes potentially observable by the police that resulted in arrests of criminals "caught in the act."

With respect to the theoretical aspects of this issue, it is noted that Blumstein and Larson (1967), Elliott (1973), Larson (1972b), Bottoms *et al.* (1972) and Kaplan (1979) have all formulated similar models of interception probability, and they have obtained similar results. An increase in the number of patrol units in an area will certainly increase the overall threat of intercepting crimes in progress. However, the actual *magnitudes* of these interception probabilities are so small that the cost of deploying additional patrol units may outweigh the benefits of the improved interception capabilities.

We previously mentioned the finding of the Science and Technology Task Force that interceptions are so rare that they occur once in 14 years. Larson (1972b) estimated that at a patrol frequency of one passing per hour, and for a crime lasting one minute, the likelihood of interception is only about 1.7 percent. In Syracuse, Elliot (1973) estimated an interception probability of 0.8 percent, while Kaplan (1979) derived an interception probability of 0.6 percent using data from San Diego. All of these probabilities are very low. Since *apprehension* probabilities are even smaller than interception probabilities, these models suggest that patrol in and of itself is not an effective strategy for apprehending offenders.

The only large scale experimental study which explicitly addressed this question was the Crime Control Team in Syracuse. It is true that at

times, the number of patrol units was increased in the experimental beat by as much as a factor of four. It is also true that the interception rate of 3.8 percent obtained was an improvement over the interception rate of the regular patrol by a factor of six. However, Elliott was disappointed with this result, having expected to achieve an interception rate of 10 percent to 15 percent. He stated that he ". . . was not able to impress the Crime Control Team with the importance of the speed of the vehicle to an effective interception patrol. All of the people connected with the experiment continued to patrol at a constant slow speed, which maximized their detection capabilities rather than their interception capabilities." (Elliott, and Sardino, 1971, p. 116).

Elliott's later monograph entitled Interception Patrol: An Examination of the Theory of Random Patrol as a Municipal Police Tactic (Elliott, 1973) consolidated his previous theoretical work and his research with the Crime Control Team. He proposed a method for constructing computer-designed patrol routes based on the notion of maximizing interception probabilities, and concluded that his methods required extensive experimental evaluation at high cost.

Larson also examined the notion of allocating patrol resources with the objective of intercepting crimes in progress. His model produces optimal coverage functions which prescribe the *relative amounts of time* different areas should be patrolled (as opposed to the fixed route patrols resulting from Elliott's model). One interesting finding from Larson's work is the idea that in order to maximize crime interception, certain areas should not receive any patrol. This theoretical result buttresses Larson's notion that "fluid patrol" could be an efficient and effective patrol option.

A detailed examination of this same model was performed by the Operations Research Task Force of the Chicago Police Department (Bottoms, *et al.*, 1972). Using actual robbery data from Chicago's Second Police District, the Chicago researchers were able to determine the amount of patrol effort that should be allocated in order to maximize the probability of a space-time coincidence. However, the maximum interception probabilities obtained were on the order of one or two percent. While these percentages may be disappointingly small, they may account for a sizable fraction of arrests for particular types of crimes (e.g., burglaries); an increase, say from two to four percent interception rate would correspond to a *doubling* of on-scene interception arrests.

It would seem, though, from this review that although one can allocate patrol resources in a manner which will maximize the interception capabilities of patrol units, these interception capabilities are quite limited even when operating at optimum levels. Thus, one would say that preventive patrol does facilitate the interception of crimes in progress, but this in itself is of limited consequence in the achievement of overall patrol objectives.

4.2 RESEARCH EXAMINING THE MERITS OF RAPID POLICE RESPONSE

Another contested issue in patrol research concerns the effectiveness of rapid police response to calls for service. Recalling our earlier discussion, police response time (too often aggregated by type of call and by response system component) is used widely as a surrogate measure of the effectiveness of the police response system.

(6) Is response time inversely related to apprehension probability?

(7) Is response time inversely related to citizen satisfaction?

(8) Is response time inversely related to the number of units on patrol?

(9) Do Automatic Vehicle Monitoring Systems reduce response time?

Our assessment of research in response time is based on those studies listed in Table IX.

(6) *Is response time inversely related to apprehension probability?*

"The probability of arrest is strongly related to the elapsed time between a criminal event and the arrival of police on the scene . . . ." (Bottoms *et al.*, 1972, p. 89). The Chicago Operations Research Task Force is not alone in assuming the correctness of the above proposition; indeed this belief has long been held by police administrators dating back to August Vollmer and the beginnings of motorized patrol. Our research has uncovered one theoretical and five empirical studies relating to this issue; the results of these efforts are as follows.

In a little known report entitled Police Tactics Against Robbery (Bottoms, 1971). Bottoms presented a model relating apprehension probability to response time (which Bottoms refers to as "time late"). Using ideas from search theory and some simple assumptions governing patrol behavior and criminal escape routes, Bottoms was able to demonstrate why the likelihood of apprehending a thief should decrease markedly with increases in response time. Thus, Bottoms' model provides a theoretical rationale for the expectation that response time and apprehension probability are inversely related.

As mentioned, we have discovered five studies which have empirically researched this issue. The approach in all these studies was similar. Essentially, each study examined the fraction of all calls with response time not exceeding minutes that resulted in at least one arrest. Here

Table IX

Research Efforts: Response Time *

(1) Analysis of Response Delays and Arrest Rates.

(2) Evaluating the Effectiveness of One-Officer versus Two-Officer Patrol Units.

(3) Patrol Staffing in San Diego: One- or Two-Officer Units.

(4) Police Response Time: Its Determinants and Effects.

(5) Police Tactics Against Robbery.

(6) Resource Allocation in the Chicago Police Department.

(7) Response Time Analysis.

(8) Science and Technology Task Force Report.

(9) St. Louis AVM: Phase I.

(10) St. Louis AVM: Phase II.

(11) The Kansas City Preventive Patrol Experiment.

(12) The Relationship of Response Delays and Arrest Rates.

(13) The Wilmington Split-Force Experiment.

(14) The Worcester Crime Impact Program.

(15) Urban Police Patrol Analysis.

(16) What Happened to Patrol Operations in Kansas City? A Review of the Kansas City Preventive Patrol Experiment.

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* Complete reference may be found in the bibliography.

"police response time" is the sum of communications room delay and travel time, and calls for service are usually aggregated over a wide class. The response time/arrest rate relationship was tested with respect to its form and strength to determine if apprehension probability and response time bear an inverse relationship to each other.

Of the five studies examined, three were able to demonstrate a strong inverse relationship between response time and apprehension probability (Isaacs, The Institute for Defense Analyses, 1967, Clawson and Chang, 1977, and Tarr, 1978), while two claimed that the postulated inverse relationship was either weak or non-existent (Kansas City Response Time Study, Kansas City Police Department, 1977, Pate, Ferraia, Bowers and Lorence, 1976). It is interesting to note that the two studies rejecting the hypothesis under discussion had sample sizes much smaller than the other three projects. Indeed, Pate *et al.*, considered only 731 calls, while the Kansas City Response time analysts sifted through 949 incidents. In sharp contrast to this, Clawson and Chang examined 2,532 calls, Tarr studied 3,639, and the Isaacs study sampled 4,376 calls for police service.

If one closely examines the methods used in these five studies, it is apparent that the Isaacs, Clawson and Chang, and Tarr papers utilized approaches which are well suited to the research question posed. The other two studies are fraught with methodological problems, some of which will be discussed in Part V. Thus, the evidence presented would seem to favor the notion that there is an inverse relationship between response time and apprehension probability (see Table X).

However, this relationship is not necessarily causal. It is not true that a quick response time will guarantee an apprehension. It may be that for certain types of calls (e.g., victim-triggered robbery alarms, to be extreme), officers will respond faster due to their knowledge that there

Table X

RESEARCH QUESTION: Is response time inversely related to apprehension probability?

CREDIBILITY

	HIGH	MEDIUM	LOW	TOTAL
YES, HYPOTHESIS CONFIRMED	2	1	0	3
INCONCLUSIVE	0	0	0	0
NO, HYPOTHESIS REJECTED	0	0	2	2
TOTAL	2	1	2	5

is a high likelihood of an arrest being made for these types of calls. This "chicken-or-egg" syndrome will not be sorted out without recourse to a carefully controlled study; Isaacs in 1967 made this clear in stating:

> The data collected on the response time in duplicating field units appears [sic] to support the hypothesis that faster response time leads to more arrests. . . . (But) only a controlled experiment designed specifically to test this hypothesis would be conclusive proof. (The Institute for Defense Analyses, 1967, pp. 100, 93)

To date, no such controlled experiment has occurred.

(7) *Is response time inversely related to citizens' satisfaction with the police?*

We have already discussed why client satisfaction is important to the police. The level of motorized and/or foot patrol is one indicator thought to be correlated with client satisfaction; response time is another assumed surrogate for citizens' satisfaction with the police. We have uncovered four studies which question the notion that citizens' satisfaction is partially governed by police response time, and it is of note that *these studies have all reached the same conclusion.*

The Police Foundation study Police Response Time: Its Determinants and Effects examined this issue in detail using data generated by the Kansas City Preventive Patrol Experiment (Pate, Ferrara, Bowers, and Lorence, 1976). It was found that citizen satisfaction with response time remained at a constant (and high) level over a large variation of *perceived* response times. However, a significant correlation was found between citizen satisfaction and the difference between *observed* and *expected* response time; if the police were able to respond quicker than expected, the citizen involved was more likely to be satisfied than if the police responded slower than expected.

The LEAA-funded Response Time Analysis (Kansas City Police Department, 1977) also researched this question. Again, surveys reported that most of the population was satisfied with response time regardless of the actual response time involved. The researchers also advanced the argument that it is the difference between perceived and expected response time which is crucial in determining citizen satisfaction. There are some technical flaws in the statistical methods accompanying this report (see Part V); however, the results obtained regarding citizen satisfaction were probably not greatly affected.

In Worcester, Massachusetts, researchers (Tien *et al.*, 1975) noted that citizen satisfaction was consistently high despite variations in response time. For example, 46 percent surveyed there experienced response times ranging from 0-10 minutes, yet 50 percent were very satisfied with the response time incurred. Like the other studies mentioned, the Worcester study also indicates that citizen satisfaction is not too dependent on response time.

The same finding appeared in Wilmington (Tien, Simon, and Larson, 1976). Of 180 people surveyed, nearly 50 percent stated that a response time of over 10 minutes would be acceptable. The researchers attempted to determine an upper bound for the range of response times which would leave citizens satisfied with the service received. One survey showed that a delay of up to 40 minutes would be unacceptable to 74 percent of 192 respondents, while another survey showed that 54 percent of 189 respondents would not accept delays of up to 30 minutes. The Wilmington study detected tremendous indifference among citizens as to the relationships between response time and quality of service. In two surveys, well over 70 percent of survey respondents stated that response time had *no*

effect on the quality of police service received. Finally, in a very limited sample, citizens were informed that a response delay would occur--and 45 percent of this sample responded that they "couldn't care less". Hence, from the Wilmington study, it would appear that response time does not have much of an effect on citizen satisfaction.

We have seen four studies, which employed different methodologies and were designed for different purposes, approach a near consensus on the issue of the relationship between response time and citizen satisfaction. It is certainly suggested from this review that response time *does not* play a major role contributing to citizen satisfaction with the police (see Table XI).

Extreme care must be exercised in interpreting this result regarding citizen satisfaction and police response time. It would be incorrect for police decision makers to interpret this result in a way which argued for indiscriminate increase in police response time; the research studies reviewed here do not claim that a deliberate increase in response time would be received favorably or, at best, indifferently by the populus at large. The measured insensitivities of citizen attitude with respect to various levels of responsiveness is due to several factors. First, the great majority of calls for police assistance are non-urgent in nature; these may either be service-related calls, such as parking violations and lock-outs, or reports of crimes that occurred hours or days earlier. For such incidents, citizens are now known to voluntarily incur significant delay between discovery of the incidents and reporting to police; this is a major finding of the Kansas City Response Time study (Kansas City Police Department, 1977). Thus, a citizen voluntarily delaying a call to

Table XI

RESEARCH QUESTION: Is response time inversely related to citizens' satisfaction with the police?

CREDIBILITY

	HIGH	MEDIUM	LOW	TOTAL
YES, HYPOTHESIS CONFIRMED	0	0	0	0
INCONCLUSIVE	0	0	0	0
NO, HYPOTHESIS REJECTED	0	4	0	0
TOTAL	0	4	0	0

the police is not likely to care whether the police respond within 5 minutes, 10 minutes, or even 45 minutes, as long as the delay incurred is not judged to be excessive. This accounts for the finding that it is citizens' anticipated delay for police service versus the actual delay that is the critical variable, not the absolute delay incurred. Thus a citizen who is calling in and who is advised that police response may require 45 minutes is not likely to be perturbed if that citizen is reporting a low-priority call. A second problem related to these studies is that each of the police departments involved in the studies are by the selection process of the study being done there in the first place relatively progressive, innovative, and willing to service calls from the public in an effective manner. We have personally visited police departments in the United States in which a sizeable fraction of calls for police assistance are never responded to, which results in a virtually infinite response time. In a number of departments, queues at dispatcher's stations of an hour or more preclude immediate dispatch of calls for service; these queues are found not only during the more traditional high crime hours but may occur at any time of the day or night. It is unlikely that citizen surveys of police response time in such cities would yield results similar to the results we have seen for the four studies cited here. Third, even the studies cited here tend to aggregate their findings over the entire class of calls for service, thereby relegating the importance of extremely urgent and high priority calls to the "back burner". It appears highly unlikely that a citizen who is calling for police assistance while someone is attempting to break into his or her residence would be satisfied with a 15-minute or 45-minute response time; the reason that

these results do not show up in the studies is that such calls for service account for a very small percentage of total calls for service.

Thus, the policy implications of a particular set of research studies, even when the research studies share a consensus of findings, are not at all obvious. In the early 1970s, mayors and city managers reacting to early press releases of the Kansas City Preventive Patrol Experiment results jumped to the conclusion that preventive patrol--due to its relative ineffectiveness--could be virtually eliminated, thus allowing a reduction of up to 50 percent of total patrol officers; this policy conclusion was also simplistic and inaccurate. It remains a challenge to translate research findings into positive, action-oriented policy results.

(8) *Is response time inversely related to the number of units on patrol?*

Related to the notion that small response times are "good" is the question of how response time may be reduced to desirable levels. One intuitive strategy is simply to increase the number of police cars fielded. Indeed, there exist reasonable mathematical models relating mean response time to the strength of the patrol force, and these models all exhibit inverse relationships between response time and the number of units on patrol.

Hence, one of the expected results of the Kansas City Preventive Patrol Experiment was that response time would vary by type of beat; i.e., proactive beats with three patrol units were expected to experience rapid responses, while reactive beats with no patrol were expected to experience lengthier responses. However, it was found that response time did not vary at all by beat. This result is tenuous at best, due to improper labelling (i.e., categorizing by type of car rather than type of beat) and due to a large number of cross-beat dispatches. In all likelihood, this

discovery says more about the inadequacies of the experimental design of the Kansas City experiment than about the "hypothesis" being tested.

In San Diego, researchers (Boydstun, Sherry, and Moelter, 1977) indirectly touched on this issue when response times involving two answering units were compared to response times involving one answering units. It was found that two-unit response times were lower than one-unit response times. Had response times been measured according to the *first* unit to arrive on-scene in the two-unit case, then this finding that two-unit response times are more rapid than one-unit response times would make sense. However, the observed result was accompanied by the fact that two-unit response times corresponded to the response times of the *second* unit to arrive on-scene. One cannot accept such an unexplained (and perhaps unexplainable) finding as proof of much; one can suspect that something was problematic with the conduct of the experiment.

Thus, although two empirical studies speak to the contrary if accepted at face value, we feel that the relationship between response time and the number of patrol units fielded is, in fact, inverse. Raising the number of available units in an area should serve to reduce response time, usually according to a "square root law" as discovered and verified empirically be Rand researchers in a fire context (Chaiken, Ignall, and Walker, 1975).

(9) *Do Automatic Vehicle Monitoring systems reduce response time?*

Another proposal for reducing response time involves the use of Automatic Vehicle Monitoring (AVM) systems. This technology provides dispatchers with real-time information pertaining to the location and availability of patrol units. The anticipated savings in response time are due to the fact that with AVM information, it would be possible to dispatch the patrol car closest to the incident.

In Urban Police Patrol Analysis, Larson (1972b) modeled the performance of AVM systems with respect to reductions in response time due to closest car dispatching. He concluded that the use of car locators such as AVM could be expected to reduce travel time by 10 to 20 percent. For cities with mean travel times of about 5 minutes, this translates into a mean savings of up to one minute in response time. However, since travel time typically comprises only about 40 percent of total police response time, even a 20 percent reduction in travel time corresponds to only an 8 percent reduction in total response time.

The Chicago Operations Research Task Force (Bottoms *et al.*, 1972) also analyzed anticipated savings in response time due to the use of car locator systems. Using a detailed simulation model, the Task Force concluded that the car locator system alone does not result in large scale improvements in system efficiency. The maximum savings in response time due to the car locator were reported to be two minutes. If intersector dispatching was allowed, and if a car locator system was in use, then response time savings were predicted to approach four minutes. However, the bulk of these savings was attributed to the allowance for intersector dispatching rather than the use of the car locator system.

Considering the analytical results discussed above, the evaluations of the implemented St. Louis AVM car locator system have revealed some surprises (Larson, Colton, Larson, and McKnew, 1976; Larson and Simon, 1979). It was anticipated that AVM could reduce travel time by as much as 15 percent. Empirically, reductions of this magnitude simply did not occur; when comparing the drop in travel time citywide to the AVM district's decrease, it was found that the AVM district experienced a net decrease in travel time of only 4 percent. Hence, the evaluators

concluded: "Regarding the effect of AVM on average travel times, we must view the results of Phase I (one-district AVM) as inconclusive" (Larson, Colton, Larson, and McKnew, 1976, p. 23).

The Phase II (citywide AVM) evaluation revealed a similar finding. "The impact of AVM on response time was small, and not sufficient to materially influence apprehension rates or the effectiveness of the department" (Larson and Simon, 1979, p. 106). Typically, AVM-related savings in response time were on the order of 15-20 seconds.

To date, the only cities that utilize AVM systems are St. Louis, Missouri; Dallas, Texas; and Huntington Beach, California. We have discovered a Master's thesis by Otto Reichart (1977) describing the response time benefits of the Huntington Beach AVM system. For this study too, there are no measurable response time benefits due to AVM, compared to the police response system operating prior to AVM.

Thus, current empirical evidence does not support the contention that an AVM system reduces police travel time. However, close scrutiny of the evaluation reports in question, both for St. Louis and Huntington Beach, reveals that the AVM systems in those two cities experienced serious technical difficulties during the period of the evaluation. In St. Louis, for instance, it is known that dispatchers frequently did not follow the "closest car" concept due to their feeling that the system was not functioning properly from a technical point of view. Thus, while the statistical evidence to date does not support response time reduction due to AVM systems, one may correctly question whether the finding is due to inadequacy in the theory or inadequacy in the technology implemented to date.

4.3 RESEARCH EXAMINING THE MERITS OF ALTERNATIVE ORGANIZATIONAL AND MANPOWER ALLOCATION SCHEMES

A broader body of research has attempted to examine several exploratory hypotheses in the areas of patrol force organization and manpower allocation. Table XII contains a list of studies that have examined at least one of the following questions:

(10) Is one-officer patrol more efficient/effective than two-officer patrol?

(11) Does one-officer patrol present a greater danger to officers' safety than two-officer patrol?

(12) Is team policing more efficient/effective than routine patrol?

(13) Is specialized patrol more efficient/effective than routine patrol?

(14) Are women as efficient/effective on patrol as men?

The results of research into these aspects of patrol are the subjects of discussion in this section.

(10) *Is one-officer patrol more efficient/effective than two-officer patrol?*

The postulated benefits of one-officer patrol are well known. Indeed, reports along the lines of the Chicago Police Department's One-Man Patrol Cars (Chicago Police Department, 1963) present a host of reasons for utilizing one-officer patrol cars. Though police officials across the country have long held differing views on this topic (see Governmental Research Institute's survey One-Man Patrol Car Operation [Governmental Research Institute, 1957]), little research has been carried out until recently with respect to patrol car staffing.

Table XII

Research Efforts: Alternative Organizational and Manpower Allocation Schemes *

(1) An Analysis of Team Policing in Dayton, Ohio.

(2) An Evaluation of the Bellevue Police Department's Experiment in Team Policing.

(3) Atlanta High Impact Program Project Evaluation.

(4) Crime Control Team.

(5) Evaluating the Effectiveness of One-Officer versus Two-Officer Patrol Units.

(6) Evaluation of Women in Policing Program, Newton, Massachusetts.

(7) Evaluation of the Community Centered Team Policing Program.

(8) Final Evaluation of Team 28 Experiment.

(9) Final Report: West Philadelphia Strike Force, Act I, North, Central-Northwest Strike Force, Act II.

(10) First Year Evaluation of the San Jose Patrol Emphasis Program.

(11) Montpelier, Vermont's Directed Patrol Experiment.

(12) One-Man Patrol Cars.

(13) One-Man Police Patrol Car Operation.

(14) Patrol Staffing in San Diego: One- or Two-Officer Units.

(15) Policewomen on Patrol: Final Report.

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* Complete references may be found in the bibliography.

Table XII

(Page 2 of 2)

(16) Report on One-Man Patrol Cars in Kansas City, Missouri.

(17) Special Police Units in Michigan: An Evaluation.

(18) Team Policing Experiment: Analysis and Evaluation.

(19) The Beat Commander Concept.

(20) The Cincinnati Team Policing Experiment.

(21) The Use of Paraprofessionals in Police Service.

(22) The Wilmington Split-Force Experiment.

(23) The Worcester Crime Impact Program.

(24) Women on Patrol: A Pilot Study of Police Performance in New York City.

One early exception to this last statement was the Kansas City Police Department's Report on One Man Police Patrol Cars (Kansas City Police Department, 1955). This study compared patrol performance in 1952, when all cars were staffed with two officers, to patrol performance in 1954, when all cars were staffed with one officer. In terms of response time, number of calls serviced, and crime rates, the one-officer patrols performed well. However, due to its short time span and lack of statistical controls, this study's findings are not easily generalized. Also, through personal communication with the Kansas City Police Department, we have reason to believe that not all results of this study were reported in an acceptably unbiased manner.

As part of the Crime Control Team experiment in Syracuse (Elliott and Sardino, 1971), a limited test was conducted to evaluate the interception capabilities of one- and two-officer patrol units. Here, manpower was held constant, i.e., two one-officer units were substituted for one two-officer unit. It was found that two-officer units consistently outperformed one two-officer unit in terms of detecting "simulated" crimes (e.g., tape on a window to represent a break-in). Since manpower was held constant while detection capabilities were increased, it was concluded that one-officer patrol is more efficient than two-officer patrol.

In Seattle, Tarr (1978) analyzed response-related arrests as a function of the number of officers per primary unit. She reported that for response times under 10 minutes, two-officer units have significantly higher arrest rates than one-officer units. However, she also notes that this relationship could be due to the dispatching policy of the Seattle Police Department.

A twelve-month experimental study of patrol unit staffing was performed in San Diego. This experiment substituted one-officer cars for two-officer cars on a unit-for-unit basis. In the evaluation report Patrol Staffing in San Diego: One- or Two-Officer Units (Boydstun, Sherry, and Moelter, 1977), it is concluded that on the basis of calls handled, arrests, response time, monetary cost, and other measures, one-officer patrol is clearly as effective and more efficient than two-officer patrol.

Finally, Kaplan (1979) has investigated this issue using mathematical models in conjunction with data provided by the San Diego report. By modeling performance measures such as patrol coverage, response time, patrol frequency and visibility, interception probability, and system cost, he was able to conclude that one-officer patrol is more efficient than two-officer patrol. However, Kaplan's research assumed that *two* one-officer units would be substituted for each two-officer unit (within cost constraints), a strategy that preserves manpower. His models would not support a unit-for-unit substitution of one-officer cars for two-officer cars.

It would appear that with the exception of the Seattle data, most researchers have found one-officer patrol to be an efficient staffing mode. The arguments for one-officer patrol have generally assumed manpower conservation within cost constraints; assuming officer safety and effectiveness are not problematic, one-officer patrol is probably justified in this context. However, one study (San Diego: Boydstun, Sherry, and Moelter, 1977) did go beyond this, suggesting that unit-for-unit substitution (and the implied manpower decrease implicit in this substitution) is both feasible and desirable.

(11) *Does one-officer patrol present a greater danger to officers' safety than two-officer patrol?*

We are aware of only two studies which have examined this question, and both studies committed the same basic mistake. In attempting to compare the safety of one-officer and two-officer patrol, researchers in Kansas City (Kansas City Police Department, 1955) and San Diego (Boydstun, Sherry, and Moelter, 1977) examined the frequency of injury for one-officer and two-officer units. The comparison statistic used was the number of injuries *per unit* as opposed to the number of injuries *per officer*. If one-officer and two-officer patrol were equally dangerous to an officer, then the number of injuries per two-officer unit would equal twice the number of inuries per one-officer unit; in either staffing mode the number of injuries per officer would be the same (Kaplan, 1979).

However, one can easily correct this error by halving the reported two-officer injury rate. In doing this, we discovered that in both mid-1950s Kansas City and mid-1970s San Diego, the injury rate per officer is *higher* for one-officer patrol. The *difference* between per officer injury rates for one- and two-officer patrol is not great, however, and in the absence of comparative statistics from other cities, we cannot yet make a judgment on this issue.

(12) *Is team policing more efficient/effective than routine patrol?*

The topic area of team policing includes a wide range of organizational strategies, not all of which are directly related to patrol. We will only concern ourselves here with the patrol aspects of team policing; results pertaining to other facets of team policing (such as new strategies for criminal investigation) are discussed in another section of this study. Also, a large number of team policing studies have been completed in recent years. To assess all of these would be outside the scope of this project.

Thus, we have chosen a sample of nine representative team policing studies for review and assessment.

The common feature linking most team policing programs is their reliance on the notions of *decentralization* and *generalization*. Thus, the hypothesis underlying team policing is that effective patrol and other services can be provided in an efficient manner via a decentralized (sometimes neighborhood-based) police department consisting of officers who are generalists in the law enforcement field. From our review of team policing studies, it would appear that the validity of this hypothesis remains an unresolved issue.

We have already commented about the preventive patrol aspects of the Crime Control Team in Syracuse (Elliott and Sardino, 1971). While it is true that crime rates went down in the CCT beat, it is difficult to conclude that this was due to the new organizational structure of policing in the experimental area. Indeed, this appears to be the major difficulty in the evaluation of team policing programs in general--there is no clear relationship between the change in police organization implied by team policing and most of the measures of effectiveness chosen for evaluation.

However, in some cases where team policing has been implemented, patrol performance has improved markedly. The Crime Control Team was one example. Crime rates were down over 30 percent in the Los Angeles experimental area following the introduction of team policing (Los Angeles Police Department, 1974). Another example occurred in Bellevue, Washington (Ulberg *et al.*, 1976), where burglary rates decreased by 12.5 percent after the implementation of team policing. Similar results were obtained by the Atlanta Crime Analysis Team's evaluation of the

Atlanta High Impact Program's team policing project (Atlanta Police Department, 1976).

There have been reports of ineffective team policing programs as well. For example, the Dayton, Ohio, team policing program was evaluated (Cordrey and Pence, 1972; Cordrey and Kotecha, 1971), and it was found that on the basis of clearance rates, apprehension rates, and the like, no differences emerged between team policing and routine patrolling. In St. Louis (St. Louis Police Department, 1977), crime rates did decrease, but not significantly so, leaving team policing and regular patrol at nearly equivalent levels of effectiveness.

Finally, in the most in-depth study of team policing to date, Schwartz and Clarren (1977b) determined that crime rates decreased in Cincinnati's team policing area and that more crimes were *reported* to the police (a desired side effect that is, presumably, indicative of a neighborhood's perception of police effectiveness). However, there appears to be the possibility that some displacement of crime occurred. The evaluators concluded that their results ". . . will serve both advocates and opponents of team policing. What one makes of the findings depends on the assumptions and background one brings to them" (Schwartz and Clarren, 1977a).

Again, we have happened upon an issue which has not been resolved by empirical research. It is also true that the credibility of most studies in team policing is low (Gay, Day, and Woodward, 1977). The generic problem of linking organizational changes in police departments to patrol performance has made the evaluation of team policing programs very difficult, *forcing* most evaluations into a state of methodological helplessness in the absence of strict experimental controls as discussed

in Part II. On top of this, there are some studies which have allowed for research designs that would be problematic even with the use of controls. For example, Bloch and Ulberg (1972) caution the reader to "be aware that the project began with a call for volunteers who may be biased in judging the project's success." The authors of the Los Angeles Team's study (Los Angeles Police Department, 1974) went so far as to recommend that ". . . any future team policing experiments not make use of control areas for evaluative purposes, but be contrasted to city-wide data."

Thus, we were simply not able to determine whether team policing is more productive than routine patrol. The conflicting findings and low credibility of the studies involved simply do not permit a definitive answer to the research question posed. This situation is summarized in Table XIII.

(13) *Is specialized patrol more efficient/effective than routine patrol?*

An organizational structure quite different from team policing is found in those programs which have experimented with specialized patrol. While team policing attempts to promote the notion of a generalist, "Jack-of-all-trades" police officer, specialized patrol strategies avoid the assignment of multiple functions to patrol officers. Terms such as "split force", "directed patrol", and "strike force" have been developed to denote the unique assignments undertaken by these patrol officers.

One concept dating back to the mid-1960s is that of split-force patrol. The idea behind split force is that the productivity of a police department may be improved if the two major activities of patrol--response to calls for service and preventive patrol--are separated. Thus, a split

Table XIII

RESEARCH QUESTION: Is team policing more efficient/effective than routine patrol?

CREDIBILITY

	HIGH	MEDIUM	LOW	TOTAL
YES, HYPOTHESIS CONFIRMED	0	1	4	5
INCONCLUSIVE	0	1	0	1
NO, HYPOTHESIS REJECTED	0	1	2	3
TOTAL	0	3	6	9

force involves the formation of both response-oriented and preventive patrol-oriented subforces within the overall command of the Chief of Police.

A demonstration experiment in split-force patrol was formulated and executed by the Chicago Operations Task Force in 1969. This three-month experiment was designed to ". . . increase the effectiveness of aggressive preventive patrol activities while providing normal police service" (Bottoms *et al.*, 1972). The results obtained indicate that through deferral of non-critical calls, police availability was increased; response time increased on average by 30 seconds (though this was deemed insignificant); and preventive patrol effort was virtually doubled (though there were no discernible changes in crime rates). Thus, though the effectiveness of the patrol appeared to remain the same, the split force did improve patrol efficiency.

In Wilmington, a one-year experiment in split-force patrol reached similar conclusions (Tien, Simon, and Larson, 1976). The Patrol Division of the Wilmington Bureau of Police was divided into two patrol elements: Basic (response-oriented) patrol and Structured (prevention-oriented) patrol. The intention of this city-wide study was "to *test* the efficacy of the split-force concept. Unlike other more goal-oriented programs, the Wilmington split-force experiment was not required to achieve any prespecified change in crime, fear, clearance or productivity level--it was solely to test a concept" (Tien, Simon and Larson, 1976). As it happened, the Wilmington split force operated in a more productive manner almost by definition. While patrol effectiveness did not decrease, patrol efficiency did increase. The conclusions of the Wilmington study strongly support the contention that split force patrol is a productive alternative to routine preventive patrol.

Building on the findings of the split-force experiment (i.e., that citizen satisfaction is a function of expectation and that the large majority of all calls for service are not critical in nature), Wilmington conducted a follow-on National Institute of Justice-funded management of demand program. What evolved was a response-oriented strategy which attempted to test the central hypothesis that "alternative response strategies cause an increase in call-for-service response productivity." The program evaluation (conducted by Public Systems Evaluation, Inc.) is completed at this writing and a draft report has been submitted which concludes that the reactive management of demand approach, as tested in Wilmington, causes a significant increase in call-for-service response productivity; results in increased capability to assess demand for police services; and permits an increase in police management effectiveness and flexibility.*

Another experiment in Worcester also lends support to the split-force concept (Tien *et al.*, 1975). Sworn police officers were freed to concentrate on patrol-related strike forces (e.g., robbery and burglary) as *civilian* Police Service Aides took responsibility for answering non-critical calls for service. Crime levels in the impact section of Worcester decreased significantly compared to the city of Worcester as a whole, and no crime displacement effects were detected. Paraprofessionals (students, in this instance) were also employed in the policing of the Claremont Colleges in Los Angeles (Howard, 1977). Uniformed patrol officers were utilized for serious incidents, while the civilian personnel maintained a patrol presence. Though crime was reduced, the possibility of crime

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* Cahn, Michael F. and Tien, James M., 1980. An Evaluation Report of An Alternative Approach in Police Response: The Wilmington Management of Demand Program. Cambridge, MA: Public Systems Evaluation, Inc.

displacement was not ruled out. It would appear, however, that the bulk of the evidence reviewed with respect to split-force/civilianization approaches to patrol is supportive of these specialized patrol options.

Programs experimenting with other modes of specialized patrol have met with varying degress of success. For example, the final evaluation of experimental strike forces in Philadelphia (Reagan *et al.*, 1974) was not able to determine the effectiveness of the project, principally due to the difficulties involved in establishing causal linkages between the strike forces activities and the crime rate. When examining implemented strike forces and other special police units in Michigan, Lewis, Greene, and Edwards (1977) could not detect any changes in crime rates, arrest rates, and clearance rates as a function of the patrol programs. In Montpelier, Vermont, a nine-month study of directed patrol yielded inconclusive results (Franks, 1980). Though Part I crime decreased in the target area by 23 percent, the city-wide crime decrease was 37 percent.

From this quick review of selected research in specialized patrol, it is apparent that organizationl changes can be made in police departments and that some of these changes may be expected to improve the delivery of patrol services. Split patrol and the use of civilians in patrol work are two examples of successful patrol specialization. However, it would be naive to expect that *any* organizational change will impact positively on patrol performance. Designing the organizational structure of patrol forces in a manner which will maximize the usefulness of patrol is a challenge to both police researchers and administrators. The results from research in specialized patrol do offer a few pointers as to what may or may not be efficient/effective blueprints for the organization of patrol personnel.

(14) *Are women as efficient/effective on patrol as men?*

Police work has long been dominated by men. As of 1970, less than one percent of American police personnel were women, and these were primarily employed in traditional women's jobs (e.g., secretarial support) (Milton, 1978). However, with the 1972 amendment of Title VII of the Civil Rights Act, it became unlawful to deny women employment as patrol officers solely on the basis of their sex. Hence, police officials were faced with another unanswered question: Can women perform all patrol functions as well as men?

In an attempt to answer this question, Urban Institite researchers conducted a one-year experimental study in Washington, D.C. According to Policewomen on Patrol: Final Report (Bloch and Anderson, 1974), 86 "new women" and 86 "comparison men" were hired by the Metropolitan D.C. Police Department. These men and women were statistically compared using a variety of patrol-oriented performance measures. The researchers concluded that "the men and women studied. . .performed patrol work in a generally similar manner. They responded to similar types of calls for police service while on patrol and encountered similar proportions of citizens who were dangerous, upset, drunk or violent. . . .There were no reported incidents which cast serious doubt on the ability of women to perform patrol work satisfactorily. . ." (Bloch and Anderson, 1974).

An earlier study in New York City examined the performance of 41 statistically-matched pairs of male and female patrol officers over a seven-month period. Using measures such as type of incident serviced, type of action instigated by officer (e.g., use of force), and citizens' reactions to police services, it was determined that no differences existed between the sexes with respect to patrol performance (Sichel *et al.*, 1978).

Similar results were obtained by Kizziah and Morris (1977) in Newton, Massachusetts. Here, the performance of 12 female and 23 male patrol officers was studied using multiple measures. After four months of observation, no differences in performance were found, a result consistent with other women-on-patrol studies.

The conclusions of these three studies support the contention that women can perform as well as men on patrol. Though each of the studies mentioned suffers from the usual methodological problems associated with experimental design, we have not been able to determine "fatal flaws" which could completely negate the reported findings. Thus, we would agree that based on the evidence that exists, women are as efficient/effective on patrol as men.

This review of completed research in police patrol has perhaps raised more questions that it has been able to answer. There have been substantive agreements in a few research areas, but by and large, conflicting results and unresolved issues abound. The technical quality of the vast majority of research projects reviewed has been disappointingly low. This only serves to aggravate the lack of substantive consensus in patrol research.

In the next two parts of this report, we will attempt to sort out the information that has been gathered in this section. We turn our attention to research methodology in Part V, and attempt to synthesize the common problems experienced in research design and conduct. In Part VI, we will try to specify both the new knowledge we have acquired as a result of patrol research, and the gaps in our knowledge which remain to be filled.

V SYNTHESIZED METHODOLOGICAL FINDINGS

From our review of research in the field of police patrol, one fact has become obvious: many studies examined exhibit low technical quality. Inappropriate methods were used in some cases, while reasonable techniques were poorly applied in other instances. Since conclusions regarding the effectiveness of alternative patrol strategies are reached through such analysis, the credibility of these studies becomes questionable. Indeed, the "findings/credibility" matrices of Part IV reflect this state of affairs.

We are not the first to have noticed the technical shortcomings of patrol research studies. For example, consider the National Evaluation Project (NEP) patrol reports. The Team Policing NEP rated studies from "low reliability" to "high reliability" on the basis of data sources. Of 56 data sources, only four were rated to be highly reliable. With respect to the large number of studies rated low, the authors of the NEP state:

> Most of the reports were rated as low primarily because of inadequate research designs which made it difficult to determine if the reported effects could be attributed to the team policing program evaluated. (Gay, Day, and Woodward, 1977, p. 4)

The NEP volume on specialized patrol also found problems with contemporary patrol research. When attempting to assess the merits of specialized patrol via a review of existing program evaluations, the NEP researchers state:

> Serious flaws in the evaluation designs hindered any definitive conclusions. The most serious flaws were:
>
> - Failure to use an adequate comparison group
> - Failure to control for historical changes in project operation
> - Failure to account for the effects of units other than the specialized patrol on target crimes
> - Inadequate study of displacement.
>
> (Webb *et al.*, 1977, p. 11)

In the introduction to the NEP volume on traditional preventive patrol, it is made clear that "... . knowledge about patrol is incomplete in many respects and frequently of dubious quality" (Schell *et al.*, 1976, p. 5).

Indeed, the Mathematica review of policy-related research in policing labeled "Improper Study Design and Analytic Methods" as a major barrier to validity. With respect to actual data analysis, the Mathematica team stated that ". . . the main theme appears to be the misuse of statistical procedures . . . . Where the techniques are discernible, what is discerned is often faulty . . . . Inference, which is the step logically following from analysis, is thereby rendered invalid" (Gass and Dawson, 1974, p. 21). Several examples of flawed methodology are discussed in the Mathematica report.

These methodological problems cannot be ignored. We feel that a decision maker could be much worse off relying on an invalid piece of research than s/he would be if left "uninformed". Though not intentionally so, poorly designed research can mislead decision makers, resulting in potentially serious misallocations of scarce resources.

Several of the studies reviewed in Part IV qualify as poorly designed and/or executed pieces of research. Though we fully intend to discuss the generic difficulties associated with patrol research, a detailed example

illustrating the research problems we have alluded to above would be most useful. Such an example will now be presented.

5.1 A CRITIQUE OF THE KANSAS CITY RESPONSE TIME ANALYSIS (Kansas City Police Department, 1977; 1979)

The LEAA-funded study of response time in Kansas City was conceived as an investigation into the traditional assumptions governing police response time. The two stated objectives of this study read as follows:

> (1) Analysis of the relationship of response time to the outcome of arrest, witness availability, citizen satisfaction with response time, and the frequency of citizens' injuries received in connection with crime and noncrime incidents.
>
> (2) Identification of problems and patterns in reporting crime and requesting police assistance.
>
> (Kansas City Police Department, Executive Summary, 1977, p. 1)

The initial data base for this study consisted of 949 Part I crimes which occurred in 56 of 207 Kansas City "beat-watches"* between March 1975 and January 1976. An additional 359 Part II crimes occurring over the same time period in the same beat-watches were also analyzed. In a lengthy statistical analysis, the components of response time (citizen reporting time, dispatch delay time, and travel time) were related to both intermediate factors (e.g., travel distance) and outcomes (e.g., arrest) via linear regression models (Kansas City Police Department, Analysis, 1977; 1979). Based on this analysis, the Kansas City researchers reached the following conclusions:

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* A "beat-watch" is defined as an eight-hour tour within a fixed geographical beat.

> First, although some patrol strategies affect police response time, a large proportion of Part I crimes are not susceptible to the impact of rapid police response. Secondly, for that proportion of crimes that can be influenced by response time, the time taken to report the incident largely predetermines the effect of police response time. Thirdly, the factors which produce reporting delays are primarily citizens' attitudes and voluntary actions rather than uncontrollable problems they encounter. Fourthly, if reporting time is not so long as to hamper police efforts, prompt field response has significant impact on crime outcomes in general. (Kansas City Police Department, Executive Summary, 1979, p. 23)

The authors of the Kansas City reports elicited several decision implications from their work, one of which states, "Because of the time citizens take to report crimes, the application of technological innovations and human resources to reduce police response time will have negligible impact on crime outcomes" (Kansas City Police Department, Executive Summary, 1977, p. 25). This is a strong statement, rooted in what appears at first glance to be solid research. However, based upon our technical review of the methodology employed by the Response Time Analysis, we question the validity of the stated policy-relevant conclusions of this study on several grounds.

(1) *Small Sample Size*

It must be noted that the majority of the analysis performed examined subsets of the crimes in the data base. Indeed, several of the analyses (particularly those of Part II crime in Volume III of the Response Time Analysis report) suffer from an exceedingly small sample size with which the researchers are trying to draw out strong conclusions. In Volume III, this is acknowledged at the end of the analysis section (on page 23), where it is written:

> Finally, because of the small sample size of the variables analyzed, caution should be taken in interpretation of results.

However, no such acknowledgement is found in the implications section of the Executive Summary.

As one indication of small sample size, Table 3.1 on page 35 of Volume III indicates an N of 134 for involvement-type crimes in which response time may be a factor. Here the number of response-related arrests is 11 out of 134--only 8.2 percent of the total. Yet the authors try to draw major conclusions from such small numbers. Here the Kansas City researchers state:

> Although the small N size presents a methodological weakness, analysis has still been conducted to obtain whatever value cautious interpretation might provide. (Kansas City Police Department, 1979, p. 34)

There *is* reason to be concerned with the representativeness of these results given the small samples utilized.

(2) *Self-Reporting of Response Time Data*

The Kansas City researchers criticize others who rely on self-reporting of response times:

> . . . self-reporting sometimes relied upon individual estimates of times; which can be confused by memory and recall or factors of stress. (Kansas City Police Department, Methodology, 1977, p. 8)

Yet, the authors of the Kansas City reports themselves base the dominant contribution of their research, namely, the time until an incident is reported to the police by the citizen, on self-reporting.

> Out of necessity, the time interval from crime occurrence to telephoning the police must be obtained from a victim or a witness, and measurement of this interval is reliant on the citizen's perception of time. (Kansas City Police Department, Methodology, 1977, p. 4)

It appears that there is a logical inconsistency here. This is compounded by the following reference to Isaacs' study (The Institute for Defense Analysis, 1967, pp. 88-106).

> The results of Isaacs' study were limited by its self-reported database which did not allow for analysis of time intervals by second and a sample bias towards in-progress calls . . . . (Kansas City Police Department, Methodology, 1977, p. 8)

If the limitations of self-reporting are severe enough to affect the results of the Isaacs study, then surely these same limitations apply to the self-reported data compiled by the Kansas City research team.

(3) *Causation I: The Determinants of Travel Time*

The authors of the Kansas City reports appear to have spent considerable amounts of time, money, and effort deriving known results. For example, Chapter 9 of Volume III presents the following hypothesis:

> Obviously, the distance which must be travelled to the scene of the crime could be expected to affect the time taken to get there. Therefore, any dispatching or patrol procedures affecting distance could be expected to exert an influence over travel time. (Kansas City Police Department, 1979, p. 86)

Then, in a remarkable regression analysis of the *logarithm* of travel time versus *18* "explanatory" variables with a sample size of 154 calls--8.6 calls per variable on average (Kansas City Police Department, 1979, p. 193)--the authors "discover" that travel distance is the major factor influencing travel time.

> As was expected, the distance that had to be traveled to reach the incident scene strongly affected travel time, with greater distances producing longer delays in arriving. (Kansas City Police Department, 1979, pp. 88-9)

This analysis was carried out apparently without awareness of numerous response time models that predict the type of relationships between response time and response distance or of the Rand researchers' studies of this same issue for fire departments. The need for cross-fertilization across artificially drawn research boundaries is apparent.

(4) *Causation II: Citizen Satisfaction with Response Time*

In Chapter 9 of Volume II (Kansas City Police Department, Analysis, 1977, p. 120), a system of regression models was proposed to determine the effects of various factors on citizen satisfaction with response time. The five equations analyzed were:

$$TT = a + b_1 TOC + e \quad (1)$$

$$DT = a + b_2 TOC + e \quad (2)$$

$$IRT = a + b_3 SC + b_4 TOC + b_5 TT + b_6 DT + e \quad (3)$$

$$(P-E)/E = a + b_7 SC + b_8 TOC + b_9 TT + b_{10} DT + b_{11} IRT + e \quad (4)$$

$$CS = a + b_{12} SC + b_{13} TOC + b_{14} TT + b_{15} DT + b_{16} IRT + b_{17}(P-E)/E + e \quad (5)$$

where:
- SC = Social characteristics of the involved citizen
- TOC = Type of crime
- TT = Travel time
- DT = Dispatch time
- IRT = Importance of response time
- (P-E)/E = Perceptions and expectations index
- CS = Citizen satisfaction
- a's, b's = constants to be estimated
- e's = residual variation

According to the report:

> This model was analyzed through successive multiple regression analysis of each equation listed above. By examining the path coefficients [b's], it was possible to obtain the total effect that an independent variable had on citizen satisfaction by examining both its direct effects and its indirect effects through other variables. (Kansas City Police Department, Analysis, 1977, p. 120)

The "model" that is presented here has some peculiar implications. Suppose that equations (1) through (5) are true. It is a simple algebraic exercise to show via the substitution of equations (1) through (4) into equation (5) that the following result is also true:

$$CS = A + B \cdot TOC + C \cdot SC + \varepsilon \quad (6)$$

where A, B, and C are constants, ϵ is a random error term, and CS, TOC, and SC are defined previously. Equation (6) states that citizen satisfaction with response time is determined solely by the type of crime committed, the social characteristics of the involved citizen, and random fluctuations. Somehow, this result is troublesome. The *best* result that could be produced by this model is one that dictates police ineffectiveness. If the proposed model is true, all attempts by the police to increase the level of citizen satisfaction with response time are doomed to fail.

Intuitively, one senses that citizen satisfaction with response time should be a monotonically decreasing function of response time. A model exhibiting this behavior could provide a useful framework for analysis. While the model depicted by equations (1)-(5) does include some of the factors which may be thought of as affecting citizen satisfaction with response time, the way these factors are related in that model is neither useful nor meaningful.

There are other problems associated with this study which are more than technical. For example, the revelation that reporting delays are large is, in fact, not a revelation at all. One only has to consult the literature on emergency medical services to realize that the median time between onset of heart attack symptoms and contacting an EMS is 3.5 hours. This has caused many in the EMS field to argue for improved citizen education, although it is not education itself which is to blame. The same 3.5 hour median delay is also found among a special subset of the population: physicians. The delay seems to be caused by a denial syndrome rather than lack of knowledge of what the symptoms mean. However, this has not caused people in the EMS field to argue against deploying ambulances to

have efficient, effective, and rapid response. It has caused them to argue for both citizen education regarding the denial syndrome and for rapid response, because when both are solved, the probability of survival and full recovery is maximized.

The claim that the Kansas City study was the first to examine reporting time is also false. Elliott collected data pertaining to reporting time in Syracuse from a sample of 2,200 crimes (Elliott, 1973, pp. 10-12). Noting that 30 percent of all crimes were reported to the police within 10 minutes of crime occurrence and that 25 percent of all crimes were reported within two minutes of crime occurrence, Elliott concluded that a significant fraction of crimes could be apprehended by the police. The reliability of Elliott's data is comparable to the Kansas City sample, as both relied on self-reporting of incident times. Thus, there is no reason to reject Elliott's work based on the quality of his data. In fact, it is interesting to note that the Kansas City data is more optimistic than the Syracuse figures in that over 60 percent of all calls experienced reporting times less than 10 minutes in length, yet the interpretation of these data by the Kansas City researchers is pessimistic.

One recurring inconsistency concerns the potential usefulness of Computer-Aided Dispatch (CAD) systems. In the Executive Summary, the researchers state:

> Other innovations which rely to varying degrees upon the assumed importance of rapid response have resulted in software 'queueing' programs, construction of computer-simulated beat configurations, installation of computer-aided dispatching equipment and design implementation of automated vehicle location systems. *It is not the potential benefits of such innovations which are in question, but their relative effectiveness, given citizen delays in crime reporting.* (Kansas City Police Department, Executive Summary, 1977, p. 26)

While the authors argue against the software queueing programs and CAD systems, they argue for selected stacking and prioritization of anticipated delay in response:

> . . . providing the expected time of officer arrival, based on the availability of officers, the type of incident reported, how quickly it was reported, etc., might be an important consideration in maintaining citizen satisfaction with response time. (Kansas City Police Department, 1979, p. 8)

It is the software queueing programs that the authors criticize that provide this feedback via an intelligent CAD system! Somehow, the authors of the Kansas City reports have been led to believe that *all* queueing software and *all* CAD software are geared towards the minimization of response time over all types of calls. This is clearly not the case, as prioritization is a normal procedure in almost all CAD systems we have observed.

The decision implication reflecting the researchers' views that "the application of technological innovations and human resources to reduce response time will have negligible impact on crime outcomes" mentioned earlier is indicative of an anti-technology bias. This major policy implication is based on, as we have seen, *very* questionable analysis. The researchers' assertion is not only misleading, it is blatantly untrue for victim-triggered robbery alarms and intrusion detection burglary alarms.* Taken at face value, this recommendation could lead to very poor decisions.

What we have tried to show is that one cannot merely accept the message of a research document based on a perusal of the Executive Summary

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* Limited evidence (See, for example, The Institute for Defense Analyses, 1967, p. 99) suggests that arrest probability when responding to a victim-triggered or suspect-triggered alarm is roughly 30 percent (this figure excludes false alarms).

or Findings and Conclusions. All research results are based on analysis of some sort, and in the field of police patrol, most of the analysis we have reviewed has been weak. This is why we have assigned the label "low credibility" to so many studies.

There have been several generic methodological problems experienced by patrol researchers. We will now discuss the major difficulties, providing examples where necessary.

5.2 THEORY AND PROCEDURE IN PATROL RESEARCH

Initially, it is useful to distinguish between two classes of methodological error in patrol research. The first class of errors we will label "procedural". The second class consists of errors that are more "conceptual" in nature.

Procedural errors refer to flaws that arise during the mechanics of analysis. Improper data aggregation, algebraic errors, and computational miscalculations may all be viewed as procedural problems. Procedural errors may be committed within the framework of a research design which is in itself technically sound, and some of these errors, if detected, can be corrected without too much difficulty. It is our guess (and hope) that these errors do not occur in isolation with sufficient frequency to warrant further attention.

Those errors we have termed as conceptual comprise a more serious group of technical problems. Conceptual errors may arise from the researcher's incorrect perception of the *process* by which the *inputs* to a patrol strategy (e.g., number of officers, number of units) are transformed into the *outcomes* of a patrol strategy (e.g., level of deterrent effect), and from the researcher's insertion of this process into a

methodological framework for purposes of analysis. In short, conceptual errors result when the relationship linking patrol inputs to patrol outputs is not well structured by the researcher.

One implication of this lack of theory concerns the anticipated outcomes of research studies. According to Nobel Laureate Peter Medawar:

> No experiment should be undertaken without a clear preconception of the forms its results might take; for unless a hypothesis restricts the total number of possible happenings or conjunctions of events in the universe, the experiment will yield no information whatever. If a hypothesis is totally permissive - if it is such that anything goes - then we are none the wiser. A totally permissive hypothesis says nothing. (Medawar, 1979, p. 72)

Problems with theory in patrol research are sufficiently basic to affect the formulation of research hypotheses. An ill-conceived hypothesis can cause all kinds of trouble, including the selection of meaningless performance measures, the collection of irrelevant data, and the application of poor analytical techniques (or unnecessary application of sophisticated methods). In our discussion of one-officer versus two-officer patrol in Part IV, we noted that the hypothesis:

> If one-officer and two-officer patrol cars are equally safe, then the number of injuries resulting from one-officer patrol units should equal the number of injuries resulting from two-officer patrol units

led to the specification of injuries per unit (as opposed to injuries per officer) as the key performance measure. This error in turn led to the data analysis which acted to refute the hypothesis in question. Luckily, this example was easy to correct, and luckier still, the correct result does not differ sharply enough from the incorrect result to affect policy significance. However, it should be obvious that this will not always be the case.

The most serious *design* problem facing patrol researchers rests with the formation of equivalent control and experimental groups. *If* one is to rely on the experimental framework outlined in Part II, then the formation and maintenance of control groups is critical. This step in the experimental methodology is essentially intended to reduce the number of explanatory factors for a particular outcome from infinity to two: chance and the experimental treatment. As we have seen, the rigidity required for this methodology is most often not obtainable in patrol settings. Thus, patrol research which relies in total upon this particular methodology is not likely to produce credible results.

In considering the relationship between theory and procedure in patrol research, it appears that the major methodological difficulties are of a self-perpetuating nature. The general cycle of knowledge accumulation in science is such that theory begets research which begets more theory, and so on. However, existing patrol theory is often insufficiently specified for research purposes, while current patrol research methodology is not entirely capable of generating new theory.

If the issues pursued by patrol research were not considered to be of great importance, there would be little reason to express our concern with research methodology. As Medawar writes:

> It has been well said that if an experiment is not worth doing, it is not worth doing well. (Medawar, 1979, p. 75)

Yet the problems addressed by patrol research are important, so we must attempt to improve the technical standards of research methodology. Otherwise, we will be forced to remain satisfied with studies which tenuously extract major policy implications from demonstrably unsound analysis.

What is to be done? Initially, we may pose two views. On the one hand, due to lack of theory, one could continue to experiment but strive to implement the *most rigorous* designs possible. This approach could lead to more definitive research results but would involve spending enormous sums of money. On the other hand, one could attempt to further develop patrol theory before embarking on major empirical voyages. For example, patrol problems are set in a spatial perspective, hence there are certain physical relationships which must be understood in order to effectively design a patrol study. Most patrol studies have failed to take these relationships into account, allowing for the possibility that impacts due to experimental modes of police patrol are overshadowed by physical phenomena. In such cases (patrol "intensity" and response time studies are good examples), the effect of the experimental patrol mode will be hidden. If, however, the implications of these spatial relationships could be anticipated a priori, then one could weed out their effect on postulated outcomes. In order to understand the nature of such relationships, one must build a body of relevant theory. For the "spatial physics" example discussed here, such theory exists (see Larson, 1972b), but for other patrol problems, we are still very much in the dark.

What we have encountered with respect to patrol research methodology is disappointing. The problems we have discussed here obviously qualify the substantive results of research efforts. It is to these substantive results that our attention now turns.

VI SYNTHESIZED SUBSTANTIVE FINDINGS

Our discussion of patrol research methodology has placed obvious limitations on the strength of *any* substantive conclusions we might wish to infer from our review of patrol studies. However, in a number of instances, a consensus of results has been reached by researchers, and we feel that such occurrences are useful to report. Similarly, it is equally as important to present those research questions which have been asked but not answered. In this section, we will present the substantive findings from our review of Part IV, beginning again with issues of police preventive patrol

6.1 FINDINGS FROM PREVENTIVE PATROL STUDIES

Research studies of preventive patrol have collectively produced inconclusive results. There are no definitive studies that have been able to clearly depict the presence (or absence) of a relationship between police patrol and crime deterrence. According to the authors of the preventive patrol NEP:

> Most of what is commonly called 'knowledge' about traditional preventive patrol is, in fact, opinion based primarily on experiential evidence. The gaps in knowledge are pervasive and, as a result, few definitive statements can be made about the impact of alternative approaches to patrol upon the ability of departments to realize the goals of patrol. (Schell, Overly, Schack, and Stabile, 1976, p. 77)

This state of inconclusiveness holds for hypotheses postulating the crime-deterrent effectiveness of both motorized patrol and foot patrol.

However, there is a difference between motorized and foot patrol when citizen satisfaction is the issue at stake. The research results were ambiguous with respect to citizen satisfaction with motorized patrol, while citizens were apparently quite satisfied with foot patrol. In "Police Patrol - Some Future Directions", Kelling and Fogel present some clues as to why this situation exists:

> Community alienation is perceived by the police as a serious problem . . . . The basic problem remains because it makes little difference what plans are developed for a beat or district between sergeants and officers, since the patraol officer immediately comes under the control of the dispatcher as soon as he enters the patrol car and turns on his radio. . . . we suggest that available evidence supports a view that the critical issue for police today is how to overcome the alienation of well-intended police strategies which have had the unintended consequence of alienating citizens. (Kelling and Fogel, 1978, pp. 167-8, 177)

These writers feel that motorized patrol has detached police officers from their community and present foot patrol as one alternative strategy which would not suffer from this problem.

The one topic of preventive patrol which produced directly comparable research results concerns the interception capabilities of motorized patrol units. In estimating the probability of a space-time coincidence of a randomly occurring crime and a randomly patrolling police car, several researchers developed similar models. The estimates of interception probabilities produced by these models compared favorably with empirical figures. All of these models point to the finding that even under optimal allocations of preventive patrol effort, the likelihood of intercepting a crime in progress will not exceed 5 percent. Since actual *apprehension* probabilities are in fact lower than these estimated interception

probabilities, the effectiveness of preventive patrol as a strategy for apprehending offenders is very low indeed.

It would seem that the most visible knowledge gap in preventive patrol research centers around the relationship among patrol levels and tactics and crime rates. This is clearly a topic which requires *very* careful research. While our review of completed studies has not proved conclusive, we are hopeful that current research will help to answer many of our questions regarding the effectiveness of preventive patrol.

6.2 FINDINGS FROM RESPONSE TIME STUDIES

Research examining issues of response time has generated some interesting results. In particular, the notion that for a typical call for service citizen satisfaction with the police is largely dependent upon police response time has essentially been disproven. Rather, it has been shown that the *difference* between experienced and anticipated response time is a major determinant of citizen satisfaction. According to this result, police should provide citizens with realistic estimates of the amount of time it will take before a police unit can arrive on-scene. Feasible methods for deriving these estimates are available; their use in conjunction with Computer-Aided Dispatch (CAD) systems is discussed in a recent PSE report (Colton, Brandeau, and Tien, 1980).

The major interest in police response time stems from the postulated relationship between rapid response and the likelihood of apprehending offenders on-scene. Again, different researchers presented conflicting results. It is our feeling that, on the whole, the studies demonstrating an inverse relationship between response time and apprehension probability are more credible than the studies demonstrating the absence of such a relationship. However, no study has successfully eliminated the

"chicken-or-egg" problem discussed earlier in which officers are likely to self-select for high-speed response those incidents judged likely to yield an on-scene arrest.

Limited research has been undertaken with respect to the ability of AVM systems to reduce response time. It was discovered that the closest-car information provided by AVM resulted in minimal reductions in response time. Thus, current empirical evidence suggests that the effectiveness of AVM in reducing response time is low. However, as discussed earlier, the empirical evidence is derived from AVM systems having serious technological and human factor problems.

The important issue to be resolved is whether or not response time and apprehension probability are causally related. A controlled experiment is not really feasible due to the high stakes involved (e.g., a mandatory slow response to an in-progress bank robbery), but well thought out quasi-experiments are possible. For example, data related to calls generated *solely* by victim-triggered robbery alarms would eradicate the "chicken-or-egg" effect mentioned in Part IV, as all officers in this sample would have sure knowledge that apprehension is possible. Using analysis similar to that employed by Clawson and Chang (1977), it could be determined if rapid response time influences arrest probabilities. Certainly, intuition would argue strongly that it does.

6.3 FINDINGS FROM STUDIES OF ALTERNATIVE ORGANIZATIONAL AND MANPOWER ALLOCATION SCHEMES

Under the heading of alternative organizational and manpower allocation schemes we reviewed studies of one- versus two-officer patrol, split-force, women on patrol, team policing, and a recently completed management of demand program. With respect to the issue of one- versus two-officer

patrol staffing, we concluded that both theoretical and empirical results favor the notion that one-officer patrol is more efficient than two-officer patrol. However, there remains the unanswered issue of officer safety. Reanalysis of injury statistics for two studies yielded "no difference" between one- and two-officer units, but the small sample sizes involved do not permit generalization of this finding.

The split-force and management of demand concepts were shown to be productive alternatives to routine patrol. While separation of the preventive patrol and call-for-service response functions and implementation of alternative response strategies have minimal impact on crime, they are much more efficient strategies than traditional patrol. The use of civilian para-professionals was also shown to increase the efficiency of the police, as sworn police officers were more often free to answer critical calls for service. Thus, the split-force/management of demand/civilianization approaches to policing offer alternatives which are no less effective, and more efficient, than routine patrol.

Several of the reports we reviewed were studies of team policing programs. As mentioned in our methodological findings, these studies encountered a good deal of difficulty in their attempt to determine the effectiveness of team policing. It should come as no surprise that the collective findings of team policing studies are inconclusive. Some studies claim improvements in patrol performance through team policing, while other studies detect no difference between the performance of team policing and routine patrol.

Finally, three reports compared the performance of female patrol officers to male patrol officers in an attempt to determine whether or

not women are as effective on patrol as men. None of the studies found significant differences between the police-related performances of male and female officers. Thus, it would appear that women may be utilized as patrol officers without sacrificing the quality of police patrol.

This section has summarized the substantive findings of our review of police patrol studies. Given what we now know about the state of patrol research, we wish to propose a number of recommendations for future research.

VII RECOMMENDATIONS

Having examined the findings and quality of a large body of patrol research, we are in a position to suggest topics for inclusion in future patrol research agendas. We do not shoulder this task lightly, as the recommendations of earlier research syntheses in police patrol appear to have had substantial impact. Consider the following partial list of previous research recommendations:

- Undertake studies in large police departments of crimes, arrests, and operations (The Institute for Defense Analyses, 1967)
- Establish a single, uniform police telephone number (The Institute for Defense Analyses, 1967)
- Undertake experiments to improve statistical procedures for manpower allocation (The Institute for Defense Analyses, 1967)
- Support operations research staffs in large criminal justice agencies (The Institute for Defense Analyses, 1967)
- Support scientific and technological research through a research institute (The Institute for Defense Analyses, 1967)
- Experiment with team policing combining patrol and investigative duties (President's Commission on Law Enforcement and Administration of Justice, Police Task Force, 1967)
- Examine the relative merits of one- vs. two-officer patrol units (Schell *et al.*, 1976)
- Develop time-dependent and location-dependent patrol manpower allocation schemes (National Advisory Commission on Criminal Justice Standards and Goals, 1973)
- Research the concept of productivity in a law enforcement context (Gass and Dawson, 1974)
- Research the relationship between response time and arrest and clearance rates, and crime levels (Gass and Dawson, 1974)

Though we do not claim that all research in the topics mentioned above stemmed from these recommendations, it is true that all of the recommendations listed have been acted upon. It is our hope that the recommendations we will now present may also be acted upon in the future.

Public sector research is often driven by larger societal forces which change the environment in which public institutions function. The research often seeks to find an accommodation between the current functioning of public institutions and desired behavior as reflected by the new social conditions. Projecting recent trends into the decade of the 1980s, one could reasonably conjecture the following:

(1) A continuation and broadening of severe fiscal constraints that will limit the growth and in some instances force diminution of municipal service agencies. (A significant number of urban police departments have already experienced sharp cutbacks in personnel.)

(2) Increasing pressures for accountability in public institutions, with the public interested in performance and productivity.

(3) At best, a maintenance of the current crime levels. More likely, a continued growth in the numbers and types of services that police are called upon by citizens to deliver. (Many of these services are not related directly to crime or to the sworn status of the police officer.)

These conflicting trends, if true, would seem to create an impossible situation in which a constant or reduced level of police resources is asked to provide more services, by number and by type.

In addressing police research needs of the 1980s, we feel that obtaining workable solutions to the above dilemma would be one worthwhile research

goal. Obviously, there are other goals as well, including the direct building on the impressive body of research that has occurred substantially over the decade of the 1970s.

In seeking workable police strategies in an atmosphere of austerity, the research of the 1970s suggest some solutions to test:

(1) Rapid police response time is not important for the majority of calls for police service. Citizens are willing to experience delays in response if they feel that the call is non-urgent and if they are advised of the anticipated delay. Deliberately delaying lower priority calls will result in a higher level of police availability when an urgent call is reported, thereby creating a lowering in response times for the small fraction of calls that really require rapid response.

(2) A significant fraction of calls for service do not require a sworn officer at the scene. Many callers can be (i) correctly advised that their call is not a police matter; or (ii) serviced over the phone (e.g., a police-related information request or reporting a minor property crime); or (iii) referred to another more appropriate public agency; or (iv) serviced at the scene by non-sworn personnel ("civilians"). Thus, the new telephone strategy of *screening*, *on-phone servicing*, *referral*, or *civilian dispatch* can help alleviate the problem of growing demands for service.

(3) Police patrol commanders have great flexibility in spatially deploying a fixed number of field units over a fixed area. Given the relatively low productivity of routine preventive patrol that is associated with fixed beat designs having "one car for one beat," there would seem to be strong arguments

favoring a more proactive problem-directed (often crime-directed) patrol. To alleviate the problem that many patrol officers treat preventive patrol periods as "rest breaks between calls for services", effective implementation of more flexible and more fluid patrol deployments might entail a *split-force* concept (with some units specializing in calls for service and others in direct patrol); these assignments could be rotated periodically.

(4) There is no evidence suggesting that police departments will become less labor intensive in the 1980s. Various technologies represent potential means for improving service levels without adding to labor costs. But several early police experiences with technology have been disappointing: CAD systems that automated procedures that had been standard since the 1930s (in effect representing little more than electronic conveyor belts) or AVM systems whose information was of poor quality and/or not utilized by police decision makers. Yet increasingly sophisticated management of police demands and police resources requires better and more timely management-oriented data and computer-implemented ways for processing the data; the police emergency response system will require technologies suited to more complex real time decision making.

(5) As exemplified by the split-force and civilianization approaches, during the past decade there has been a greater emphasis on productivity-oriented approaches to meeting the

demand for police services. The recent management of demand program discussed above was based on the premise that a police demand pattern can be managed *reactively* so that a more optimal supply pattern could be achieved. Traditionally, demand for police services has been a given, while the corresponding supply is somehow allocated to meet the given demand. In addition to causing a significant increase in response-related productivity, the management of demand program suggests that the approach is worthy of evaluation and further testing by other police departments; and that a *proactive* management of demand program (i.e., which seeks to change the underlying demand pattern through strategies which affect service availability or mitigate potential demand) has the potential to bring about even greater productivity improvement, and deserves testing.

Police field services research for the next decade could potentially be structured around a conjectured model (such as the one outlined above) of an efficient, effective and socially just police department operating in a fiscally restrained environment. Each of the items (1) through (4) above represents conjectures arising from earlier research and implementation experiences that should be tested in a new research environment. One striking feature of these conjectures is their interconnectedness. It would seem beneficial to test them all simultaneously in one or more *urban police laboratories* rather than to test one item at a time in each of several cities. This would provide an opportunity for synergism that is not available in an incrementalist ("try one thing at a time") approach.

If police field services research for the 1980s is to be driven by overriding societal concerns, seeking to find "better" ways of doing things within a new environment, then research designs will of necessity have to become more action-oriented. The popular null hypothesis approach to research usually takes a conservative stance: H_0: (the innovation will result in no change.) Then, within limited research resources, one is forced to disprove this hypothesis in order to argue for the change. A preferred way of structuring research would be to try and avoid biasing in favor of any hypothesis, but rather to develop a stance that a priori fairly reflects one's current knowledge about each possible alternative hypothesis. Then the research can be geared toward updating and firming one's initial information profile in hopes of finding that hypothesis that is most likely to hold up under continued testing. Hopefully the surviving hypothesis has implied action consequences that will assist and guide police administrators, at least until more definitive research findings are available.

Finally, one complaint about previous research is that a progressive, innovative, well-staffed department is the one willing and eager to do the research. For instance, Clarence Kelly--when he headed the Kansas City police department--was in large part responsible for the impressive set of studies done in that department (both during his tenure and, as a result of his tradition, after as well). However, the selection process in the past could be said to have suffered from a form of selection bias that precluded the results being useful to more typical departments (e.g., those having strong police unions or high calls-for-service workloads or other similar problems). If police field services research in the 1980s is to have external validity (i.e., be generalizable across a wide range

of police departments), then the "urban laboratories" that are established should be representative of United States sample police departments. The entire cirminal justice enterprise could only benefit from such a representative network of research centers.

APPENDIX A

ANNOTATED BIBLIOGRAPHY

Atlanta Police Department, 1976. Atlanta High Impact Program Project Evaluation, April 1, 1975 - September 30, 1975: Model Cities Crime Control Team. Atlanta: Atlanta Crime Analysis Team, Atlanta Police Department.

This interim report presents an analysis of six months of data from the Atlanta Model Cities Crime Control Team Program. The primary goals of this project were to reduce the incidence of stranger-to-stranger crimes, and to reduce the amount of community fear in the target area. Total stranger-to-stranger crime decreased by 20 percent over the six-month evaluation period. As of the time of publication, no information was available regarding citizen fear. This report does not describe the workings of the Model Cities Crime Control Team; rather, the main body of the report illustrates data analysis techniques to be applied throughout the evaluation of the team policing program.

‡Bloch, P. and Anderson, D., 1974. Policewomen on Patrol; Final Report. Washington, D.C.: Police Foundation.

This report evaluates the Washington, D.C. Women on Patrol program. Over the course of one year, the performance of 86 female officers was compared to that of 86 "comparison men." Overall, the women and men were quite comparable, though some questions can be raised regarding the practice of assigning women to light duty more frequently than men. With the exception of number of arrests and traffic citations, women and men performed equally as patrol officers.

Bloch, P. and Ulberg, C., 1972. "The Beat Commander Concept." The Police Chief, September, pp. 55-63.

This article presents some results from a team policing program in Detroit. Under the "Beat Commander" system, a group of officers is assigned to a particular neighborhood under the command of the beat sergeant. Though the program did not seem to reduce crime levels, the team appeared to perform favorably in other regards. For example, a higher percentage of team arrests resulted in court cases when compared to the remainder of the police precinct. Response times were also lower in the team area over the 14-month experimental period. The authors conclude that the team policing system appeared to benefit the police and the community.

NB: Abstracts for studies marked with an asterisk (*) are modified National Criminal Justice Reference Service (NCJRS) abstracts.

Studies marked with a dagger (†) are previous summary studies.

Studies marked with a double dagger (‡) are major research efforts.

Bottoms, A., 1971. Police Tactics Against Robbery. Monument Beach, MA.

This study attempts to demonstrate that coordinated police "pounce" tactics are feasible, require a minimum of specialized training, and do not require many resources. Indications are that these concentrated units can increase robbery arrests by up to 300 percent over present levels. Also included in this study is a model relating response time to arrest rate, indicating that arrest rates decline as response times increase.

‡Bottoms, A., Nilsson, E., Olson, D., and Charanian, T., 1972. Allocations of Resources in the Chicago Police Department. Operations Research Task Force, Chicago Police Department. Washington, D.C.: Government Printing Office.

This is the final report of the Operations Research Task Force, a team of eleven individuals established to examine resource allocation problems in the Chicago Police Department. The team attempted to examine police response to calls for service, methods of aggressive preventive patrol, and results from team-designed field experiments. The chapters of this report cover applications of systems analysis to law enforcement, allocation uses of budgeting (e.g., PPBS), allocation models of police manpower, response time analysis, preventive patrol, and the results of a mini-experiment in resource allocation. This report serves as a good example of how operations research can be applied to police problems.

‡Boydstun, J., Sherry, M., and Moelter, N., 1977. Patrol Staffing in San Diego: One- or Two-Officer Units. Washington, D.C.: Police Foundation.

This report evaluates a one-year experiment in patrol staffing. The performance of 22 one-officer units and 22 two-officer units was monitored using variables such as response time, number of calls for service handled, officer initiated activities, safety, cost, citizen and officer satisfaction. It was concluded that one-officer patrol is as effective as two-officer patrol, and certainly more efficient. Also, one-officer patrol was claimed to be *safer* than two-officer patrol.

Brannon, B., 1955. Report on One Man Police Patrol Cars in Kansas City, Missouri (Comparing the completely two men cars of 1952 with the completely one man cars of 1954). Kansas City, MO: Kansas City Police Department.

This report examines two years of Kansas City patrol data in order to determine the impact of the introducton of one-officer patrol on policing and crime. In 1952, the Kansas City Police Department staffed only two-officer cars; in 1954, only one-officer cars were fielded. The numbers presented indicate that crime rates decreased while the fractions of crimes cleared by arrest increased. Regarding safety, there was an actual increase in the number of injuries, but a decrease in the number of injuries per unit. Of course, the use of "injuries per unit" as a performance measure

is questionable; the number of injuries *per officer* increased slightly from 1952 to 1954. Other data pertaining to patrol workloads and system costs are presented. This information seems to suggest that one-officer patrol is as effective as two-officer patrol, and certainly more efficient.

Bright, J. A., 1970. The Beat Patrol Experiment. London, England: Home Office Police Research and Development Branch.

This paper reviews the implementation and evaluation of a British experiment in foot patrol. A one-year experiment in foot patrol was performed in the cities of Cardiff, Manchester, Newcastle, and Sheffield beginning in December 1965. Each city selected one beat as a control (1 foot officer/beat) and one as experimental (0, 2, 3, 4 foot officers/beat). The major result indicates that the crime rate is very sensitive to changes from 0 to 1 officer per beat. However, the crime rate is apparently insensitive to manpower changes above one officer per beat.

Budnick, F., 1972. Crime Correlated Area Model: An application in evaluating intensive police patrol activities. Kingston, RI: University of Rhode Island, College of Business Administration.

The majority of this report is devoted to the development of a statistical model for estimating crime levels. Budnick hypothesizes that crime rates in certain areas of a city may be treated as functions of crime rates in other areas. Using 30 months of index crime data from Washington, D.C., Budnick discovered that the crime rates of certain areas were highly correlated. .This model was used as an evaluation tool. It was determined that the crime rate experienced by an area of intensive police patrol was less than the "expected" crime rate based on model predictions, indicating the effectiveness of the intensive patrol.

Carte, G. and Carte, E., 1975. Police Reform in the United States: The Era of August Vollmer, 1905-1932. Berkeley, CA: University of California Press.

This biography of August Vollmer traces his career in police work from his initial involvement with the Berkeley Police Department to the establishment of the Berkeley school of criminology in 1951. As a result of their research, the authors have written a very readable account of the life of one of policing's greatest innovators.

Central Iowa Area Crime Commission, 1977. A Preliminary Evaluation of the Des Moines Police Department's Comprehensive Neighborhood Patrol Program. Des Moines: Central Iowa Area Crime Commission.

This preliminary evaluation presents an analysis of one month of data collected during the Neighborhood Foot Patrol program, and as such, this document is intended to be read as an interim report. The program placed an additional eight officers on foot patrol in target areas, increasing the total (foot and motor) patrol manpower by around 50 percent. The major goal of this program was to increase police effectiveness via improved police/citizen cooperation. Evidence is presented regarding police/community interaction and crime prevention activities. While the indications are that the foot patrol has been moderately successful, the one-month evaluation period is too short to consider these results as more than tentative.

†Chaiken, J., 1978. "What is Known about Deterrent Effects of Police Activities." In Preventing Crime. Edited by J. A. Cramer. Beverly Hills, CA: Sage Publications, Inc.

This review thoroughly examines the problems and prospects of patrol research. After listing police activities which are claimed to be effective in reducing crime, Chaiken identifies several measurement problems which hamper patrol research. He also discussed problems which are specific to cross sectional studies and longitudinal studies. Empirical research reviewed includes the 20th precinct and Operation 25 experiments in New York City, the New York City subway patrol project, Dahman's comparison of three projects from the High Impact Anti-Crime program, the Kansas City Preventive Patrol Experiment, the Los Angeles and Seattle response time studies, and other projects of interest. Chiken concludes that the deterrent effect of patrol will not be determined by a single study; rather, a long-term commitment to patrol research is required.

Chaiken, J., Lawless, M., and Stevenson, K., 1974. The Impact of Police Activity on Crime: Robberies on the New York Subway System. New York: Rand Institute.

This report presents an interrupted time-series analysis of subway robbery data in New York City. Eight years of data were subjected to analysis. During this period, police presence in the subway almost tripled. Robberies apparently decreased after the increase in police presence at an estimated cost of $35,000 per crime deterred. During the day, crimes were not displaced to other times; rather, a "phantom effect" prevailed whereby crime decreased at hours just outside the extremes of the patrol shifts. Unfortunately, it has been learned since publication of this study that the data analyzed were falsified by the New York City Transit Police, weakening what was a careful job of research by the Rand Team.

Chapman, S., ed., 1970. Police Patrol Readings. Springfield, IL: Charles C. Thomas.

This book contains several articles which address various issues of police patrol. Chapter headings include the police in a democracy, the patrol force and patrolmen, methods of patrol, patrol force distribution, British team and unit beat policing, violence, traffic and special functions, and vocational training. This reference provides an excellent account of traditional approaches to police patrol.

Chicago Police Department, 1963. One-Man Patrol Cars. Chicago: Chicago Police Department.

This report outlines the pros and cons of one-officer patrol as perceived by the Chicago Police Department. Reasons for using one-officer units include improved patrol coverage, reduced response time, more effective police observation capabilities, reduced costs, and reduced risk to officer. Arguments against one-officer patrol include the danger factor felt to be associated with this type of staffing, reduced aggressiveness of officers assigned to one-officer cars, inability of one-officer cars to handle many calls due to insufficient manpower, and problems with one officer simultaneously driving and observing the street. It is concluded that one-officer cars have proved their value in policing, and that a well thought out mix of one- and two-officer cars is best.

Clawson, D. and Chang, S., 1977. "Relationship of Response Delays and Arrest Rates." Journal of Police Science and Administration, Vol. 5, No. 1, pp. 53-68.

This paper examines the relationship between arrest rates and travel time, delay time, and overall response time. Statistical curves were evaluated predicting arrest rates from Seattle response time data. The data from Isaac's Los Angeles study were also reanalyzed. It was found that shorter travel and response times are significantly related to higher arrest rates. However, it was also emphasized that this relationship is not causal, that is, quick response times do not guarantee arrests.

Cleveland Impact Cities Program, 1975. Cleveland Impact Cities Program - Deterrence, Detection, and Apprehension Operating Program - Final Evaluation Report. Cleveland: Cleveland Impact Cities Program.

This report evaluates the Deterrence, Detection, and Apprehension program of the Cleveland Police Department. This high visibility patrol program was initiated in order to address a rising crime rate. The goal of the program was to reduce stranger-to-stranger crimes of violence. During the course of this program, crime rates initially decreased, but later increased, so the results of this study are viewed as inconclusive.

*Cordrey, J. and Kotecha, K., 1971. Evaluation of Community Centered Team Policing. Dayton, OH: Wright State University.

This report evaluates a Dayton, Ohio experiment in generalized policing. Aside from the implementation of decentralized team policing, civilians were trained as police assistants, and hired to perform certain tasks. The objectives of this experiment were to determine the effectiveness of team policing in improving police services and to produce a community-centered police structure which would be more responsive to neighborhood life styles. The number of dispatch calls answered, clearance rates, the value of property lost and recovered, apprehension time and successful prosecutions were all compared to a period prior to the experiment. Two community attitude surveys were also conducted. Evaluation of this program showed that, in general, team policing had helped develop a more community-centered police department. The 39 officers who volunteered for this experiment achieved measures of effectiveness comparable to prior time periods. It was recommended that the team policing experiment be continued.

Cordrey, J. and Pence, G., 1972. "An Analysis of Team Policing in Dayton, Ohio." The Police Chief, August, pp. 44-49.

This article examines the experience of team policing in Dayton, Ohio. The major objective of the team policing program was to improve police effectiveness. Using performance measures such as number of calls answered, clearance rates, recovery rates for stolen property, apprehension time and number of successful prosecutions, the authors concluded that no major changes in police effectiveness resulted. However, the authors concluded that team policing can be expected to improve police effectiveness in Dayton over the long run.

*Dahman, J., 1975. Examination of Police Patrol Effectiveness - High Impact Anti-Crime Program. McClean, VA: Mitre Corporation.

This document presents an analysis of crime data for three overt police patrol projects which were funded and implemented as part of the Law Enforcement Assistance Administration's high impact anti-crime program. The projects examined are the special crime attack team in Denver, Colorado, the concentrated crime patrol in Cleveland, Ohio, and the pilot foot patrol in St. Louis, Missouri. Each of the three projects is examined individually and the crime levels during the time period covered by police patrol project operations are analyzed. This crime level analysis is conducted using four time series models developed as part of the research. These models predict crime levels for the treatment period based on past crime levels in the area. These predicted or expected levels are then compared with the actual levels of crime observed during project operations. For each case at least one of the crimes examined (murder, rape, aggravated assault, robbery, burglary) was significantly lower during project operations

than expected. In no one project were all five crimes lower than expected, and no one crime was lower than expected in all three cases. In general, the results suggest that while there may be no uniform relationship between overt police patrol activity and official crime levels there is evidence that patrols implemented in high crime areas have been accompanied by crime levels which are lower than would have been expected.

Elliott, J., 1973. Interception Patrol: An Examination of the Theory of Random Patrol as a Municipal Police Tactic. Springfield, IL: Charles C. Thomas.

This short book draws together Elliott's work in the area of random patrol. Elliott defines his research problem as one of deploying police patrol in a spatial and temporal manner so as to maximize the probability of intercepting a crime in progress. Pursuant chapters cover the theory of random area search, methods for implementing an interception-oriented patrol, and methods for designing high intercept-probability patrol routes. This book also contains many of the interesting results from the Crime Control Team study, as well as data pertaining to the length of time it takes for committed crimes to be reported to the police.

†Elliott, J. and Sardino, T., 1971. Crime Control Team: An Experiment in Municipal Police Department Management and Operations. Springfield, IL: Charles C. Thomas.

This report describes and evaluates the Syracuse Crime Control Team. The team leader is given complete authority to determine how the team officers are deployed in the team beat according to this scheme; hence the Crime Control Team represents a decentralized approach to police patrol. Also, the theory of random area search was incorporated into the design of this study in an attempt to demonstrate the usefulness of an offensive police force. Evaluation methods and the rationale for using these methods are discussed in detail. The Crime Control Team appeared to be moderately successful in terms of reduced crime rates, increased clearance rates, and increased interception probabilities; implications of these results and suggestions for implementing similar programs elsewhere are discussed.

Franks, W. D., 1980. "Montpelier, Vermont's Directed Patrol Experiment." The Police Chief, January, pp. 24-26.

This short article by Chief Franks describes the effect of a directed patrol effort in Montpelier, Vermont. The program eliminated patrol services from 70 percent of the city, concentrating instead upon intensive foot and vehicle patrol of the downtown area. Utilizing a nine-month comparison, it was determined that the frequency of target crimes (burglary, vandalism, and disorderly

conduct) had decreased, calls for service did not increase, and displacement of burglary and disorderly conduct did not occur. However, reported incidents of vandalism increased by 183 percent. Also, the Part I crime decrease experienced in the target zone was less than the decrease experienced by the surrounding area.

†Gass, S. and Dawson, J., 1974. An Evaluation of Policy-Related Research: Reviews and Critical Discussions of Policy-Related Research in the Field of Police Protection. Bethesda, MD: Mathematica, Inc.

This report represents a major effort in the area of police protection. Approximately 200 research reports were examined in this study, and a subset of these studies are detailed in the report. Research reports concerned with police management, crime prevention, resource allocation, patrol operations and other areas are examined in terms of their internal and external validity. The major criticisms of police research surfaced by this report are:

(1) Lack of commitment to research by policy makers;
(2) Failure to articulate goals and objectives of police protection; and
(3) Improper study design and analytic methods.

Gay, W., 1977. Patrol Emphasis Evaluation - Cleveland Heights, Ohio. Washington, D.C.: University City Science Center.

Beginning in 1974, patrol operations oriented towards the three goals of prevention, deterrence, and criminal apprehension were introduced in Cleveland Heights. This report documents the patrol tactics employed, and analyzes relevant data regarding program performance. Patrols were redeployed according to a scheme that would increase officer visibility and availability during high workload periods. For example, the department converted to one-officer cars and used foot patrols in commercial areas to improve visibility. Crime did decrease in Cleveland Heights, but crime also decreased citywide. Thus, it could not be established whether or not the crime drop was caused by the new patrol tactics.

*Gay, W., Day, H., and Woodward, J., 1976. National Evaluation Program Phase I Summary Report: Neighborhood Team Policing. Washington, D.C.: National Institute of Law Enforcement and Criminal Justice (NILECJ), Law Enforcement Assistance Administration (LEAA), U.S. Department of Justice.

The information contained in this report relies heavily upon formal evaluations of team policing programs in 14 cities. The report describes characteristics of team policing programs, assesses the state of the knowledge about team policing and indicates what additional information is needed to fully evaluate team policing. This review of team policing programs indicates that several team

policing programs have failed because of the inability of departments to implement the most basic components of the program. Where team concepts have been operationalized, however, several departments have demonstrated that team policing can improve the performance of patrol, investigative, and community service activities because evaluators often fail to carefully monitor the extent to which planned program activities have been implemented. It is said to be difficult to determine whether the concepts of team policing or extraneous variables are responsible for the evaluation results reported.

Governmental Research Institute, 1957. One-Man Police Patrol Car Operation: A Report to the Board of Commissioners, St. Louis, Missouri. St. Louis, MO: Governmental Research Institute.

This report contains the results of a survey of 16 large American cities pertaining to the use of one-officer patrol cars. The 27 questions asked covered a range of topics, including the number of one-officer cars in use, where and when these units are in service, types of incidents serviced by these units, dispatching considerations, safety considerations, and other issues. The report also contains a brief summary of the pros and cons of one-officer patrol, and recommendations to the St. Louis Police Department regarding the use of one-officer cars.

Howard, W. B., 1977. "The Use of Paraprofessionals in Police Service." The Police Chief, January, pp. 52-56.

A program involving students as patrol aides was initiated in 1974 at the Claremont Colleges in Los Angeles. This article briefly describes the program and examines related performance statistics. The crime rate at Claremont Colleges decreased soon after the introduction of paraprofessional patrol, and the article attributes this to the program. While displacement may have occurred, this issue is not addressed by the article.

‡ Institute for Defense Analyses, 1967. Task Force Report: Science and Technology (A Report to the President's Commission on Law Enforcement and Administration of Justice). Washington, D.C.: Government Printing Office.

This report examines in detail the application of Science and Technology to criminal justice issues. Areas of application include the police apprehension process, police command, control, and communications, court management and corrections, crime analysis, and the total criminal justice system, criminal justice information systems, and criminal justice research and development. Several independent "mini-studies" are presented as appendices, including Isaacs' study of response time in Los Angeles. This report represents one of the earliest independent research efforts that examined problems of police patrol.

Isaacs, H., 1967. "A Study of Communications, Crimes, and Arrests in a Metropolitan Police Department." In Task Force Report: Science and Technology (A Report to the President's Commission on Law Enforcement and Administration of Justice). Washington, D.C.: Government Printing Office.

This study examined two months of data collected in August and September 1966 in Los Angeles, California. Information pertaining to response time, arrests, clearances and other variables was obtained. The data collected is consistent with the hypothesis that faster response times lead to more arrests. It was also noted that the clearance rate was very low for cases with unnamed suspects. Isaacs' recommendations for further research include the institutionalization of a fundamental research program in police issues, and the development of criteria for emergency dispatching.

Iutocovich, M. and Iutcovich, J., 1977. Safe Streets Evaluation Report, 1976-1977. Erie, PA: Northwest Institute of Research.

This report presents an evaluation of a five-year "Safe Streets" saturation program undertaken in high crime areas of Erie, Pennsylvania. The evaluation included a victimization survey to discern whether or not victimization had increased in the target area. The study also surveyed citizens' satisfaction with the police. No significant differences emerged between pre-saturation and saturation victimization and satisfaction levels.

‡Kansas City Police Department. Response Time Analysis: Executive Summary, 1977. Volume I: Methodology, 1977. Volume II: Analysis, 1977. Volume III: Part II Crime Analysis, 1979. Kansas City: Board of Commissioners, Kansas City, MO.

This study presents a detailed statistical analysis of ten months of Kansas City Response Time data. Volumes I and II examine 949 Part I crime incidents, while Volume III considers 359 Part II crime incidents. The major objective of the study was to test the relationship of response time and various outcome measures such as arrest likelihood, witness availability, citizen satisfaction with response time, and frequenty of citizen injury. Included in the measurement of response time were self-reported estimates of the length of time citizens take to contact the police. It was concluded that response time does not influence outcomes of serviced calls, largely because of the amount of time citizens take to contact the police. Rather, citizens' expectations of response time were identified as explaining observed citizen observed citizen satisfaction. In the Executive Summary of this report it is strongly suggested that response time minimization is not a justifiable goal, and that technologies geared towards response time reduction are not likely to be effective. Though some of these findings may be true, there are enough methodological problems with this study to warrant serious questioning of the published results.

Kaplan, E., 1979. "Evaluating the Effectiveness of One-Officer versus Two-Officer Patrol Units." Journal of Criminal Justice, Vol. 7, No. 4, pp. 325-355.

This article presents an analysis of one- versus two-officer patrol staffing. Relying primarily upon probabilistic models used in conjunction with data from the Police Foundation report Patrol Staffing in San Diego: One- or Two-Officer Units, this paper considers issues of patrol coverage, response time, frequency and visibility of patrol, probability of intercepting crimes in progress, injury probability, and comparative costs. Kaplan concludes that one-officer patrol is more effective than two-officer patrol in light of the performance measures mentioned above.

†Kelling, G. and Fogel, D., 1978. "Police Patrol - Some Future Directions." In The Future of Policing. Edited by A. W. Cohn. Beverly Hills, CA: Sage Publications, Inc., pp. 151-181.

This paper reviews empirical research in police patrol. After an historical section, the authors review a number of challenges to contemporary modes of police patrol. Studies reviewed include Press's analysis of the manpower increase in New York City's 20th precinct, the Kansas City Preventive Patrol Experiment, the Nashville experiments of Schnelle, *et al.*, the St. Louis AVM studies, the Kansas City response time studies, and several others. The authors suggest that motorized preventive patrol has been proven ineffective, and that foot patrol might be a promising avenue for patrol strategists to pursue.

*†Kelling, G., Pate, T., Dieckman, D., and Brown, C., 1974. The Kansas City Preventive Patrol Experiment: A Technical Report. Washington, D.C.: Police Foundation.

This is the evaluation report of the famous Kansas City Preventive Patrol Experiment. In this year-long experiment, three controlled areas of routine preventive patrol were used. One area, termed "reactive" received no preventive patrol. Officers entered the area only in response to citizen calls for assistance. In the second area, called "proactive" police visibility was increased two to three times its usual level. In the third area, termed "control" the normal level of patrol was maintained. Analysis of the data gathered revealed that the three areas experienced no significant differences in the level of crime, citizens' attitudes toward police devices, citizens' fear of crime, police response time, or citizen's satisfaction with police response time. This technical report includes an analysis of the strengths and weaknesses of the study. A discussion of design issues and methods of analysis and comparisons of Kansas City with other cities of similar size. Though this study remains the most ambitious patrol experiment to date, it has received its share of criticism. See Larson (1975) for a critique of this report.

Kinney, J. A., Howlett, J. B., and Harris, D. H., 1976. Isla Vista Foot Patrol - History, Operations, and Evaluation. Santa Barbara: Anacapa Sciences, Inc.

This report constitutes a description and evaluation of the Isla Vista Foot Patrol Program. Jointly established by the Santa Barbara County Sheriff's Office and the University of California at Santa Barbara Police Department, the foot patrol was a response to a wave of serious incidents in Isla Vista. In the five years following the initiation of the program, serious reported crime decreased while petty reported crime increased. The authors claim that crime itself went down, but that reporting rates went up. Also, a survey showed that Isla Vista residents preferred foot patrol to other forms of policing, though some misgivings existed with respect to certain aspects of the program.

Kizziah, C. and Morris, M., 1977. Evaluation of Women in Policing Program - Newton, Massachusetts. Oakland, CA: Approach Associates.

This report evaluates the Newton, Massachusetts Women in Policing Program. Between May 1 and August 31 of 1977, the performances of 12 female and 23 male officers were compared. Using measures such as number of arrests, number of calls handled, commendations and reprimands, accidents, injuries and illnesses, and supervisors' assessments, it was concluded that there is little difference between the performance of male and female officers. However, it was also found that the male officers hold a negative opinion regarding the ability of women to do police work.

Larson, G. and Simon, J., 1978. Evaluation of a Police AVM System: A Phase II City-Wide Implementation. Cambridge, MA: Public Systems Evaluation, Inc.

The findings of Public Systems Evaluation, Inc.'s Phase II (city-wide) evaluation of Automatic Vehicle Monitoring (AVM) in St. Louis are presented in this report. The objectives of the project were similar to the Phase I program: reduce response time, improve officer safety, reduce voice band congestion, and improve police command and control. (See Larson, Colton, and Larson, 1976). As in Phase I, response time reductions were minimal; results regarding the other goals were mixed. However, several potentially positive uses of AVM were identified, including improved dispatching of units to extraordinary events (e.g., "hot pursuits"), dynamic reallocation of patrol forces to maintain patrol presence or reduce queuing levels, and better supervision of the force.

‡Larson, R., 1972. Urban Police Patrol Analysis. Cambridge, MA: The M.I.T. Press.

This book, the first of its kind, introduces the reader to a multitude of analytical methods available for analyzing police patrol operations. Dr. Larson outlines the types of operational problems faced in police patrol, and provides detailed descriptions of the police emergency response system, a typical eight-hour tour of patrol duty, and measures of effectiveness for police patrol. These issues are illustrated in a chapter which examines patrol operations in a hypothetical city. Technical chapters present models of travel time and optimal beat design, models of preventive patrol, a patrol allocation algorithm, a simulation model of patrol operations, models of Automatic Car Locator systems, and models of intersector cooperation and repositioning. This book is invaluable to anyone involved in the study of police patrol.

Larson, R., 1975. "What Happened to Patrol Operations in Kansas City? A Review of the Kansas City Preventive Patrol Experiment." Journal of Criminal Justice, Vol. 3, No. 4, pp. 267-297.

This paper reviews various aspects of the design, execution, and evaluation of the 1972-73 Kansas City (MO) Preventive Patrol Experiment, focusing on the operational behavior of the patrol force during the experiment. The design of the experiment is examined to see whether the conditions expected were actually brought about. The types of data used in evaluating the final outcome of the experiment are reviewed. Where appropriate, simple probabilistic models are employed to estimate frequencies of preventive patrols and response times in each of the experimental areas. Larson argues that the operational consequences of the experimental design were not adequately considered by the original researchers and were so different from those expected that the validity of the design as a means for greatly reducing patrol levels in a subregion must be questioned. This suggests two policy conclusions: (1) great caution should be used in attempting to induce the general value of a visible patrol presence from the results of the Kansas City Preventive Patrol Experiment; (2) patrol administrators in other cities could remove conventional patrol coverage from certain beats and markedly increase manning in others nearby without incurring significant degradations in service.

Larson, R., Colton, K., and Larson, G., 1976. Evaluation of a Police-Implemented AVM System - Phase I, A Summary Report. Cambridge, MA: Public Systems Evaluation, Inc.

This report summarizes the findings of Public Systems Evaluation, Inc.'s Phase I (one district) evaluation of the St. Louis Automatic Vehicle Monitoring (AVM) system. The evaluation examined AVM technology, the impact of AVM on police operations (in terms of response time, officer safety, voice-band congestion, and command and control), and attitudinal/organizational concerns. It was found that AVM did not result in substantially reduced response time, nor was AVM sufficiently relied upon to affect officer safety. Also included in this report is a series of recommendations relating the potential advantages and disadvantages of AVM to those of other technologies (e.g., computer-aided dispatching systems, 911 systems).

Lewis, R. G., Greene, J. R. and Edwards, S. M., 1978. Special Police Units in Michigan: An Evaluation. Criminal Justice Systems Center.

This report is an evaluation of some 23 special projects undertaken by police agencies in the State of Michigan. Projects were of three types: regionalized detective units, saturation patrol units and surveillance units. The major objective of this program was to reduce crime in target areas. Using the techniques of time series analysis, the authors concluded that there is no reason to believe that establishment of the special police units resulted in crime reduction. Despite certain deficiencies in their data, the authors are convinced that the statistical analysis has demonstrated the ineffectiveness of the special units as implemented in Michigan.

Los Angeles Police Department, 1973. Final Evaluation of Team 28 Experiment: Introduction and Overview. Los Angeles, CA: Los Angeles Police Department.

The results of the Los Angeles Team 28 Experiment are discussed in this summary report. Team policing was introduced in 1972 to one Los Angeles "Basic Car area" as a new approach to crime reduction. According to the writers, the experiment was successful. Burglaries were 31.7 percent lower than expected, while community attitudes towards the police improved. The attitudes of police officers towards the community were also reported to have become more positive.

†Milton, C., 1978. "The Future of Women in Policing." In The Future of Policing. Edited by A. W. Cohn, 1978. Beverly Hills, CA: Sage Publications, Inc., pp. 183-204.

This chapter summarizes current knowledge pertaining to the performance of women in police work. Statistics pertaining to the participation of women in policing are presented in a background section, followed by a review of traditional women's roles in law enforcement agencies. The Washington, D.C. Policewomen on Patrol study is reviewed in some detail; other studies referenced include a St. Louis project reported by Lewis Sherman, and an unpublished Police Foundation study of women on patrol in New York City. Milton points out the problems women face when they are integrated into police departments, presenting several actual examples. The chapter concludes with an assessment of the effectiveness of women on patrol.

† National Advisory Commission on Criminal Justice Standards and Goals, 1973. Police. Task Force on Police, National Advisory Commission on Standards and Goals. Washington, D.C.: National Advisory Commission on Criminal Justice Standards and Goals.

This document presents and discusses a number of normative standards that the authors feel should be adhered to by the police. Chapter 8 of this report is dedicated to patrol, while Chapter 6 examines team policing. With respect to patrol, standards are proposed to:

(1) Establish the role of the patrol officer;
(2) Enhance the role of the patrol officer; and
(3) Guide the deployment of patrol officers.

It is interesting to note that in discussing these standards, references to current research are made (This is especially true for the sections on patrol deployment).

*New York City Police Department, 1972. "Operation 25." In Police Patrol Readings. Edited by S. Chapman. Springfield, IL: Charles C. Thomas, pp. 342-353.

The four-month experiment described in this paper took place in 1954 in New York City's 25th precinct in Manhattan, an area with a very high crime rate. Increased police personnel, including foot patrolmen, detectives, traffic, emergency and supervisory personnel were assigned to the precinct. A special juvenile aid bureau and a special narcotic squad were also established. An in-service training program was also set up, using four instructors from the Police Academy. Compared to the same period in 1953, the number of felonies reported decreased 55.6 percent, total crime complaints decreased 27.5 percent, and arrests increased by one-third. Precinct residents and businessmen also became more relaxed and confident due to the presence of more uniformed patrolmen on the streets.

‡ Pate, T., Ferrara, A., Bowers, R., and Lorence, J., 1976. Police Response Time: Its Determinants and Effects. Washington, D.C.: Police Foundation.

This report presents an analysis of response time data collected in conjunction with the Kansas City Preventive Patrol Experiment. Using regression and correlation techniques, the authors set out to statistically determine both the determinants of response time and the degree to which response time influences the outcomes of crime incidents. The authors state that the length of time between the reporting of an incident and the dispatching of an officer, and the distance to the scene are the only two variables significantly correlated with response time. The authors also claim that response time is not the most significant predictor of outcome variables like result of encounter, (e.g., arrest), citizen satisfaction with response time, and attitudes towards police officers and the police in general. Rather, the difference between observed and expected response time was the most important variable in determining citizen satisfaction with response time. While the results of this study are interesting, questions may be raised concerning these findings in light of small sample sizes and the types of statistical methods used.

Pendland, M. B. and Gay, W. G., 1972. "Foot Patrols: The Fort Worth Experience." The Police Chief, April, pp. 46-68.

In response to a rapidly increasing crime rate, the Fort Worth Police Department established a special foot patrol unit. This article briefly describes the goals of the program, and presents some statistical results. After one year of foot patrol in a high crime area of Fort Worth, Part I crime in this area decreased by 25 percent as opposed to 11 percent city-wide. Also, citizens were favorably disposed towards the foot patrol in general. In the absence of detailed program description, stronger controls, and a longer time series data base, however, these results must be viewed as somewhat tentative.

Press, S. J., 1971. Some Effects of an Increase in Police Manpower in the 20th Precinct of New York City. New York: The New York City Rand Institute.

The results of a 40 percent increase in police manpower in New York's 20th precinct were statistically analyzed in this after-the-fact study. In some crime classifications, reported crime decreased from 20 percent to 50 percent when compared to control precincts; in other crime classifications, no changes were detected. Crime displacement effects existed, but were typically smaller than observed decreases in crime rates. This report does *not* describe the actual deployment conditions which may have given rise to these results, making the interpretation of the statistical analysis difficult.

*Reagen, M., Cooper, J., Gabriel, C., Gordon, F., MacDowell, C., and Makarushka, C., 1974. Philadelphia Police Department - West Philadelphia Strike Force - Act 1 - North, Central - Northwest Strike Force - Act 2 - Final Report. Syracuse, NY: Police and Security Management Consultants.

This report presents an evaluation of a project aimed as the reduction of stranger-to-stranger burglary and robbery in two high-crime areas of the city by utilizing computer technology in the tactical and logistical deployment of special police strike forces. The evaluation examined internal factors of the information processing and analysis system. These included records control and procedures, the overall records system, and statistical evaluation of the success of the project in reducing priority crimes. The consistency in reporting and processing offenses and the reliability of internal processing and preparation of the data were evaluated. Also examined were the reliability of the computer software and data automation systems. Statistical charts are provided showing the impact of the project in terms of offense rates, clearance rates, utilization and testing of new patrol techniques, police awards and morale, and citizen complaints regarding policemen in the units.

St. Louis Metropolitan Police Department, 1977. Team Policing Experiment: Analysis and Evaluation (Technical Report). St. Louis: Management Services Section, Planning and Development Division, St. Louis Metropolitan Police Department.

In April of 1976 the St. Louis Metropolitan Police Department implemented a team policing experiment. This report constitutes an evaluation of that experiment. According to the report, the major area of difference between team policing and traditional policing rests with management and administrative practices. The researchers found evidence that the police had become more effective under team policing, though no statistical changes in attitudinal variables such as job satisfaction and police community relations were found.

† Schell, T., Overly, D., Schack, S., and Stabile, L., 1976. National Evaluation Program Phase I Summary Report: Traditional Preventive Patrol. Washington, D.C.: NILECJ, LEAA, U.S. Department of Justice.

The authors of this report identify the commonly accepted goals of patrol, and examine each of these goals in relation to the assumptions which link certain patrol activities to goal attainment. The writers also attempt to assess the validity of these assumptions and the type and quality of related performance measures. Patrol issues in need of further study are identified. This report based its findings on a reivew of available patrol literatute, a survey of 300 police and sheriff's departments, and 26 site visits.

Schnelle, J., Kirchner, R., Casey, J., Uselton, P., and McNees, M., 1977. "Patrol Evaluation Research: A Multiple-Baseline Analysis of Saturation Police Patrolling during Day and Night Hours." Journal of Applied Behavior Analysis, Vol. 10, No. 1, pp. 33-40.

This article presents the results of a carefully monitored experiment in saturation patrol. Over four ten-day periods, patrol movement was reliably monitored using tachographs. Patrol movement was increased by a factor of four for normal levels and by a factor of 30 for patrol under 20 miles per hour. Using a multiple-baseline time series approach, it was determined that crime levels remained constant during daytime saturations, but that nighttime crime levels decreased significantly. However, the authors question the value of saturation patrol based on cost considerations.

Schnelle, J., Kirchner, R., McNees, M., and Lawler, J., 1975. "Social Evaluation Research: The Evaluation of Two Police Patrolling Strategies." Journal of Applied Behaviour Analysis, Vol. 8, No. 4, pp. 353-365.

This article presents a statistical evaluation of two police patrol strategies. A time series design was used to evaluate the effects of a home-burglary patrol; no effects could be attributed to the police. A multiple-baseline design was used to examine the effects of a foot patrol program. This second analysis revealed an increase in crime reporting, but no other effects were discovered.

‡ Schwartz, A. and Clarren, S., 1977. Evaluation of Team Policing in Cincinnati: A Technical Report (Volumes I and II), Washington, D.C.: Police Foundation.

This detailed report describes and evaluates the Cincinnati Team Policing Experiment. Initially planned to be an eighteen-month project, the program was extended for an additional year. The maintenance of this program became quite a problem, however, as the differences between team policing in the experimental area and routine policing in Cincinnati as a whole began to disappear within eighteen months of project initiation. The major goal of the program was to reduce crime and improve police-community relations. While burglary rates decreased in the experimental district, the rates of other crimes remained comparable to city-wide figures. Also, citizen satisfaction with the police did not increase as expected, though the level of citizen satisfaction remained high. The authors suggest that there is no reason to believe that team policing is less effective than routine policing. Rather, they feel that team policing could be beneficial to both the police and the public.

Sichel, J., Friedman, L., Quint, J., and Smith, M., 1978. Women on Patrol: A Pilot Study of Police Performance in New York City. Washington, D.C.: Government Printing Office.

This report evaluated an experiment involving women on patrol. Forty-one men and 41 women were roughly matched statistically; these officers were then comparatively evaluated over a seven-month period. Officer effectiveness was based on measures such as type of incident serviced, type of action instigated by the officer (e.g., use of force), citizens' reactions to police service, "successful" attempts at controlling subjects, and number of arrests made. No statistical differences emerged between the male and female officers based on the majority of these measures.

Tarr, D., 1978. "Analysis of Response Delays and Arrest Rates." Journal of Police Science and Administration, Vol. 6, No. 1, pp. 429-451.

This paper presents a replication of an earlier study by Clawson and Chang. Statistical curves were used to relate response times and arrest rates; a significant inverse relationship between these variables emerged. Also, it was found that arrest rates were heavily influenced by the number of officers in the preliminary response unit, with two-officer units obtaining a significantly higher arrest rate than one-officer units.

*Tien, J., Larson, R., Green, J., Williamson, J., Dunlap, V., 1975. An Evaluation Report of the Worcester Crime Impact Program. Cambridge, MA: Public Systems Evaluation, Inc.

This report presents a process evaluation of the Worcester Crime Impact Program. The program consisted of seven components aimed at achieving goals of civilianization, decentralization, and specialization within the department through concentrated patrol, increased investigative manpower, improved administrative support, use of civilians to answer service calls, and establishment of a crime prevention unit. All available data elements traditionally collected by the Worcester Police Department relevant to the project and especially those demonstrating the impact of the use of police service aides were analyzed. The results of a questionnaire administered to and interviews conducted among program participants were analyzed, as were telephone interviews with service call clients. The findings state that the Worcester Crime Impact program has successfully met its main output goal of reduced target crime, primarily because of the increase in manpower and improved flexibility and organization provided by the impact program.

‡ Tien, J., Simon, J., and Larson, R., 1977. An Evaluation Report of an Alternative Approach in Police Patrol: The Wilmington Split-Force Experiment. Cambridge, MA: Public Systems Evaluation, Inc.

This report presents an evaluation of the Wilmington Split-Force program. The evaluation is based on data collected from December 1, 1975 through November 30, 1976. During this time period, the Wilmington patrol force was divided into response-oriented (basic) and preventive patrol-oriented (structured) sub-forces. It was found that the split-force approach increased call-for-service response efficiency, in that pre-experimental volumes of calls for service were handled with reduced manpower. Although the purpose of this program was not to reduce crime, Part I crime did decrease by six percent over the study period. The structured patrol officers were responsible for a large increase in the number of crimes cleared by the patrol division, but many of these clearances came at the expense of the detective division, resulting in a net drop in the clearance rate. Citizens were found to be very satisfied with the performance of the split force, though two-thirds of the officers surveyed indicated they would like to see the program discontinued. The authors conclude that the split-force approach does constitute a more productive style of policing than traditional patrol; additional methods for improving productivity are also suggested as worthy of future consideration.

Ulberg, C. and Bentson, L., 1976. An Evaluation of the Bellevue Police Department's Experiment in Team Policing. Seattle, WA: Battelle Memorial Institute of Law Enforcement and Criminal Justice.

In this brief report, the authors describe the implementation and implications of a team policing program established in 1975 in Bellevue, Washington. The goals of this project were to involve citizens in crime investigation and prevention, to improve officers' job satisfaction, and to reduce the rate of burglary in particular and Part I crime in general. It was found that citizens having direct contact with the police were more satisfied with the police, though the overall level of citizen response to the program was not determined. Also, it was found that officer satisfaction decreased over the course of the project. Before and after examination of burglary rates yielded a 12.5 percent decrease, but this cannot be attributed to the team policing program.

Wagner, W. F., 1978. An Evaluation of a Police Patrol Experiment. Pullman, WA: Washington State University.

This Ph.D. thesis constitutes an evaluation of Albuquerque's Special Operations Section (SOS). The SOS consisted of two eight-officer teams which, when deployed along with regular patrol, served to create saturation conditions in various parts of Albuquerque. Hypotheses tested pertained to the effect of the

increase in patrol on the crime rate, and the effectiveness of marked versus unmarked patrol cars. No statistical changes were detectable in the crime rates, and no statistical differences surfaced between the effectiveness of marked vers us unmarked cars. However, Wagner claimed on substantive grounds that unmarked units were more effective in the apprehension of felons. The presentation by Wagner is good, explaining the weaknesses of the SOS study as well as its strengths and explaining in detail what the SOS actually did.

*Walsh, J., 1975. St. Louis Metropolitan Police Department - Foot Patrol Project Evaluation Report. St. Louis, MO: St. Louis Metropolitan Police Department.

This is the final report on an impact cities project to augment the number of foot patrolmen in high crime areas of St. Louis in order to reduce crime, improve police-community relations, and supplement normal police patrol. Project results reveal that crime reduction has not been significant as a result of this program. The program was an outstanding success in terms of improved police community relations. However, the arrest rate per 100 man-hours of patrol was significantly below that of the remainder of the department.

†Webb, K.W., Sowder, B. J., Andrews, A. J., Burt, M. R., and Davis, E. F., 1977. National Evaluation Program Phase I Summary Report: Specialized Patrol Projects. Washington, D.C.: NILECJ, LEAA, U.S. Department of Justice.

This report reviews 21 projects in specialized patrol. The 21 programs are divided into low visibility patrol (eight cases), high visibility patrol (five cases), and combined low/high visibility patrol (eight cases). The report concludes that more research is needed regarding the effectiveness of specialized patrol. Also mentioned is the finding that existing research is of questionable quality given recurrent problems with the reliability and overall accuracy of completed evaluations.

‡Wilson, O. W. and McLaren, R., 1977. Police Administration. New York, NY: McGraw Hill.

This is the fourth edition of O. W. Wilson's classic text. Relevant to police patrol are the chapters on team policing, patrol, and allocation and distribution of operational manpower. Review of this work is essential for anyone undertaking research in patrol operations.

APPENDIX B

BIBLIOGRAPHY

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2 INVESTIGATION/PATROL INTERFACE

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other reasons for not implementing them. Police researchers appear to have limited research designs to acceptable subjects within the confines of a limited political and funding situation.

In summary, police research has closely embodied the values of the police organizations being studied, and thereby has served as a justification of the organizations' values. Studies have measured productivity in terms of the standard measures of arrests or clearances, though these measures have been universally criticized as unreliable and subject to manipulation.* Such research cannot be expected to produce analysis and/or problem solutions that depart from traditional wisdom. The research is instead destined to develop a logic and data base to support the continued specialization of investigation, and as a consequence, to produce permutations of traditional police organizations. What is needed is a controlled experiment testing the impact of a drastic reduction in specialized investigators.

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* It is ironic that our argument relies in part on the findings of studies that employ such measures. For studies that criticize arrest and/or clearance rates, see:

Datz, Morris, Tendler and Kalmanoff, pp. 13-17.
Bernard Greenberg, Oliver S. Yu and Karen I. Lang, Enhancement of the Investigative Function - Volume I: Analysis and Conclusions (Menlo Park, California: Stanford Research Institute, 1972), pp. 43-48.
Greenwood, Chaiken and Petersilia, pp. 225-226.

through a systems approach towards the investigative function, a "checklist" of the information essential to the investigation of burglary cases; a 1976 study by the Police Foundation entitled, Managing Investigations: The Rochester System, which explored the use of teams in Rochester, New York; and a 1977 Police Foundation report entitled, The Cincinnati Team Policing Experiment: A Summary Report, which analyzed the use of teams in Cincinnati, Ohio. These studies and eighteen others are reviewed and discussed in this research paper, in order to assess the "state of the art" of research on the patrol/investigation interface since the President's Commission presented its study and recommendations. The result of this paper is an assessment of the "gaps" in the research on the interface and suggested areas for future research to fill these gaps.

In this introductory section the reader will find a definition and discussion of the patrol/investigation interface that sets a framework for the later discussion of the research. This initial discussion of the interface includes a "traditional model" of the interface, as well as a discussion of how the interface exists, functions, and changes as part of the practical operations of a working police department. At the end of this introductory section, the reader will find an outline of the topics covered by each section in the report.

I INTRODUCTION

This research paper is the result of a study undertaken to assess the research that has been done on the interface between the patrol and investigative functions. The division of responsibility between the patrol unit and the investigative unit, as well as the extent to which these two units coordinate their activities, can be a vital determinant of the manner and success with which a police department pursues its goals and objectives. Until the President's Commission on Law Enforcement and Administration of Criminal Justice issued its series of reports in 1967, the basic traditions of police operations (e.g., preventive patrol, the specialization of the investigative function) remained largely unexplored and unchallenged. The President's Commission raised a number of questions and issues and suggested paths for future research and innovations in policing. One of the major innovations recommended was team policing--a direct manipulation of the interface between patrol and investigation--designed to have a significant impact on the effectiveness and efficiency of service delivery, as well as police-community relations and officer morale.

Since 1967 a number of important studies have been concluded that bear on the interface between patrol and investigation. Included among these studies are a 1975 RAND study entitled The Criminal Investigation Process, which analyzed investigators' contributions to the achievement of criminal justice goals; a 1972 study by the Stanford Research Institute entitled, Enhancement of the Investigative Function, which developed,

1.1 THE INTERFACE

An interface is defined as "the place at which independent systems meet and act on or communicate with each other."* Within a police department, the two "systems" which are most responsible for carrying out police objectives are the patrol division and the investigative division. In a traditional police department, the patrol division is primarily responsible for the police objectives of response to calls-for-service, crime prevention, emergency services provision, and preservation of order. The investigative division assumes primary responsibility for following up unsolved cases and for preparation of cases for prosecution. Both units are responsible for identification and apprehension of offenders.

Patrol, through its response to calls-for-service, is responsible for gathering information at the scene of the crime; investigators are responsible for the follow-up investigation and subsequent arrest of the perpetrator (if an arrest was not immediately made by patrol). This traditional model represents a fairly narrow interface between patrol officers and investigators, both of whom work toward the same end (i.e., arrests) but on a fairly independent basis.

The traditional model of a police department's organization, described above, is, of course, vastly oversimplified. In practice, the interface between patrol and investigation is not so simply or clearly defined. In some departments the interface may be broader--investigators and patrol officers may work together (e.g., information supplied by patrol may be employed for such self-initiated activities on the part of investigators as narcotics investigations); information supplied by investigators may be

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* Webster's New Collegiate Dictionary (Springfield, Massachusetts: G & C Merriam Company, 1977), p. 602.

employed by patrol officers to determine the areas requiring heavy patrol, etc. In other departments, there may be no interface at all (i.e., the department is either so small or so decentralized that there are no specialized investigators).

The interface between patrol and investigation is, in part, the consequence of certain administrative decisions intended to maximize the achievement of departmental objectives. For example, if the police administration chooses to place more emphasis on police-community relations than on criminal apprehension relatively little effort will be made to increase the flow of communications between patrol and investigators. Or, if a decision is made that the apprehension of offenders needs higher priority, investigators may be encouraged to request that patrol officers pay particular attention to certain areas or groups of suspects and, thus, the interface is broadened. The interface, then, may be altered in direct relation to the priority of various departmental goals and objectives.

However, the interface is also the result of factors primarily unrelated to the achievement of departmental objectives. For example, the extent to which a police union regards the specialization of the investigative function as a desirable reward or sign of status, may serve to maintain a minimal interface betwen patrol and investigation. Or, a supposed lack of adequate overtime compensation may discourage patrol officers from performing more extensive preliminary investigations that would broaden the interface between patrol officers and investigators.

Thus, two points about the interface must be clear. The first is that the patrol/investigation interface is manipulated by police commanders deliberately to achieve a specific end, and it is manipulated inadvertently as a by-product of other administrative decisions. The second point is that although the degree to which the patrol/investigation interface exists may

be a response to the need to achieve departmental objectives; it may also be a response to factors totally unrelated to these departmental objectives.

The interface, then, is not simply a question of administrative design or, for that matter, research design. The interface between patrol and investigation is an organic response to a multitude of complex and interrelated factors.

1.2 THE REPORT

This report is the result of an analysis of twenty-two research studies that bear either directly or indirectly on the interface between patrol and investigation. The studies reviewed are of two types. First, there are studies which analyze police operations without the use of an experimental design. These are primarily operations research studies and typically involve analyses of patrol, investigation, or joint operations as they were practiced at the time of the studies. The second type of studies are those which attempt to alter traditional police practices through the use of an experimental approach. These studies tend to proceed from specific hypotheses (e.g., field interrogations are useful; team policing increases the arrest rate). Especially when based on preliminary operations research, these studies are usually aimed at demonstrating the impact on police objectives occasioned by certain changes in patrol, investigation and/or joint tactics and/or procedures.

The approach employed in the review of these studies is to view the interface between patrol and investigation from two perspectives:

1. As an interchange in organizational communications.
2. As a junction point for shared responsibility concerning departmental objectives.

Viewed from these two perspectives, the approach seeks to investigate both the procedural interface between patrol and investigation and the

substantive interface. Procedural issues center on the routing of information between patrol and investigation, the use of such information, impediments of information exchange, etc. Substantive issues center on the implications of various organizational arrangements and forms designed to achieve common objectives, particularly in terms of the responsibility for investigation and apprehension on the part of patrol and investigative units. Specific topics covered in the report include the contribution of investigators to the "solving" of crimes and the apprehension of criminal offenders, and the use of field interrogation reports in criminal investigation. In addition, the report covers such policing innovations as the use of crime data analysis, team policing, and report screening and enhancement procedures.

The first section of the report is "The History of the Interface Between Patrol and Investigation." This section contains a brief discussion of the ways in which the interface between patrol and investigation has developed and changed over time. This section also includes discussion of the findings of the President's Commission that bear on the interface and have served as catalysts for research studies since that time. The second section, "The Normative Model of Research," contains a description and discussion of the methodology used in research pertaining to the interface. This discussion includes the measures employed in the research, the use of explicit hypotheses, the use of controlled experiments, etc. This section also discusses the differences between the "ideal" research model and the research studies actually carried out. Problems found throughout the research on the interface are presented in this section. The third section, "A Synthesis of the Research," includes hypotheses tested in the research and an analysis of the research findings and conclusions. The hypotheses reviewed in this section are not just those explicitly defined, but those implicitly examined in the research studies. The fourth section, "Issues," includes a discussion

of the issues raised by the research as a whole. The fifth and final section, "Annotated Bibliographies," includes brief bibliographies of the twenty-two studies analyzed. Although these studies cover a multitude of issues, the bibliographies pertain only to the aspects of the studies that bear on the interface between patrol and investigation and thus represent only a narrow treatment of each study. The bibliography of all the works that contributed to this report and the footnotes can be found at the end of the report.

II THE HISTORY OF THE INTERFACE BETWEEN PATROL AND INVESTIGATION

The origins of the policing function in the United States are found in the ninth century England, where villages were divided into units called "tythings." In each tything, the position of "tythingman" was rotated among the men. The tythingman was responsible for maintaining order in his section of the village. Since this was a fairly large responsibility for one individual, the tythingman relied on assistance from the other villagers in the performance of his duties. Although policing was a community function, investigation during this period was a private matter, performed at the discretion of and by the victim.*

According to Simpson's Criminal Investigation: A Selective Review of the Literature, it was not until the emergence of three institutions between the thirteenth to sixteenth centuries that the state began to adopt some responsibility for investigations. These institutions were coroner's inquests, the Privy Council, and the Privy Council's Court of Star Chamber. Although investigations were held by these institutions, the investigations were of a specific type. The coroner's inquests dealt with deaths under suspicious circumstances; the Privy Council and the Court of Star Chamber dealt with the investigation of political crimes or the investigation of powerful people. There was still no authorized body to assume the responsibility for the investigation of "ordinary" crimes and criminals. Eventually, the office of the magistrate or justice of the peace became "...the principal

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* Alan Kalmanoff, Criminal Justice: Enforcement and Administration, (Boston, Massachusetts: Little, Brown and Company, 1976), pp. 28-29.

state mechanism for the investigation of crime and the indictment and prosecution of suspected persons."* In most instances, however, investigative action on the part of a magistrate was initiated at the request of the victim. During the industrialization of Great Britain in the eighteenth century, the magistrate's office proved to be incapable of coping with the crime problem. As a result, private institutions began to investigate crimes.**

It was during the eighteenth century that the detective function began as a specialized police responsibility. In the nineteenth century, bureaucratized police forces were established in Great Britain and the United States. One result of these forces was the recognition that investigation could no longer be a private function. The first police agency to establish a separate investigative force was the London Metropolitan Police in 1842. In major cities in the United States, officers began to be assigned to detective duties in the 1840s; however, detective units were not routinely adopted by state police agencies until after World War I. Towards the end of the nineteenth century, detective units expanded rapidly both in size and in the scope of their operations.*** It was not until specialized investigative units were established that the interface between patrol and investigation emerged.

Until the President's Commission on Law Enforcement and Criminal Justice issued its series of Task Force Reports in 1967, the traditional values and assumptions on which policing was based remained largely

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* Antony E. Simpson. Criminal Investigation: A Selective Review of the Literature (New York, New York: John Jay College of Criminal Justice, 1976), p. 5.

** Ibid., pp. 4-7.

*** Ibid., pp. 7-8, 10-11.

unexamined. The Task Force examined many traditional practices of policing to determine ways in which the police could maximize their effectiveness. The interface between patrol and investigation was one area on which the Task Force focused. The Task Force recognized the vital role of the patrol officer. It noted that "...the initial responsibility for confronting the entire range of police problems rests with the patrolman."* Furthermore, investigation was described in terms that suggest it is a supportive rather than a primary activity: "When patrol fails to prevent a crime or apprehend a criminal, the police must resort to investigation."** The Science and Technology Task Force made a study of Los Angeles Police Department records, which indicated that 90 percent of the arrests in the crime sample were made by patrol officers, rather than investigators. The Task Force also found that the majority of arrests were made within eight hours of the crime. One of the most important factors in the clearing of a case was whether the suspect was named by the victim in the crime report. It was determined that "...if a suspect is neither known to the victim nor arrested at the scene of the crime, the chances of ever arresting him are very slim." In almost two-thirds of the cleared cases where a follow-up investigation was performed, suspects were named in the initial crime report. Detectives were unlikely to provide followup on cases that did not contain investigative leads in the crime report.*** Thus, the Task Force Report served to mitigate some of the "mystique" surrounding the criminal investigator's role.

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* The President's Commission on Law Enforcement and Administration of Justice. Task Force Report: The Police (Washington, D.C.: U.S. Government Printing Office, 1967), p. 121.

** Ibid., p. 1.

*** The Institute for Defense Analyses. Task Force Report: Science and Technology (Washington, D.C.: U.S. Government Printing Office, 1967), p. 8.

The Science and Technology Task Force suggested two possible approaches to improve police effectiveness in apprehending suspects not identified in the preliminary investigation. The first suggestion concerned more intensive preliminary investigation at the crime scene, possibly by civilian specialists, to provide more leads to detectives. The second suggestion--for burglary cases--was the deployment of detectives in the field through the use of tactical detective squads or stake-outs in heavy burglary areas. This suggestion was based on the idea that on-scene arrests, rather than follow-up investigations, are the most effective means of apprehending burglars. The Task Force also determined that in the LAPD sample arrest probability was correlated with response time. However, the Task Force noted the need for further studies to determine whether there was a cause-and-effect relationship between these two variables or whether an intervening variable was responsible for the correlation.* Thus, this analysis of LAPD's crime reports highlighted the importance of the interface between patrol and investigation through the following major points:

1. The apprehension of criminals is primarily due to patrol rather than investigation, both through on-scene arrests and information recorded in crime reports.

2. An investigator's effectiveness in apprehending criminals is directly related to the quality of the preliminary investigation performed by patrol officers.

3. Response time may be the key to criminal apprehensions. This relationship, if valid, would have major ramifications for the deployment of both patrol officers and investigators (as well as for a police department's overall operations.)

In response to a number of needs--effective and efficient service delivery, police-community relations, and the need to improve personnel

* The Institute for Defense Analyses. Task Force Report: Science and Technology (Washington, D.C.: U.S. Government Printing Office, 1967), p. 9.

assignments--the President's Commission made the recommendation that police departments experiment with "team policing." As described in the Task Force Report, team policing would mitigate the overspecialization of the patrol and detective functions, which can have negative results:

> When intelligence is not centralized and coordinated, staff planning for the purpose of either apprehending specific criminals, or solving crime problems such as an outbreak of burglaries in some neighborhood, is almost impossible. When lines of command are kept rigidly separate, it is difficult to bring the full resources of a department to bear on crime solution. Also, considerable conflict exists in many forces between uniformed branch officers and the detective division.*

The concept of team policing, as described in the Task Force Report, is as follows:

> ...that police work, including patrol and criminal investigation, in a given number of city blocks, should be under unified command. A 'field supervisor' would have under his command a team of agents, officers, and community service officers. The team would meet at the beginning of a tour of duty and receive a briefing on the current situation in the neighborhood--what crimes were unsolved, what suspects were wanted for questioning, what kinds of stolen goods to look out for, what situations were potentially troublesome, and so forth. On this basis the members would be assigned to specific areas or duties. If conditions warranted it, agents might be assigned to patrol and wear uniforms or plainclothes. Officers might be assigned to investigation. Community service officers might be delegated to help either. In specific investigations or incidents, agents would be given authority over the actions of CSOs and officers. If the conditions in the area changed during the tour, if a major crime were committed or a major disorder erupted, the assignments would be promptly changed by the field supervisor.
>
> Obviously, this proposal does not envision the abandonment of special duties or special squads. An agent serving as a narcotics, juvenile, or community-relations specialist, for example, would almost always cover a territory policed by several teams and would be moved into other work only in emergencies. There still would be a need for squads of officers with special knowledge of certain kinds of crime.**

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* The President's Commission on Law Enforcement and Administration of Justice, p. 53.

** Ibid.

Agents would be a group of the most competent officers who would replace traditional detectives but would assume responsibility for all areas of complexity (e.g., uniformed patrol in high tension areas) and would no longer complete lesser investigative assignments that did not require special expertise. Police officers would enforce the law, as well as investigate crimes that can be solved by immediate follow-up investigations or that are likely to have suspects near the crime scene. Community Service Officers would be recruited from neighborhoods and would assist officers and agents and improve police-community relations. The teams would operate, at least partially, out of neighborhood locations, rather than out of the centralized department.* Thus, the team policing concept as originally conceived would, in effect, eliminate the interface between patrol and investigation by dividing assignments flexibly and according to skill rather than according to a rigid functional scheme. In addition, the team policing model would increase the contact and flow of information among team officers.

The Task Force Reports also dealt with another interface issue--the need for information systems that would analyze crime data and patterns, as well as provide information needed for investigation. Such information systems would allow all units to remain aware of and utilize the information generated by one unit. For example, crime data could be utilized in the deployment of personnel; the fingerprints and lists of criminal associates of specific subjects would be immediately available to investigators.**

The Task Force also advocated the use of civilians for those activities that either require an expertise not found among law enforcement

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* The President's Commission on Law Enforcement and Administration of Justice, pp. 122-124.

** Ibid, pp. 49, 57.

officers or that could be as easily performed by civilians, thus freeing sworn personnel for more important tasks.* Although this recommendation does not directly address the interface between patrol and investigation, the use of civilians has been included in a number of research designs intended to affect the interface.

The investigations into policing contained in the Task Force Reports were not conclusive. However, the Task Force Reports served as catalysts for police research in criminal investigation, the relationship between response time and apprehension rates, team policing, the use of information systems, and the use of civilians in police departments. Throughout the Task Force Reports, the need for further experimentation is emphasized; however, it is also stressed that such experimentation must be carefully controlled and monitored.

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* The President's Commission on Law Enforcement and Administration of Justice, pp. 124-125.

III THE NORMATIVE MODEL OF RESEARCH

Research is ideally based on a model of the scientific experiment--i.e., an experiment is devised which comprises an explicit set of hypotheses, experimental and control groups, careful monitoring, and a set of standards and procedures designed to ensure that the results of the experiment are conclusive. Such precise considerations are clearly impossible to achieve outside the laboratory, particularly within the dynamic setting of a police department. With this in mind, a discussion of the important components of research and the degree to which these components are incorporated into the research on the patrol/investigation interface is integral to an understanding of the research.

The discussion of the research components is divided into six sections:

1. Hypothesis selection
2. Performance measures
3. Research design
4. Conduct of the research design
5. Evaluation of the research results, and
6. Use of the research results.

By way of introduction to the studies on the interface, it should be noted that the studies that bear on the patrol/investigation interface are generally of two types: 1) studies that involve experiments and 2) operations research studies that analyze police department operations as they existed at the time of the study. The latter studies are generally reliant on surveys, case studies, and data collected by the police departments in question. An important characteristic of both of these types of studies

is that they cover a multitude of topics and often do not primarily address interface issues. Thus, in a number of studies, the findings that pertain to the interface represent contributions to the research but are not, in and of themselves, conclusive.

3.1 HYPOTHESIS SELECTION

The selection of hypotheses is fundamental to the value of research; hypotheses form the frame work of a research effort. To the extent that the researchers' hypotheses are clearly stated, the reader can identify the exact standards against which the experimental results are applied, the specific areas in which the researchers are interested and the assumptions that the researchers bring to the experiment. The reader can then determine whether the research and analysis is of interest and whether the researchers' approach is well thought out and does, in fact, address the questions and issues with which it is supposed to deal.

The research on the patrol/investigation interface is, in general, characterized by a lack of explicit hypotheses. However, the studies contain implicit hypotheses--i.e., the researchers' choice of methodologies and analyses (e.g., the performance measures employed, the comparisons drawn) indicates their approach and their expectations of the results.

The major hypotheses of the research on the interface (both explicit and implicit) are discussed subsequently in this report.

3.2 PERFORMANCE MEASURES

Perhaps the most crucial aspect of the research methodology is the researchers' choice of performance measures. Performance measures assume the importance of a "language," in that they translate to the researchers the phenomena under study. Clearly, if the performance measures chosen

do not accurately reflect the unknown quantity that the researchers are attempting to measure, the researchers will base their conclusions on totally erroneous results.

PSE's papers on patrol research and investigation research present three criteria which performance measures must meet to be considered reliable:

1. The measures should be able to gauge the desired phenomena under known conditions.

2. The measures should respond to environmental changes in a predictable fashion.

3. The measures should be based on available or collectable data.

The first criterion is that under known conditions, the performance measures should accurately reflect the phenomena under study. The second criterion is that the measures' response to factors other than the experimental program should be identifiable to explainable. The third criterion is simply that the measures must be able to be observed and recorded. If all of these conditions are met, the measures will accurately reflect the phenomena under study and, if an experiment is used, the measures will assess the impact of the experiment rather than that of extraneous variables.

In actual research, however, performance measures that meet these three criteria are difficult to attain. Due to the difficulty of developing more sophisticated measures and utilizing them within a working police environment, research efforts often rely on the performance measures traditionally used and collected by police departments. In order to mitigate the negative effects of the use of these measures, some studies contain discussions of the ways in which the police departments collect their data, as well as the limitations of the data. These explanations provide the reader with a basis from which to determine whether the measures are

sufficiently precise. Multiple measures are also employed to present a more complete picture of the subject under study and to avoid reliance on a single performance measure. The following table displays some of the topics found in the research on the patrol/investigation interface and the corresponding performance measures employed.

Performance Measures in the Research on the Patrol/Investigation Interface

Topic	Corresponding Measures
Productivity in crime prevention	Reported crime rate Victimization rate
Productivity of the investigative function	Clearance rate Arrest rate Prosecution rate Officer-hours per arrest Officer-hours per clearance Officer-hours per charge filed Officer-hours per conviction Interviews with police personnel Observation
Use of field interrogation reports in investigation	Investigator requests to review field interrogation reports Interviews with police personnel
Use of crime analysis	Arrest rate Officer-hours per arrest Officer-hours per charge filed Officer-hours per conviction Crime data submitted by officers Interviews with police personnel
Officer cooperation	Interviews with police personnel Observation
Job satisfaction	Interviews with police personnel
Development/implementation of projects	Interviews with police personnel Observation Document Review

The research on the patrol/investigation interface is characterized by a reliance on reported crime rates, arrest rates, clearance rates, interviews and observation on the part of reserachers. To a lesser extent, the research is based on prosecution data and victimization surveys. Reported crime rates, arrest rates, and clearance rates are generally criticized as unreliable measures of productivity. Reported crime rates are considered unreliable because they exclude an unknown number of crimes which are not reported to the police; it is widely accepted that, depending on the crime, this "number" can be quite large. Furthermore, the use of reported crime rates is based on the assumption that if the police are effective, reported crime rates will drop. However, effective policing can also have the reverse effect--if citizens perceive that the police are effective, they may report additional crimes and the reported crime rate will increase. Reported crime rates within a department can vary due to changes in the way that a police department collects its data or as a reflection of changes in department operations. A valid comparison of reported crime rates among a number of police departments is difficult, due to the diversity of operations and data collection procedures. A more appropriate measure of crime is the victimization survey in which a random sample of citizens is interviewed about their experiences with crime. However, this procedure is costly and time-consuming and is only rarely used in the research on the interface.

Arrest rates are also open to criticism. This is because in some jurisdictions, an arrest can be effected for investigative purposes rather than for the purpose of charging a suspect with a crime. In addition, arrest rates, per se, do not indicate the quality of an arrest--i.e., whether the arrest is legal and/or results in prosecution and/or conviction. In departments with arrest quotas, the quality of arrests is a particular

problem. As with the reported crime rate, the arrest rate within a department can vary with changes in data collection procedures or police operations. To some extent, these problems can be mitigated by the use of performance measures that take into account the outcome of an arrest; however, these performance measures are more time-consuming to use and are subject to their own peculiarities--e.g., they reflect the use of diversion programs or reasons for prosecution that are not within a department's control and should not be used to reflect on a department. However, the use of prosecution data in the research on the interface does provide the analysis with additional credibility.

Clearance rates are perhaps the most unreliable of the measures. The meaning of clearance rates varies widely among departments and is also subject to data collection and operational changes within departments. In general, clearance rates are not representative of cases that are solved; they are representative of cases that are closed. This closure may be due to any number of factors, including the suspect's disappearance, the District Attorney's refusal to prosecute, etc. Perhaps the most blatant problem with clearance rates is the use of a single arrest to clear a number of cases, based on such factors as the modus operandi of the perpetrator or on a suspect's willingness to admit guilt to a number of crimes in return for being charged with only one crime. Police departments' traditional reliance on clearances as a measure of investigators' effectiveness has served as an inducement to manipulate clearance statistics.

The research literature on the interface also relies heavily on interviews and observation on the part of the researchers. Both of these "measures" are legitimate and important aspects of research. However, in some respects interviews have been relied on in lieu of more concrete data

(e.g., in the determination of whether field interrogation reports are useful in criminal investigations). This reliance on interviews is for three reasons: first, some of the areas explored are subjective in nature or are not responsive to known quantitative indicators; second, if the topic is of secondary importance in the research, interviews may be relied upon in lieu of more in-depth quantitative analysis; third, interviews may be the researchers' main method of gathering information if the study is retroactive.

Thus, many of the performance measures used in the research on the patrol/investigation interface are suspect in their ability to reflect accurately the attributes which they are intended to measure. This suggests that the conclusions drawn by many of the studies are tentative and open for further inquiry, rather than conclusive.

3.3 RESEARCH DESIGN

The ideal research design is an experiment that utilizes an experimental group and a control group. These two groups are supposed to be identical in composition and characteristics; the only difference between the groups should be that the experimental group receives "treatment" and the control groups does not. Ideally, only one variable changes, so that any measured response can be conclusively attributed to the specific form of "treatment."

The research on the interface includes the use of control groups, primarily in the literature on team policing. However, there are two problems with the control groups used in this research. The first problem is contamination, which is discussed in the next section. The second problem is the composition of the experimental group. In a number of the team policing studies, the experimental group is composed of volunteers, and the

control group is not. Clearly, volunteers are inclined to be more enthusiastic than officers who are randomly assigned to a specific duty; this enthusiasm may affect the outcome of the experiment. Furthermore, the team leaders may not have been chosen randomly. Other examples of dissimilarity between the experimental group and the control group are evident in the research.

The research also includes a number of studies that do not utilize control groups. Some of these studies are retroactive in that researchers analyze past data or events, and there is no way to develop a legitimate control group for that period. Or, the researchers may be present throughout the experiment, but as the experiment encompasses the entire police department, the use of a control or comparison group is automatically eliminated. In some studies a comparison group is used which is not as precisely regulated as a control group. Studies that do not include a control group or a comparison group may rely on before-and-after comparisons of the experimental group, projected performance models, surveys, and case studies.

Another problem with the research is that the experiments include changes in a multitude of variables. This is particularly true in team policing, where the modifications of traditional policing may include such factors as increased responsibility for handling investigations, participation in decision-making, increased contact with the community, increased overtime compensation, etc. The number of variables altered and the dramatic nature of the alterations make it difficult to determine which of them are vital to the success of the experiment or responsible for its failure.

3.4 CONDUCT OF THE RESEARCH DESIGN

Once the research design has been implemented, it is imperative that the experiment or other forms of research be continuously monitored to make sure that the research retains its integrity. For example, it is important to make sure that the "treatment" received by the experimental group occurs as planned and that the control group's operations are not affected by the experimental group; it is also important to monitor data collection procedures to make sure that they have not varied over time. Research that is retroactive in nature involves a strenuous effort on the part of researchers, who must identify past events (e.g. changes in arrest policy) that might have altered the data base.

The research on the interface is comprised of studies that have been carefully monitored by the researchers. Despite the researchers' efforts, however, the contamination of both the experimental and control groups has been a recurring problem, particularly in team policing experiments. In some cases, the plans for the experimental group have been drastically altered by police management in the middle of the experiment; in addition, the control group cannot help but be aware of the team policing experiment and may become resentful of the extra attention paid to the experimental group. Furthermore, unless the evaluation period is a fairly lengthy one, the "Hawthorne effect" may apply--i.e., the experimental group may become increasingly productive, not because of the "treatment," but because of the extra attention paid to the group and its members. If the research period does not include a time period sufficient to mitigate the possibility of the "Hawthorne effect," there can be a significant problem in determining the extent to which the measured results are due to the "treatment."

Flexibility--including the ability to respond to problems and institute necessary solutions--while desirable in a program, can also create problems

for research. Flexibility can make the difference between an effective program and an ineffective one. However, in terms of research, it represents a deviation that interferes with the experimental design. This may be a particular problem with team policing experiments which are essentially based on the goal of enhanced flexibility.

3.5 EVALUATION OF THE RESEARCH RESULTS

The extent to which the evaluation of the research results is conclusive is dependent on all of the factors described thus far--the use of explicit hypotheses, the reliability of performance measures, the extent to which the research design is controlled, and the extent to which the research design is followed.

In the classical model of experimentation, data from the control and experimental groups is gathered prior to the experiment and throughout the experiment. The measured changes in the two groups are compared and the changes in the control group, which are considered to be the changes that occurred extraneously to the experiment, are taken into consideration in the analysis of the experimental group's changes. The standard means of evaluating the results of an experiment is to use statistical procedures to determine whether measured differences in the two groups are due to chance or to the experimental treatment.

Some of the research on the interface includes this type of statistical evaluation analysis. However, researchers have been somewhat hampered by the lack of baseline data. In these cases, no pre-project comparisons are possible. As described previously, in research where no control or comparison group is available, other methods of analysis (e.g., before and after data for one group, projected models, surveys, case studies) may be employed.

3.6 USE OF THE RESEARCH RESULTS

Research may be done for its own sake, in order to understand various phenomena, with no further application of the findings. Research may also be undertaken with the intention of applying the results to a particular agency or institution in the hope of improving its operation in some way. Although this paper is geared towards an academic approach to the research on the interface, it is worthwhile to discuss briefly the potential implementation of the research results.

In general, the use of the results in the research on the interface is hampered by the inability to generalize among police departments. Most experiments are specific to the police departments in which they are based. The number of variables modified in the course of an experiment makes it difficult to relate to other departments the specific variables which are most important. However, the number of factors modified in the experiments is secondary to another limiting factor that is evident throughout the literature, namely, the personality variable of both the participants in the experiments and the non-participant police personnel. The attidudes and personal interests that all these individuals bring into the experimental arena have tremendous ramifications for the outcome of the research and the fact that it cannot easily be generalized for use by other departments. Thus, there is no experiment that defines what team policing per se can and cannot accomplish. There are as many definitions of team policing as there are team policing programs. In consequence. research results are not easily replicated and general findings cutting across a number of studies are difficult to discern.

In addition to the considerations stated above, some studies have noted that the political nature of decision-making in a police department keeps

research results from being a prime consideration in implementation decisions. To the extent that this is true, research will continue to be confined within the boundaries defined for it.

IV A SYNTHESIS OF THE RESEARCH

This section of the report is divided into two components: 1) a synthesis of the hypotheses contained in the research and an assessment of the conclusiveness of the research findings, and 2) a discussion of the findings and issues stemming from the research.

As noted previously, most of the research does not contain explicit hypotheses by which study findings can be examined. Rather, research hypotheses are implicit in the selection of performance measures and subsequent analyses. In seeking to review the studies' results by hypothesis, the lack of explicit hypotheses presents a problem, further compounded by a body of research not organized for a synthesis of interface areas. Many studies dealing with the interface are fairly limited in scope--i.e., interface issues per se account for a relatively small portion of larger studies in which interface issues emerge as by-products or tangential issues. Findings on the interface must be gleaned from a number of studies which, when viewed in their entirety, do not present an in-depth and cohesive whole. Particularly in the team policing studies, so many variables are altered in such significant ways that it is virtually impossible to conclusively attribute research findings to interface issues. Thus, hypotheses and analyses in this section suffer from quite a few inherent constraints.

To present the following discussion in an integrated and useful manner, hypotheses have been extrapolated from the research, according to our approach to the topic and sense of the research field. Thus, the hypotheses offered for analysis are not necessarily the chief hypotheses of the research;

the hypotheses represent our attempt to coordinate relevant study findings in a manner that allows the reader to grasp issues that cut across a number of research efforts.

In order to assess the research on the interface between patrol and investigation, twenty-two studies were reviewed. The studies are representative of the scope of the issues embodied by the interface research as a whole. The studies are individually discussed in the Annotated Bibliographies section of this report. Throughout the remainder of this report, the studies are referred to by the authors' surnames.

4.1 HYPOTHESES

The hypotheses on the interface between patrol and investigation comprise the following categories:

1. Hypotheses which test the validity of the traditional (and most common) measures used to evaluate police performance.
2. Hypotheses which test the validity of traditional assumptions regarding case solution.
3. Hypotheses which test the merit of the patrol officer-investigator model.
4. Hypotheses which test the merit of the partial decentralization of the investigative function.
5. Hypotheses which test the value of crime data analysis.
6. Hypotheses which test the value of case screening and decision models.

The hypotheses are discussed only in reference to the interface on patrol and investigation. Each group of hypotheses is presented with a brief discussion of the ways in which the hypotheses relate to the interface. The first two groups of hypotheses focus on assumptions inherent to traditional policing. The other four groups of hypotheses address major policing innovations proposed in the last decade. Although team policing and split-force patrol projects are not specifically mentioned

in the hypotheses listed above, a discussion of these projects is included wherever appropriate; the vast number of definitions of "team policing" and "split-force patrol" preclude the adoption of hypotheses based on these generic terms.

4.2 RESEARCH FINDINGS

1. HYPOTHESES WHICH TEST THE VALIDITY OF THE TRADITIONAL (AND MOST COMMON) MEASURES USED TO EVALUATE POLICE PERFORMANCE.

Police performance and productivity have historically been evaluated by a standard set of measures--crime rates, clearances and arrests. These measures have been used both for internal review and in studies conducted by outsiders. While the use of these measures is not an interface issue per se, their predominance throughout the literature necessitates their review. Clearly, the extent to which these indicators are valid interpreters of police performance affects the validity of the research on the interface.

Hypothesis: *Crime rates are reliable measures of police performance.*

The assumption that a police department can reduce crime underlies much of the research on the interface. Bloch and Bell stated that crime reduction is an important goal of the criminal justice system; many other researchers implicitly agreed by utilizing crime data as indicators of police performance.

The difference between reported crime and real crime is an important distinction in the literature. That reported crime rates vastly undercount the rate of real crime was noted by Elliott (in his work with Sardino); Bloch and Bell; Sherman, Milton and Kelly; and Schwartz and Clarren. Schwartz and Clarren deomonstrated that numerical changes in crime records can result from changes in reporting procedures or police operations, as well as changes in real crime; Bloch and Bell suggested that many factors, including socio-economic conditions, are involved in the crime rate and that a change in crime cannot conclusively be correlated with a change in the criminal justice

system. Schwartz and Clarren and Sherman, Milton and Kelly further noted that a reduction in real crime can be camouflaged by increased citizen reporting. Elliott, however, took the argument a step further to suggest that the quality of a police department has no affect on reported crime.

These problems with reported crime have led some researchers to rely on victimization surveys in an attempt to acquire real crime rates. Sherman, Milton and Kelly noted that the use of victimization surveys is the only reliable (albeit expensive) way to measure real crime. However, Schwartz and Clarren, who used victimization surveys in their study, concluded that such surveys reflect not only crime but the citizens' own interpretations of crime, as well as their levels of awareness and personal concerns. Schwartz and Clarren noted that definitions of crimes found in the FBI's Uniform Crime Reports allow for a wide variation of opinion--on the part of citizens as well as police officers--concerning the application of crime definitions to incidents.

Hypothesis: Clearance rates are reliable measures of police performance.

A number of research efforts have assessed the reliability of clearance rates, both in general and in reference to their use in specific departments. Greenberg, Yu and Lang provided a comprehensive analysis of the use of clearances, based on a review of burglary investigations in six California police departments. They reported that although a case clearance rate is defined as "...a ratio of the cases claimed to be solved to the crimes reported to the police" (Volume I, Page 44), policy differences result in numerous interpretations across departments. One identified practice resulting in inflated clearance statistics is the use of multiple clearances per arrest; this practice is based not only on tenuous inferences regarding a single offender's connection to a number of crimes (e.g., on the basis

of similar modus operandi) but often on "bargains" drawn with offenders whereby they are encouraged to confess to a number of crimes in return for lessened presecution. The analysis by Greenberg, Yu and Lang focused on the fact that "...each agency has a different policy in making burglary clearances and, consequently, is reporting on a different set of statistics." (Volume I, Page 48). The authors reported that "...the distinction between cases 'cleared by arrests' and 'cleared other' does not represent in all the departments surveyed a separation between cases in which there was sufficient evidence to move the case forward in the courts and those in which the perpetrator could not be prosecuted. A better measure of effectiveness for investigations obviously is needed." (Volume I, Page 47). Other areas in which clearance rates differ among departments were also cited by the researchers.

In their study of the Oakland Police Department's Criminal Investigation Division, Datz, Morris, Tendler and Kalmanoff noted that clearances by arrest and prosecution received no more weight than other clearances and thus gave investigators incentive to perform such questionable practices as presenting poor cases to the District Attorney's Office in order to clear cases as "complaint refused by D.A." or dissuading citizens from prosecuting their cases in order to clear cases as "complainant refuses to prosecute." The authors concluded that "...the clearance rate gives an extremely distorted picture of investigative effectiveness...." (Page 15) and that "...the clearance rate as an effectiveness measure was useless..." (Page 17).

Greenwood, Chaiken and Petersilia called attention to the administrative manipulation of clearance rates and investigators' attempts to classify crimes as unfounded in order to clear them. The researchers stressed that clearances are particularly unreliable as measures of investigators'

effectiveness because the vast majority of clearances stem either from patrol, the identification of the suspect at the crime scene or routine police procedures. The authors concluded that "...any attempt to compare effectiveness among departments using clearance rates is evidently meaningless. Even comparisons over time within a single department are unrealiable unless steps are taken to assure that no change occurs in administrative practices concerning clearances and classification of crimes." (Page 226).

Bloch and Ulberg, in their analysis of clearance statistics of the Rochester Police Department, investigated various ways in which the statistics might have been inaccurate representations of improved police performance. The analysis was undertaken precisely because of the widely recognized unreliability of clearance data. However, in this instance the authors determined that the clearance statistics did reflect improved performance on the part of the Rochester Police Department.

Hypothesis: *Arrest rates are reliable measures of police performance.*

The reliability of arrest rates as measures has received significantly less attention than clearance and crime rates. However, Datz, Morris, Tendler and Kalmanoff viewed arrests resulting in prosecution as a sufficiently reliable measure to recommend that it replace clearances as an objective and performance measure for the Oakland Police Department's Criminal Investigation Division. It was thought by the authors that the implementation of this recommendation would resolve a number of operational problems in that division.

However, arrest rates alone (without the additional criterion of prosecution) are criticized by Greenwood, Chaiken and Petersilia because arrests may be made for investigative purposes and do not necessarily indicate criminal apprehension. In addition, the authors noted that arrest rates are

unreliable as measures of investigators' effectiveness due to the predominance of patrol and witness involvement in departmental arrest statistics.

Analysis

The literature on the interface conclusively demonstrates that two of the traditional measures used to evaluate police performance--reported crime rates and clearance rates--are unreliable and misleading, particularly when used for comparison purposes among departments. Arrest rates, while also open to criticism, appear to be more valid. However, both arrest rates and clearance rates have been criticized as inadequately reflecting investigators' productivity. Victimization surveys and arrests resulting in prosecutions are two recommended modifications that would substantially increase the utility of crime and arrest statistics; however, these measures are also subject to certain difficulties.

2. HYPOTHESES WHICH TEST THE VALIDITY OF TRADITIONAL ASSUMPTIONS REGARDING CASE SOLUTIONS.

Traditional assumptions about case solution have played a large role in police executives's choice of organizational form and operations. Ideas about the manner in which cases are solved determine such factors as the type of personnel who work on cases (e.g., patrol officers or specialized investigators) and the emphasis placed on different types of operations (e.g., crime interception or follow-up investigation). These traditional assumptions, therefore, have a direct bearing on the interface in terms of the junction of responsibioity between patrol officers and investigators, as well as the degree of information exchange that occurs between the two groups.

Hypothesis: Crimes are generally solved by investigators.

In their study of the Oakland Police Department's Criminal Investigation Division, Datz, Morris, Tendler and Kalmanoff revealed that burglary, robbery and auto theft cases were solved almost exclusively by patrol. These findings were corroborated by Greenberg, Elliott, Kraft and Procter in their study of four felony crimes (robbery, auto theft, rape, and assault with a

deadly weapon) handled by the Oakland Police Department; the authors determined that patrol was responsible for a larger percentage of cases cleared by arrest than were investigators.

In their national study, Greenwood, Chaiken and Petersilia reported that about 30 percent of all clearances were on-scene arrests made by patrol; in an additional 50 percent of clearances, the offender was identified in the crime report; most of the remaining 20 percent of cleared cases were solved by patrol, the public or routine police practices. On the basis of data from the Kansas City Police Department, the authors concluded that only 2.7 percent of clearances were due to special techniques on the part of investigators and that 97 percent of cleared crimes could be cleared as long as obvious routine steps were pursued. Greenberg, Elliott, Kraft and Procter agreed that the four felonies studied essentially solved themselves through the use of routine procedures. Greenwood, Chaiken and Petersilia pointed out, however, that in the crimes of homicide, robbery and commercial theft, investigation could significantly affect the clearance rate.

Greenberg, Elliott, Kraft and Procter noted that in reference to robbery, the information necessary to case solution had to be obtained at the crime scene; if not, and the offender had not been apprehended at that time, case solution was unlikely to occur at the detective level. In both of the case decision models developed by Greenberg, Yu and Lang, and Greenberg, Elliott, Kraft and Procter, the most useful information for case clearance was provided by a witness who had viewed the crime or by a victim involved in the crime. In three of the four felonies studied (robbery, burglary and assault with a deadly weapon), clearances by arrest were generally made within eight hours. Datz, Morris, Tendler and Kalmanoff similarly concluded that the probability of case solution did not increase with the amount of

investigative time expended. The authors suggested that investigators rarely identified suspects, witnesses or physical evidence not already found in the initial crime report. In the majority of crimes, the suspect was apprehended at or near the crime scene within eight hours of the crime; if the suspect had not been arrested or at least identified on the day of the crime, the probability of apprehension was very low. Exceptions to this finding were identified as homicide, assault and other crimes against persons where no property was taken.

The obvious question stemming from these findings is how the investigators spent their time. Datz, Morris, Tendler and Kalmanoff showed that investigators interrogated suspects already in custody, contacted witnesses and prepared cases for prosecution. Greenwood, Chaiken and Petersilia noted that 93 percent of investigators' time was spent on activities that did not result in the solution of reported crimes--e.g., reviewing reports, documenting files and attempting to locate and interview victims.

An important conclusion drawn by Greenberg, Elliott, Kraft and Procter was that, due to the importance of the information gathered by patrol at the crime scene and investigators' reliance on that information, patrol and investigation were not discrete functions.

Another interesting point raised by Datz, Morris, Tender and Kalmanoff was that the time lag between the time of the crime and the time when the follow-up investigation began limited the value of the investigation. This conclusion was the basis for the authors' recommendations that patrol's response time be decreased and/or that investigators be deployed in the field for immediate response.

On the basis of their findings, Greenwood, Chaiken and Petersilia recommended that generalist patrol officer-investigators handle the routine investigative tasks now managed by specialized investigators while a small

group of experienced investigators handle major unsolved crimes. This recommendation would result in a significant reduction in investigative personnel.

Hypothesis: *The collection of large quantities of information at the crime scene is important to case solution.*

As part of their study of four felony crimes in the Oakland Police Department, Greenberg, Elliott, Kraft and Procter developed a case decision model for robbery investigation. The authors determined that only a small number of investigative elements of information proved useful in crime solution. Such elements as physical descriptors were rejected as non-essential elements of information. In part on the basis of this finding, the authors concluded "...that collection of unlimited numbers of information elements for computer processing is not a panacea for crime solution." (Page xxxi). Some of the important information elements contained in the robbery case decision model further reflected preliminary routine investigative procedures rather than crime scene information. Although not explicitly stated in their report, the burglary case decision model developed for the Oakland Police Department by Greenberg, Yu and Lang also contained only a small number of information elements determined to be important to case solution.

Hypothesis: *Patrol-generated field interrogations are important to case solution.*

Morris, in his report on field interrogation reports in the Oakland Police Department noted that investigative personnel valued field contact reports but were only able to identify a few instances where the reports had played an important role in case solution. On the baiss of interviews with investigators, Morris determined that about 10 percent of field contact reports were pertinent to cases worked on by investigators, and that only

1 percent of the reports provided information vital to case solution. On a case basis, field contact reports produced important information in 2-5 percent of cases and vital information in less than 2 percent of cases. Morris also determined that field contact reports which stemmed from investigators' requests for specific information were most useful. The author's conclusion was that the usefulness of the field contact reports was limited by operational problems and a lack of department policy regarding field contacts. On the basis of his analysis, Morris recommended that field contacts be based on information about crimes, suspects and crime patterns, as well as on requests by investigators for specific information. In addition to a host of other recommendations, Morris also suggested that feedback on the usefulness of the field contact report be communicated from investigators to patrol.

Boydstun's analysis of field interrogation reports in San Diego produced findings similar to those of Morris' Oakland study. The majority of investigators interviewed thought that field interrogation reports were useful in case investigations; 37 percent of the investogators attributed one or more case clearances during the preceding six months directly to field interrogation reports. A review of three months of forms used by investigators to request that field interrogations be conducted as part of specific investigations revealed that, at best, three case solutions and arrests were direct results of the field interrogation reports. In addition, several investigators noted that the requested field interrogations had contributed, to a small degree, to case clearances. Only 15.5 percent of the field interrogation reports had been examined by investigators; Boydstun identified operational problems (e.g., the manual filing system) as an obstacle to the use of field interrogation reports by investigators.

Analysis

The studies that bear on the three traditionally-accepted hypotheses listed above have generally demonstrated that assumptions about the way cases are solved may be without basis.

The studies discussed refute the notion that crimes are generally solved by investigators. However, two of these studies were focused primarily on the same or similar crime categories within the same police department. The findings of these two studies are, nevertheless, corroborated by Greenwood, Chaiken and Petersilia in their analysis of other police departments in the country. It should be noted that two of the studies listed crimes that are responsive to investigative efforts; these lists, however, are contradictory in reference to the question of whether property is taken during the course of the crime. Other problems found in these studies are a reliance on clearances as a measure of police performance (with the exception of the study by Datz, Morris, Tendler and Kalmanoff); and Datz', Morris', Tendler's and Kalmanoff's reliance on data samples which may be too small to adequately represent investigative performance.

The conclusiveness of the finding that only a limited amount of information is important to case solution is itself limited by the small number of studies cited. These studies also rely on clearance measures. It is important to note that the studies only represent police operations and policies as practiced at the time of the study. Thus, the studies' findings may not be valid for other departments. Furthermore, information not routinely gathered by police officers was probably too statistically insignificant to be accurately tested in the experiment.

The two studies on field interrogation reports are mutually supportive in their finding that the reports play a limited role in case solution. However, these studies are both flawed by the reliance on investigators'

memories rather than on the tracking of either cases or field interrogation reports. In addition, both departments' use of field interrogation reports was hampered by operational problems. Thus, there is no assessment of the value of field interrogation reports to investigation where operational problems in use have been eliminated.

3. HYPOTHESES WHICH TEST THE MERIT OF THE PATROL OFFICER-INVESTIGATOR MODEL.*

Since the Task Force Reports were released, a number of police departments have experimented with increasing the investigative responsibilities of patrol. In most departments, patrol officers perform only a cursory preliminary investigation with a more in-depth follow-up investigation conducted by detectives. However, in an increasing number of departments, patrol is responsible for the entire investigation, perhaps with the exception of certain crimes or unusually complicated cases. Added investigative responsibility for patrol is an integral component of some manifestations of team policing and split-force patrol. As patrol assumes more of the investigative responsibility traditionally assigned to detectives, the patrol/investigation interface shifts. This shift in the interface may affect not only department productivity but the two groups' relationship to each other and feelings about their own jobs.

Hypothesis: *Investigation handled by patrol reduces crime.*

A number of studies in which patrol officers were given investigative responsibility reported subsequent reductions in crime. Schwartz and Clarren, in their study of team policing in Cincinnati, reported that during the first eighteen months of the project, burglaries declined in the team district while they rose in the rest of the city; during the final twelve months of the study, the burglary rate rose but remained lower than the level prior to the implementation of team policing. No significant changes were reported in other Part I crimes. The victimization survey showed a reduction

* It should be noted that the studies reviewed under this hypothesis are ones in which patrol was given investigative responsibility. However, in some of these studies, the patrol officers did not adopt as much investigative responsibility as had been anticipated.

in burglaries and robberies of neighborhood businesses during the first eighteen months of the team policing project and a return to pre-project levels during the project's last twelve months. Watkins' and Hanseman's report on the Cincinnati project indicated that during the first twelve months of the project, reported index offenses declined 7.5 percent in the team district while the rest of the city showed a 5.5 percent crime increase. During this period, burglary and auto theft declined in the team district while burglary rose and auto theft stayed at the same level in the remainder of the city. The authors suggested that, although team policing could have been responsible for the reduction in reported burglaries, an additional factor might have been a population decline in the team district.

Elliott and Sardino reported that in Syrcause the Crime Control Team beat was superior to the majority of other beats in the city in terms of both the reduction of all crimes and the reduction of Part I crimes. O'Malley, in her study of team policing in Holyoke, noted that the team area showed a 31 percent decrease in the Part I crime rate at a time when the city's Part I crime rate showed a slight increase; this decrease in reported crime was measured in spite of increased calls-for-service in the team area.

In contrast to the above findings, Bloch and Specht noted that few team policing projects had an impact on reported crime; furthermore, the authors suggested that reported crime may actually increase as a result of team policing's emphasis on improving citizen coopration. However, the authors also identified St. Petersburg--a city with a team policing project that employed a patrol-investigator model--as one jurisdiction that had experienced improved crime rates.

Tien, Simon and Larson noted a significant decrease in reported crime (a decrease of 6.1 percent in Part I crimes and 9.0 percent in Part II

crimes) during Wilmington's experiment with the split-force patrol concept; the authors suggested that this decrease could be partially attributed to the experiment.

Hypothesis: *Investigation handled by patrol increases arrest-related productivity.*

Schwartz and Clarren reported that a comparison of investigations performed in Cincinnati within three different organizational frameworks (investigations handled by team personnel; investigations handled by a special unit of investigators within a single district; investigations handled by specialized units of the Centralized Investigative Section) showed that the team approach resulted in a higher clearance by arrest rate than either of the other two approaches. This result was attributed to arrests made on the day of the crime. The fully decentralized model also produced a higher overall clearance rate than the other models. However, in terms of the investigative function alone, both of the more centralized models demonstrated higher overall clearance rates for cases requiring investigative followup than did the team approach.

O'Malley reported that team officers in Holyoke were considered comparable to detectives in general investigative performance. The two teams' Part I clearance rates (49 percent and 53 percent) were substantially better than the Part I clearance rate nationwide (20 percent).

Elliott and Sardino noted that Syracuse's Crime Control Team beat was superior to the majority of beats in the city for all measures employed in the survey. Although the Crime Control Team beat's performance was surpassed by other beats in individual measures, it was never surpassed in all three measures (the reduction of all crimes, the reduction of Part I crimes, and clearances). The authors noted, however, that these results may not necessarily have been due to the organizational structure of the project

but may also have been due to such factors as superior officers, the Hawthorne effect, etc. The authors also suggested that the team's proven investigative ability contradicts police departments' traditional reliance on a separate group of detectives. It was noted, however, that the team officers did not make as many crime interceptions as expected.

Cordrey's and Pence's report on team policing in Dayton included the following results: the team district handled more calls on the average than other districts in the city in spite of the team district's investigative responsibilities and smaller percentage of the department's manpower; clearance rates in the team district remained unchanged from the pre-team level; the recovery of stolen property was approximately one-half of that prior to the experiment; the pattern of apprehension time was mixed in comparison to the period prior to the experiment; and the team displayed a similar level of successful prosecutions in comparison to the whole department prior to the experiment.

Tien, Simon and Larson's study of split-force patrol in Wilmington recorded an increase in patrol's arrest-related productivity, primarily due to immediate investigation by the Structured Patrol officers. The authors suggested that the increase in patrol arrests (an increase of 4 percent per officer, per month) did not appear to have compromised the quality of the arrests. During the experiment, patrol reported a 105.5 percent increase in Part I clearances. However, patrol's improvement was identified as having been partially at detectives' expense; detectives experience a substantial decrease in clearances, resulting in an overall department decrease of 28.0 percent in Part I clearances.

In direct contrast to most of these findings, Greenwood, Chaiken and Petersilia pointed out that arrest and clearance statistics did not vary among departments as a result of differences in the organizational structure

of the investigative function. However, the authors did comment that police departments employing a patrol-investigator model had lower clearance rates but not lower arrest rates than other departments; the authors suggested that since patrol officers do not carry files with them, they do not attempt to clear previous cases with new arrests. Greenberg, Yu and Lang reported that "the nature and level of burglary clearances" (Volume I, Page 43) can be affected by differences in patrol's role.

Hypothesis: *Investigation handled by patrol increases the exchange of information between patrol officers and investigators.**

In their ideal model of team policing, Bloch and Specht recommended that detectives be assigned to teams; as part of their responsibilities, the detectives would train patrol in investigation and, in conjunction with patrol, develop informants and contacts. A review of existing projects convinced the authors that such exchanges of information did occur and that, as a result, patrol's investigative work had improved. Sherman, Milton and Kelly also suggested that departments that adopted the patrol-investigator model encouraged maximum interaction among team members.

The studies on team policing suggest that the relationship between patrol officers on teams who handle investigation and investigators in the rest of the department is very poor. Conflict between generalist team members and the rest of the department was reported by Schwartz and Clarren; Elliott and Sardino; Angell, Galvin and O'Neill; and O'Malley. Schwartz and Clarren and Elliott and Sardino specifically mentioned centralized investigators as a group with whom patrol-investigator team members either had conflict or, at best, shared little cooperation. Watkins and Hanseman,

* Although there is a great deal written on information exchange among team policing members, it is only included where relevant to this specific hypothesis (i.e., if both patrol officers and investigators are involved and patrol handles investigations).

however, reported that the Cincinnati team members (on whom Schwartz and Clarren also reported) experienced an improvement in their relationship with the centralized specialized units.

Tien, Simon and Larson also reported animosity between patrol officers handling investigations and the department's detectives. This animosity interfered with the handling of arrests and general productivity of the detectives, as discussed under the previous hypothesis.

Hypothesis: *Investigations handled by patrol increase officers' job satisfaction/morale.*

O'Malley reported that Holyoke's team officers experienced higher morale and more job satisfaction than other department members; the freedom to handle an entire investigation was identified as one of the factors contributing to increased job satisfaction. Schwartz and Clarren reported that Cincinnati's team officers enjoyed an increase in job breadth, influence over decisions and independence. Although job satisfaction rose initially, it decreased by eighteen months into the project; the expansion of job breadth similarly declined by eighteen to thirty months into the project. On the basis of an examination of an expansion of team policing in Cincinnati, the authors concluded: "The implementation of a team policing program does not automatically result in positive attitudes and satisfaction concerning work." (Page 63). The authors discovered that, whereas some officers experienced greater job satisfaction at the initiation of team policing, others did not. Both the officers' personal characteristics and the implementation process were identified as factors bearing on job satisfaction.

Tien, Simon and Larson noted that the Wilmington officers who comprised the Structured Force experienced job satisfaction. However, the morale of the department overall declined during the project, in part due to the experiment and in part due to other problems.

Analysis

On the surface, the studies suggest that use of the patrol-investigator model can reduce crimes as long as the model remains intact (a problem in Cincinnati and Holyoke). Although Bloch and Specht noted that few team policing studies had shown reduced crime rates, most of the studies cited were written after Bloch's and Specht's analysis. In spite of the fairly consistent findings, however, there are a number of problems, the most significant of which is that the findings cannot be conclusively attributed to adoption of the patrol-investigator model when so many other changes are made in the course of the experiments. A second limitation is the studies' reliance on reported crime rates as measures (with the exception of Schwartz' and Clarren's victimization survey). It should be noted that some of the authors themselves offered alternative explanations of the results and/or criticisms of crime rates as measures.

Although a number of the studies reported that team personnel performed better than the remainder of their departments, the findings cannot be conclusively linked to the patrol-investigator model. (This conclusion is supported by Greenwood's, Chaiken's and Petersilia's contention that arrest and clearance rates do not reflect changes in investigative organization.) Problems apparent in many of the studies include poor performance measures, the lack of an appropriate control or comparison group, the non-random assignment of personnel to the experiment and significant alterations during the conduct of the experiment.

Although Schwartz and Clarren reported that team officers had better clearance by arrest and overall clearance rates than other investigative models, the teams were less successful in case clearance resulting from investigative follow-up; as the first two measures may predominantly reflect patrol activities (as suggested by Greenwood, Chaiken and Petersilia), the

tracking of follow-up investigations is the only measure that looks at investigation per se. However, with the exception of one of Cordrey's and Pence's measures (i.e., the recovery of stolen property), the investigative function per se is not quantitatively measured by any of the other studies. Although these two studies (and two measures) alone cannot conclusively determine the investigative productivity of the patrol-investigator model, it is important to note that most of the research does not take into consideration whether measures adequately reflect the investigative function.

The research also suggests that the patrol-investigator model causes dissension between patrol and detectives. Although the conflict may be due to patrol's role (this seems to have been the problem in the Wilmington split-force patrol project), it may also be due to such other factors as increased publicity for team personnel or simply a reaction to any change in traditional policing. It does seem to be clear, however, than an increased investigative role for patrol can increase patrol's morale and job satisfaction at the same time that it may decrease morale elsewhere in the department. It should be noted, however, that sustained job satisfaction appears to be dependent upon the patrol-investigator role remaining intact.

4. HYPOTHESES WHICH TEST THE MERIT OF THE PARTIAL DECENTRALIZATION OF THE INVESTIGATIVE FUNCTION.

A number of police departments employ decentralized investigators rather than turning total investigative responsibility over to patrol officers. This decentralization often brings patrol officers and investigators into closer working proximity. Increased contact beteen patrol officers and investigators may affect both police productivity as well as the interface itself (e.g., the information exchange between patrol officers and investigators).

Hypothesis: *The partial decentralization of the investigative function reduces crime.*

Bloch and Specht reported that few team policing projects had shown

an impact on reported crime and suggested that improved citizen cooperation--another goal of team policing--may actually cause an increase in reported crime. However, one of the projects reported by Bloch and Specht to have reduced crime (Venice, California) had a team with detective members.

Bloch and Bell noted that in the Rochester team policing experiment, where detectives were assigned to teams with patrol officers, the crime rate trends for burglary, robbery and larceny decreased in team areas while they increased in non-team areas. Furthermore, officers in team units as well as non-team units indicated that they thought teams were more effective in crime fighting. The city of Rochester as a whole showed crime trends similar to those of other cities.

In their study of the Worcester Crime Impact Program, Tien, Larson, *et al*, identified the following crime rate trends in the Impact area as compared to the remainder of the city: a slight decrease in total reported crime as compared to a slight increase in the remainder of the city and the city as a whole; a significant decrease in robbery as compared to a slight increase in the non-Impact areas and a slight decrease in the city as a whole; and a significant decrease in burglary as compared to smaller decreases in the remainder of the city and the city as a whole. No significant indication of crime displacement to other cities was noted. The authors concluded that the project had achieved its goals of reducing robbery and burglary, in part due to the flexibility and organization resulting from decentralization.

Hypothesis: *The partial decentralization of the investigative function increases arrest-related productivity.*

In their study of the Cincinnati team policing experiment, Schwartz and Clarren reported that the team generalist approach was superior to the

partial decentralization of investigators, both in clearances by arrest and in the overall clearance rate. However, the partial decentralization of investigators resulted in higher overall clearance rates for cases requiring investigative follow-up than did the team generalist approach.

Bloch and Specht suggested that the assignment of both detectives and patrol to teams had improved the quality of the investigative work done by patrol. The authors also reported that some team policing projects had shown an increase in the percentage of arrests resulting in prosecution. These projects included Detroit and Venice which had detectives assigned to the teams.

On the basis of their findings in Rochester, Bloch and Bell concluded that clearance and arrest rates can be improved through the assignment of detectives to work as members of police teams. The team units were found to be more successful than non-team units in terms of the percentage of cases in which arrests were made, the percentage of cleared cases, the percentage of larceny and robbery cases resulting in on-scene arrests and the percentage of burglary and robbery cases resulting in arrests due to follow-up investigations. The team units' larger percentage of larceny and robbery cases resulting in on-scene arrests was in part attributed to one aspect of the partial decentralization of investigators--more frequent response by investigators to crimes in progress. The team units' larger percentage of arrests as a result of follow-up investigation in robbery and burglary cases was in part due to a possible ramification of the partial decentralization of the investigative function--a more effective use of information collected by patrol. No significant difference was found between team and non-team units in terms of on-scene burglary arrests and largency arrests resulting from follow-up investigations. Similarly, the percentage of cases prosecuted in which the arrests resulted from follow-up investigations was

similar for the team and non-team units. The non-team units were found to be more superior than the team units in terms of the percentage of on-scene burglary, robbery and larceny arrests resulting in prosecution.

In contrast to the findings cited above, Greenwood, Chaiken and Petersilia found that arrest and clearance statistics did not vary among departments as a result of investigative organization.

Hypothesis: *The partial decentralization of the investigative function increases the exchange of information between patrol officers and investigators.*

Bloch and Specht suggested that information exchange between patrol officers and investigators is furthered by the assignment of detectives as team personnel. Bloch and Bell reported that patrol/detective teams experienced a higher degree of cooperation between patrol and investigators than did non-team personnel. Both team and non-team personnel noted that the teams were more effective in resolving the morale problems between investigators and patrol officers. The authors also concluded that preliminary investigation reports (a vital type of information exchange) completed by team personnel contained no more information than those completed by non-team personnel. Sherman's, Milton's and Kelly's study of various team policing projects indicated that some teams with detectives as members experienced excellent communication among team members whereas teams of similar composition displayed a lack of communication.

In their study of the Worcester Crime Impact Program, Tien, Larson, *et al* reported that patrol officers and detectives in the Impact Sector shared more information than patrol officers and detectives outside of the Impact Sector. This increase in communication was seen as one benefit of taking detectives from patrol and housing patrol and detectives together.

Datz, Morris, Tendler and Kalmanoff reported on preliminary attempts to implement their recommendation to deploy investigators in the field. The authors describe conflict between investigators and patrol officers, due in part to confusion over areas of responsibility and jurisdiction.

Hypothesis: *The partial decentralization of the investigative function increases job satisfaction/morale.*

Schwartz and Clarren reported that in Cincinnati's comparison of the three modes of investigation described previously, investigators indicated a preference for the partially decentralized approach to investigation over the team approach or the totally centralized approach. The investigators noted that they preferred decentralized investigation in conjunction with patrol teams and a centralized coordinated agency for information dissemination.

Tien, Larson, *et al* reported that in Worcester, partially decentralized investigators displayed more job satisfaction and morale than the investigators in the remainder of the department. This satisfaction was due in part to the opportunity to become detectives directly from patrol.

Analysis

The conclusiveness of the study results in this section is again limited by the performance measures used and an inability to conclusively link the study findings with the partial decentralization of the investigative function. This is particularly a problem in reference to the findings on crime reduction. Other problems include the non-random assignment of team leaders and/or project personnel, retroactive evaluation, and the possible existence of the Hawthorne effect. It should be noted, however, that the Hawthorne effect may be somewhat mitigated in Bloch's and Bell's study due to research which occurred more than two years after the teams were established. The misleading nature of clearance rates is also reduced by Bloch's and Ulberg's study of

clearance rates in Rochester prior to the team policing evaluation.

The findings on arrest-related productivity include some performance measures not found in many of the other studies. Schwartz and Clarren and Bloch and Bell each employed a measure specifically related to investigative effectiveness. In both studies, the decentralized model was more successful in relation to the investigative measure than the centralized comparison group, although in Schwartz' and Clarren's study, the decentralized model was also more successful than a team generalist approach. Although the findings are too restricted to be conclusive, the use of measures based specifically on the outcome of follow-up investigations suggests measures for future studies.

Bloch and Bell also used arrests resulting in prosecution as a measure. Depending upon the variations in the measure employed, the teams were found to be either equally successful to the non-teams or less successful than the non-teams; these findings are in contrast to the bulk of Bloch's and Bell's findings which compared the teams favorably to the non-teams. Again, the findings are too narrow to be conclusive, although they do suggest the need for further analysis of whether arrests actually result in prosecution. It should also be noted that in Bloch's and Bell's study, the authors partially linked the larger percentage of on-scene arrests in larceny and robbery cases to the more frequent response by investigators to crimes in progress. However, the number of other causal variables listed by the authors in reference to this one finding attests to the difficulty of positively linking study results to the partial decentralization of the investigative function.

The study findings in reference to the information exchange between patrol officers and investigators are mixed, suggesting that an increase in cooperation is not a routine result of closer contact between the two

groups, although such cooperation can occur. Datz', Morris', Tendler's and Kalmanoff's study suggests that the process by which patrol and investigators begin to work more closely together may be vital to information exchange. Bloch's and Bell's analysis of the information contained in patrol's preliminary reports is an interesting measure of whether closer contact between patrol and detectives alters a specific vital form of information exchange between the two groups.

Although there is evidence of increased job satisfaction/morale among partially decentralized investigators, the number of studies cited in this area is limited.

5. HYPOTHESES WHICH TEST THE VALUE OF CRIME DATA ANALYSIS.

Crime data analysis is an assessment and coordination of information supplied by patrol and/or investigators, which is ultimately returned in some form (e.g., as deployment strategies) to patrol and/or investigators for use. As such, it represents a unique type of information exchange in the interface between patrol and investigation. Crime data analysis is often viewed as an application of rational planning and flexibility to the coordination of police operations, since the use of crime data analysis implies that police activities are based on information about crime incidence and patterns, rather than on traditional policing techniques. Bloch and Specht, for example, included crime data analysis for support of deployment strategies as part of their "ideal" team policing system.

Hypothesis: *The use of crime data analysis increases arrest-related productivity.*

As suggested above, crime data analysis is occasionally used as a basis for personnel deployment. In the split-force patrol experiment described by Tien, Simon and Larson, a significant increase in patrol's arrest-related productivity was secondarily attributed to the "directed problem-oriented patrol" (Page viii) of the Structured Force. The change in arrest-related productivity was evidenced by a 105.5 percent increase in Part I clearances, as well as a 4 percent increase in Part I arrests per patrol officer, per month. The authors also noted that the crime data

analysis function was hampered by the analysts' isolation from the "street" and a lack of coordinated information from detectives (stemming from problems discussed earlier); nevertheless, patrol officers reported that the crime data analysis had "slightly" increased their effectiveness (Page 6-5).

Pate's, Bowers' and Parks' study in Kansas City of deployment on the basis of crime data analysis included an assessment of deployment corresponding to high crime areas (Location-Oriented Patrol or LOP) and deployment based on the surveillance of a selected group of subjects (Perpetrator-Oriented Patrol or POP). The authors concluded that the Apprehension-Oriented Patrol Project (LOP/POP) was "...more effective than the South Patrol Division in the criteria addressing the goal of arresting suspects for robbery and burglary and the conviction of these suspects for target crimes." (Page 123). (The target crimes were robbery and burglary.) In terms of arrest-related productivity, LOP and POP were identified as superior to the South Patrol Division (SPD) in overall apprehension effectiveness (LOP effected more target crime arrests per officer-hours expended, although there was no difference between LOP and POP in their rates of target crime interception); and arrest quality (a higher percentage of LOP's target crime arrests were for the more serious crime of robbery, although there was no difference between LOP and POP in the percentage of robbery arrests made for armed robbery and the persons arrested by POP had a greater median number of prior felony arrests than those arrested by LOP.) In terms of arrest-related productivity, the South Patrol Division was considered superior to the Apprehension-Oriented Strategies in the disposition of target arrests (the SPD made a higher percentage of target crime arrests for which charges were filed, although there was no difference between SPD and LOP/POP in the conviction rate of target crimes and both LOP and POP recorded fewer officer-hours per conviction for a target crime). On the basis of these findings,

the authors concluded that LOP was superior in terms of "apprehension and 'removal'" strategies. (Executive Summary). The authors also determined "...that the Apprehension-Oriented strategies seemed to have had only a negligible impact on the tactical unit's performance during the program year....During the extension period, both LOP and POP dropped on almost all performance criteria compared to the program year." (Executive Summary).

Pate, Bowers and Parks also assessed the contribution of the police department's Criminal Information Center which gathered information about criminal activities and suspects and disseminated it to units throughout the department. The authors determined that, in units other than the tactical unit (the tactical unit contained the POP and LOP squads) the arrest rate was significantly greater for the suspects about whom information was provided than for the suspects about whom no information was provided. This difference was identified for all crimes combined and for crimes other than robbery and burglary. Differences in the arrest rate for the two groups of target subjects were not noted for the tactical unit. The authors suggested that the lack of an increase in the tactical unit's arrest of target suspects about whom information was supplied may have been due to the tactical officers' prior familiarity with the suspects. A user survey indicated a high level of satisfaction with the information received from the Center, although only slight usefulness in making arrests was reported.

Hypothesis: *The use of crime data analysis increases the exchange of information between patrol officers and investigators.*

In their research on Kansas City's Criminal Information Center, Pate, Bowers and Parks studied whether providing information on target subjects affected the amount of information about target subjects reported to the Center. The authors determined that providing information about target

subjects to the tactical unit resulted in a greater percentage of inputs to the Criminal Information Center about these subjects than about target subjects on whom no information was distributed. The authors suggested that this result was due to inputs resulting from POP's surveillance of perpetrators. In contrast, the non-tactical units did not provide additional information about target subjects on whom information was distributed as compared to target subjects on whom no information was distributed. The authors also noted that inputs about subjects and requests for information came from all units in the department as well as more than twenty neighboring police departments. The authors determined that "No significant interaction effect existed between the effect of providing information to the tactical unit and the effect of providing information to other units." (Page 119).

It should also be noted that the very act of disseminating crime information in the manner described represents an information exchange between patrol officers and investigators.

Hypothesis: *The use of computers for offender-identification is helpful in case solution.*

Greenberg's, Elliott's, Kraft's and Procter's analysis of the investigative function in the Oakland Police Department included an assessment of the use of computerized systems for offender identification. The authors concluded "...that collection of unlimited number of information elements for computer processing is not a panacea for crime solution." (Page xxxi). The authors noted that computer systems are dependent on large data collection efforts which, the authors suggested, would be burdensome for both patrol officers and victims. Furthermore, as stated previously, the authors determined that only a small number of variables were of use in case solution. Of the 205 cases processed in Oakland for suspect identifica-

tion, eight useful leads were produced. Similarly, of the 28 cases processed for vehicle identification, two useful leads were discovered. The authors suggested that the poor computer results may have been due to a mismatch between old data and new cases; operator error in entering too limited a description range of personal descriptors that vary widely among observers (e.g., hair length); and problems of program design. The authors expressed a need for determination of the information elements about a crime or offender that can realistically be obtained; the procedures for maintaining the information; and whether the concept of modus operandi can be defined sufficiently for computer recognition.

Analysis

The number of studies presented on the value of crime data analysis is limited. The study by Pate, Bowers and Parks is the only one which employed an experiment specifically designed to evaluate crime data analysis per se. However, this study experienced certain problems identified by the authors, such as an inadequate control group (e.g., the South Patrol Division had standard patrol responsibilities and were not totally arrest-oriented as were the tactical squads assigned to the Apprehension-Oriented Patrol Project), officer assignment to LOP/POP on a voluntary basis, a significant change in POP strategy during the extension period and coordination problems between the department and the valuation personnel. In addition, as suggested by the program's deterioration during the extension period, the Hawthorne effect may have applied to the participating officers.

Although it is inadvisable to form conclusions on the basis of one study, the study suggests that information on specific target subjects, disseminated to officers throughout a department, can improve the arrest rate of those subjects, although the quality of those arrests is not

indicated. The findings on deployment on the basis of crime data analysis are less definitive, due both to the problems listed above and the South Patrol Division's superiority in the disposition of target arrests.

The findings also suggest that the dissemination of information about target subjects may not generate more information specifically about the target subjects; however, it is reasonable to assume that the existence of an information center generates more general information exchange (in the form of input and requests for information) than would exist otherwise. It should be noted, however, that usage of the Criminal Information Center dropped during the extension year. Although the tactical unit's usage of the Center remained higher than that of the rest of the department, this may have been due to physical proximity. Clearly, although this study raises a number of interesting issues, its results cannot be considered conclusive.

In terms of computer usefulness, the results of one study are again insufficient for forming conclusions. However, the findings suggest a need for further analysis of a current trend on policing.

6. HYPOTHESES WHICH TEST THE VALUE OF CASE SCREENING AND DECISION MODELS.

A case screening and decision model assesses the information contained in a crime report to determine whether the case is likely to be cleared by arrest and, therefore, should be investigated further or whether the case should be suspended due to a lack of sufficient information to make the case "investigatable." Case screening and decision models are employed to give priority to investigators' efforts for cases that have the highest potential to be solved--a consideration of particular importance because of the high volume of crime reports referred for specialized follow-up investigation. In order to further relieve detectives of excessive paperwork, the use of civilians to perform the case screening process has been recommended. Case screening and decision models are part of the interface between patrol and investigation because they interpret the value of the information exchange from patrol to investigators and serve either to further or suspend that communication.

Hypothesis: *The elements of information necessary to case solution can be pre-determined for use on a case-by-case basis.*

Greenberg, Yu and Land designed a case screening and decision model for burglary investigation with the participation of six California police departments. The following information elements and their respective weightings* were statistically determined to be essential to the solution of burglary cases: the estimated range of time of occurrence (5)--less than one hour (5), one to twelve hours (1), twelve to twenty-four hours (0.3), more than twenty-four hours (0); witness reporting offense (7); on-view report of offense (1); usable fingerprints (7); suspect information developed--description or name (9); vehicle description (0.1); all other elements (0). If the sum of the weighted elements totalled less than or equal to 10, the case was to be suspended; if the sum of the elements was greater than 10, a follow-up investigation was to be initiated on the assumption that the case would be cleared by arrest. Variables of undetermined usefulness were identified as property description, serial number, other physical evidence, suspect vehicle description, informants, possession of stolen property and modus operandi. Variables rejected as not essential to case solution included the time between occurrence and report, facility category and type, victim reporting offense, cash value of stolen property and property type.

Greenberg, Elliott, Kraft and Procter statistically derived a robbery case decision model for the Oakland Police Department. The following elements and their corresponding weightings were identified as essential to case solution: suspect named (10); suspect known (10); suspect previously seen (10); evidence technician used (10); places suspect frequented named

* The elements and weightings presented here are modifications of the original case screening and decision model. Three of the six original departments participated in the refinement process.

(10); physical evidence--each item matches (6.1); vehicle registration--query information available (1.5), vehicle stolen (3.0), useful information returned (4.5), vehicle registered to suspect (6.0); offender movement description--on foot (0), vehicle not car (0.6), car (1.2), car color given (1.8), car description given (2.4), car license given (3.0); weapon used (1.6). If the sum of the weighted elements was less than 10, the case was to be suspended; if the sum of the elements was 10 or more, a follow-up investigation was to be initiated. The authors noted that this case screening and decision model reflected not only information gathered at the crime scene but information developed from preliminary case enrichment procedures; thus, this decision model was best used after certain investigative procedures had been pursued.

The authors attempted to develop case screening and decision models for the crimes of rape, assault with a deadly weapon and auto theft, but were unsuccessful due to the nature of the crimes and the Oakland Police Department's policies and procedures. The most important case solution factors for each of the three crimes--the victim knowing the offender in rape cases and in cases of assault with a deadly weapon; and the apprehension of car thieves in the stolen vehicles--overwhelmingly statistically dominated the other elements of information.

Hypothesis: *Case screening and decision models are reliable methods of predicting case clearance by arrest.*

The original burglary case screening and decision model developed by Greenberg, Yu and Lang was determined accurate 80 percent of the time within the six participating departments. A field test of the modified model revealed an accuracy of 90 percent, 82 percent and 67 percent in the three departments that participated in the modification process. A composite of the testing in the three departments showed an error of

30 percent in cases that were in fact cleared but which would have remained uninvestigated using the model. Thirteen percent of the cases that remained uncleared would have been makred for follow-up investigation by the model.

An independent study of this model was undertaken in the Oakland Police Department where approximately 300 burglary cases were screened by a combination of analysts, clerical personnel and a police intern for comparison with cases selected by experienced investigators for suspension or follow-up investigation. A clearance-to-investigation ratio of 76 percent was noted in cases chosen for followup by both the checklist and investigators, as opposed to a clearance-to-investigation ratio of 55 percent for cases selected for followup by the investigators alone. In another set of results, with the combined review of analyst and clerical assistant personnel, the checklist correctly predicted 71 percent of all clearances and 92 percent of clearances by arrest and prosecution.

Eck reported on a study of twenty-seven police agencies that tested the burglarly case screening and decision model developed by Greenberg, Yu and Lang. The model's accuracy ranged from 79 percent to 97 percent among departments that did not have their own screening procedures (15 departments); the mean score of accuracy was 85 percent. About 59 percent of the cases actually cleared by arrest would have remained uninvestigated using the model; 9 percent of the cases that remained uncleared would have been selected by the model for investigation. Eck reported that use of the model could result in a significant loss in the number of cases cleared by arrest, due to the model's conservative nature. He also suggested that the model was more accurate for departments that cleared relatively few cases by off-scene arrest than for departments with a high rate of off-scene arrests. Nevertheless, the author noted that the model was more

accurate than the non-statistical informal case screening used in many police departments.

The robbery decision model developed by Greenberg, Elliott, Kraft and Procter demonstrated 90 percent accuracy in the classification of the cases sampled from the Oakland Police Department. The authors noted, however, that most of the cases actually cleared, but rejected by the model for further investigation, were cleared without investigation by the Oakland Police Department. Investigation by Oakland Police Department detectives led to suspect identification in only two cases in which the information in the crime report was insufficient for further investigation according to the case screening and decision model.

It should be noted that all authors cited under this hypothesis stressed the need for interested departments to develop case screening and decision models tailored to their individual operations and policies. The models developed were intended to reflect only the operations of the departments under study at the time of the study. Eck, in particular, emphasized that the location of the cut-off point between suspension and investigation could be manipulated to alter the balance the two types of errors (i.e., underestimation and overestimation of the cases that could be cleared by arrest) depending upon the priorities of the specific department.

Hypothesis: *A checklist of the elements of information essential to case clearance, when distributed to patrol officers, will result in the inclusion of more of these elements in preliminary investigative reports.*

Greenberg, Yu and Lang instituted an experiment to test the use of such a checklist in the three California police departments that participated in the derivation and modification of the burglary case screening and decision model. Checklists were used by reporting officers in each

reported burglary (within certain limitations). The authors found that the use of the checklist did not result in more complete reports containing more of the essential elements of information. The authors noted that the checklist form used was too cumbersome for patrol use and a simplified form was devised.

Analysis

The research clearly demonstrates that case screening and decision models can be developed for certain crimes. Although the error in the burglary investigation model (particularly in the prediction of cases to be suspended) seems to be high*, the literature suggests that continued experimentation within a specific environment can refine the error to an acceptable level. Nevertheless, such continued refinements within a functioning police department are not documented in the research cited.

One problem with the models is that they were based on crime report files, which are often inadequate descriptions of the factors leading to case solution. Furthermore, elements of information not routinely collected by patrol officers would not have been adequately represented in the statistical analysis. Thus, the models do not suggest improvements in the types of information to be collected; the models start from the assumption that the procedures and major items of information routinely collected are adequate. This is not to say, however, that the models will not fulfill the objective of increasing investigator productivity by stemming the flow of cases destined to remain unsolved. It should also be noted that

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* Part of the reason why the rate of error may be high is that in Greenberg's, Yu's and Lang's study the model was designed for a group of departments rather than tailored to the operations of one department and in Eck's study, the model was tested in departments for which it was not designed.

the models do not adapt to changes in department policies and procedures; thus, in order to fully use the models, periodic re-evaluation appears to be required.

The discussion of the use of an investigative checklist suggests that more analysis in this area is needed when the problems of format are resolved. In practice, the potential impact of case screening and decision models may be improvements in investigator productivity and perhaps large-scale reductions in the number of specialized follow-up investigations. Regarding these areas, the models could be further evaluated.

V ISSUES

As documented throughout this report, most research findings on the interface have been inconclusive. The exceptions are researchers' findings regarding the unreliability of reported crime and clearance rates as performance measures; researchers' ability to develop case screening and decision models for certain crimes; and patrol's, rather than investigators' predominance in the arrest-related productivity of a police department. Many of the researchers, after years of work, were unable to make definitive statements about the value of the experimental programs studied. Instead, some programs were modestly characterized as "alternatives." For example, Schwartz and Clarren concluded: "What can safely be said about the COMSEC experiment in Cincinnati is that it leaves no reason to believe neighborhood team policing carries the risk of inviting crime or that it is worse than regular police practices in other ways. Rather, it seems that neighborhood team policing could hold benefits and is one reasonable option for change in police organization and practice." (Page 9). It is certainly to researchers' credit to honestly state findings that are less concrete than they might have hoped. However, in light of the large investment represented by the literature on the interface, it seems more expedient to discuss the major reasons why the literature has been inconclusive, rather than to attempt to discern common findings among the studies reviewed.*

* For a more comprehensive discussion of the problems in the research, see "The Normative Model of Research" and the analyses referring to each section of hypotheses.

One obvious issue is that similar hypotheses have been explored by too few studies to produce a general consensus. While true, this argument avoids the fact that a number of studies on the same topic can, as a group, still be inconclusive. One example of this is team policing, where many variations have been studied, but without an overall consensus of findings.

A second issue raised by a review of the research on the interface is the choice of performance measures. As noted throughout this paper, reported crime rates and clearances, although unreliable, are widely used. One solution to this problem is the adoption of more revealing measures, such as arrests resulting in prosecution and the crime rates discovered through victimization surveys. Clearly, the problem with these measures is that the necessary data is not maintained and use of the measures would require an even greater investment of time, labor and funding. At the least, studies employing clearance rates should include a discussion of the ways in which clearances are produced <u>within the departments under study</u> and what the ramifications may be for research results. Although a few studies discussed the use of clearances within the subject department, this essential caveat has generally been lacking in the literature.

A third obstacle to conclusive research is that "follow-up" studies, while many times required, are often not performed. For example, the studies that dealt with the value of field interrogation reports in investigation determined that, within the particular departments studied, operational obstacles precluded use of the reports in investigation. However, potential "follow-up" studies which would determine the value of field interrogation reports once certain obstacles are removed (based on the tenuous assumption that the obstacles are eventually removed) have not been performed.

A fourth obstacle to conclusiveness is the unique nature of each experiment, as well as the myriad number of changes instituted within each experiment. Thus, it is difficult to conclusively attribute findings to specific changes or to generalize across experiments.

In spite of the issues discussed thus far, the most significant obstacle to conclusive findings in the literature relates to the environment in which the research takes place. Police operations research is subjected to changes and problems imposed by administrators and police personnel who are not participants in the experiments. A controlled study is difficult to achieve, if only because all police personnel are aware of the experiment. In a number of documented cases, police administrators violated basic tenets of the experiments (e.g., team autonomy in decision-making, deployment of only team personnel within the district).*

The critical environmental constraints limiting most research raise questions concerning the commitment of the host departments to the research and the implementation of a research and planning process. The problems encountered demonstrate the need to focus on the process of research and the means whereby local police cooperation at all levels is achieved.

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*Similarly, hostility between personnel who participate in the experiments and those excluded has interfered with the experimental results. For example, as documented by Tien, Simon and Larson, Wilmington detectives who resented patrol officers' new investigative responsibilities, occasionally refused to handle arrests initiated by those officers. In the Worcester experiment evaluated by Tien, Larson *et al*, the officers (themselves participants in the experiment) would not include the civilian crime data analyst as part of their investigative unit; thus, her position deteriorated from the integral planning position originally envisioned. Another type of distortion was documented by Schwartz and Clarren in Cincinnati, where patrol officers were reluctant to assume additional generalist investigative responsibility and occasionally instituted an informal "specialized" system among themselves. In Holyoke, as documented by O'Malley, the officers on subsequent teams did not know how to perform investigations and thus relied on members of the first team or on centralized investigative personnel. O'Malley was sufficiently concerned about disintegration of the program design to recommend that funding be terminated unless the program design was adhered to.

Although these environmental aspects of the research have been discussed to varying degrees, it may be that future research should not proceed until they are more completely addressed.

Thus, certain basic issues about police research need to be addressed, particularly in light of the environmental problems. First, there is the question of whether controlled experiments are even possible within a functioning police department. If not, the ramifications for research validity as a whole must be explored. Second, there is the question of the type of research most feasible in a police department and most worth funding. It appears that these overall questions about police research should be addressed prior to continued research.

APPENDIX A

ANNOTED BIBLIOGRAPHY

Angell, John; Raymond Galvin and Michael O'Neill. Evaluation Report on the Model Cities Team Policing Unit of the Holyoke Police Department, Holyoke, Massachusetts: Holyoke Police Department, 1972.

This report presents the results of an evaluation of the Model Cities Team Policing Unit of the Holyoke, Massachusetts, Police Department. The evaluation compared the team policing area (Ward I) with a control area (Ward II). These areas were similar in terms of socio-economic conditions as well as geographic separation from the rest of Holyoke. The evaluation was intended to analyze the effects of team policing on community attitudes towards the police, clientele satisfaction with police services, performance and attitudes of police officers and the effectiveness of police service. It was expected that team policing would result in reduced community criticism of the police, increased job satisfaction among the officers and more efficient communication among team members; all of these results were expected to increase the team officers' effectiveness. The evaluation began at the start of the project's implementation and continued throughout the experiment's first year.

The team policing experiment included independence from a normal command hierarchy and the assignment of responsibility for providing police services in one area. The goals and procedures of the team operations were left to the team to determine; however, the officers were required to work closely with community members and community organizations. Democratic methods of decisionmaking were employed within the team, and community involvement in policymaking was obtained through periodic meetings with the team. Community Service Officers were hired by Model Cities to assist the team. The team officers were volunteers who received training throughout the project and formed committees to study problems and make recommendations; the officers completed a manual of procedures for their team.

The interface issues addressed by this report are: 1) the junction of responsibility between patrol and investigators; and 2) the exchange of information between patrol and investigators.

The team did not include any "investigators" per se; the team officers were responsible for entire investigations. In practice, however, there were only a small number of cases to be handled; the officers spent most of their time assisting people in the neighborhood. The small number of cases corresponds to the team officers' service orientation; arrests were viewed as a last resort rather than as a goal. A special panel of five police executives who observed field operations, conducted interviews and attended conferences in Holyoke over a two-day period concluded that they had not seen sufficient investigative activity to evaluate the officers' investigative skills; the panel noted, however, that the team officers seemed to have more knowledge of steps in the investigative process than did non-team officers. Informal interviews with team

officers revealed that they enjoyed the freedom of handling cases throughout the investigative process.

Due to the lack of specialized investigators on the team, there is no assessment of the information exchange between patrol and investigators in the team area. However, the authors reported a great deal of conflict between the team and the rest of the department over team decisions and the department's lack of control over the team unit. Within the team, the regular meetings and participatory decisionmaking enhanced the exchange of information.

The authors believed that the team was more efficient and effective than traditional policing due to its organizational form; however, data sufficient to determine if the team was more efficient and effective was not maintained by the police department. The authors, therefore, stated that on the basis of the information available, they could not judge team policing as a success or failure. However, the authors noted that the the evidence supported team policing as a viable approach to urban policing.* The authors indicated, however, that as part of the continuation of team policing in Holyoke, improvements would be needed in two areas: 1) data collection to reflect departmental activity and 2) communications with the rest of the department, as well as with other agencies with an interest in the project. In addition, the authors concluded that further experimentation with the concept of team policing was called for, with evaluation as a component built into continuation of the program.

Bloch, Peter B. and James Bell. Managing Investigations: The Rochester System, Washington, D.C.: Police Foundation, 1976.

This report presents the results of a study to determine why clearance and arrest rates increased in areas policed by teams in Rochester, New York.** The study was retroactive in that past data and events were reviewed by the authors. The period studied was July 1, 1973, through November 30, 1973--a time period approximately two years after the establishment of the two teams. In order to evaluate the team units' performance, the remainder of the areas from which the team units were drawn was used for comparison. The study addresses the crimes of robbery, burglary, and larceny. The data sources of the study include: performance data, case records, observation, interviews, police department documents, questionnaires, and a review of variables that might be related to the effectiveness of a policing strategy (e.g., personnel policies, equipment).

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*The evaluation's focus was police-community relations, which is not an interface issue and therefore is not included in this bibliography. The improvement in police-community relations, officer morale and job satisfaction are large parts of the "evidence" supporting team policing in Holyoke.

**The increase in clearance and arrest rates was validated in Auditing Clearance Rates by Bloch and Ulberg, published by the Police Foundation in 1974.

The interface issues addressed by this study are: 1) the junction of responsibility between patrol and detectives in terms of meeting departmental objectives; and 2) the exchange of information between patrol and detectives.

The authors' primary conclusion is that clearance and arrest rates can be improved through the assignment of detectives to work as members of police teams. The authors found that the team units were more successful than the non-team units in terms of: the percentage of cases in which arrests were made, the percentage of cases which were cleared, the percentage of larceny and robbery cases which resulted in on-scene arrests (team and non-team units were similar in terms of on-scene arrests in burglary cases), and the percentage of arrests in burglary and robbery cases that were due to follow-up investigations (the units were similar in terms of arrests resulting from follow-up investigations in larceny cases). The team units' larger percentage of larceny and robbery cases resulting in on-scene arrests was attributed to: a greater emphasis on arrests as indicators of success, a more frequent response by investigative personnel to crimes in progress, the use (by one team)of investigative personnel to block criminal escape routes, and the use of photography; the on-scene arrests were not attributed to the teams' familiarity with the neighborhood and the information furnished by witnesses at the crime scene. The team units' larger percentage of arrests as a result of follow-up investigation in robbery and burglary cases was attributed to: a more effective use of information collected by patrol, "early case closure" (a procedure in which cases were reviewed to separate those cases which had the potential for investigative results and to close the remainder), one team unit's "centralized case management" (a procedure in which the team command supervised each investigation), and the emphasis on arrests rather than administrative reclassification of case disposition. The arrests were not attributed to physical evidence from the crime scene and the tracing of stolen property.

In addition to the benefits of team policing listed above, the team units reported a higher degree of cooperation with investigators than did the non-team units. Both team and non-team units thought that the teams were more effective in fighting crime and were more able to resolve morale problems between investigators and patrol officers.

The authors also found a significant area in which the team units were not superior to the non-team units: on-scene arrests made by the team units for all three crimes were less likely to result in prosecution than the on-scene arrests made by the non-team units. The reasons for this problem had not been determined at the time of the study.

The authors also found that the preliminary investigations completed by the team units contained no more information than those completed by the non-team units. Similarly, the percentage of cases prosecuted in which the arrests resulted from follow-up investigations was similar for the team units and the non-team units.

The authors used crime rates to study two comparisons: a comparison of Rochester's crime rate trends with those of comparable cities and a comparison of crime rate trends in the team areas with those in the non-team areas. In the first comparison, it was determined that Rochester had experienced the same crime rate trends as those of other cities, both for overall crime and for robbery and burglary specifically. In the second comparison, it was determined that the team areas had shown improved crime rate trends for all three crimes, as compared to the non-team areas.

The authors did not make any recommendations in this study. However, the study team did caution that crime data should be used cautiously and that each police department must assess its own experience if it chooses to implement the Rochester System.

Bloch, Peter B. and David Specht. Neighborhood Team Policing, Washington, D.C.: Urban Institute, 1973.

This report is a synthesis of the theoretical framework for neighborhood team policing and the experiences of individual police departments, as well as a practical manual for the planning and implementation of neighborhood team policing systems. The authors define "neighborhood team policing" as a combination of the team concept and the neighborhood concept, which seeks to: hold a team commander and team responsible for police service and crime control in a given neighborhood; strengthen the relationship between the police and the community; increase the flow of crime-related information from the neighborhood to the police; give the team a maximum amount of responsibility, keeping other units out of the neighborhood whenever possible; and rely on information to control crime rather than on street stops and other patrol techniques that may jeopardize police-community relations. The report includes discussion of eleven cities' experiences with team policing: Holyoke, Massachusetts; Albany, New York; St. Petersburg, Florida; Cincinnati, Ohio; Detroit, Michigan; Venice, California; Oxnard, California; New York City; Los Angeles, California; Dayton, Ohio; and Syracuse, New York. The topics for practical application include planning and implementation, administration, training and education, lines of authority and methods of supervision, the responsibilities of a team commander, and the planning of a budget. The authors also include their conception of an ideal neighborhood team policing system, against which existing projects are compared.

The interface issues addressed by this study include: 1) the junction of responsibility between patrol and investigators in meeting departmental objectives; 2) the exchange of information between patrol and detectives; and 3) the use of crime data analysis for the deployment of personnel.

In the authors' ideal model the assignment of detectives to the team units is an integral part of the neighborhood team policing mandate of territorial responsibility, according to which the teams are expected to provide as much of the total policing responsibilities of an area as possible. In addition, detectives assigned to teams can train patrol in investigation, discover crime patterns, and, in conjunction with patrol, develop informants and contacts. The investigation of cases is assigned on a flexible basis, and, according to the skills required, can be assigned either to patrol or detectives, or officers from both groups. On the basis of the analysis of the existing projects, the authors concluded that the assignment of detectives to teams had improved the quality of investigative work done by patrol. The exchange of information between patrol and detectives is furthered by including team personnel in plans and decisions surrounding the team unit.

The authors also include crime analysis as a factor in the ideal neighborhood team policing system. Crime analysis would be used to determine the times and locations at which crime was most likely to occur so that manpower could be allocated accordingly.

In terms of the impact of existing neighborhood team policing systems, the authors concluded that few projects had had an impact on reported crime; in fact, the authors suggest that if citizen cooperation is improved, reported crimes may actually increase. Some projects were reported to have increased the percentage of arrests resulting in prosecution.

Bloch, Peter B. and Cyrus Ulberg. Auditing Clearance Rates, Washington, D.C.: Police Foundation, 1974.

This report presents the results of a study to determine whether a substantial increase in clearance rates, as claimed by the Rochester, New York Police Department reflected an improved performance by police officers or was the result of factors other than improved performance (e.g., errors in computer records). In 1971 and 1972, the Rochester Police Department established two team policing units. The department subsequently became convinced that investigations in the neighborhood teams had become more effective, due to increased cooperation between patrol officers and investigators; the department believed that the success of the neighborhood teams was reflected by a change in clearance statistics, particularly by increased clearance rates in robbery and burglary cases. Due to the unreliability of clearance statistics in general,* it was deemed necessary to undertake a retroactive evaluation of the statistics' validity, as a prerequisite to a proposed study of the team program and its impact on investigations.

The authors identified six explanations (other than the results of team policing) that could potentially account for the higher clearance rates measured for the team units. The plausibility of each explanation was examined in reference to the team policing units. The six explanations were: 1) Higher clearance rates existed in team areas before the introduction of teams; the high rates were simply continued. 2) Team officers did not make more arrests, but they recorded more clearances

*As defined in the study, a clearance occurs when a crime is followed by an arrest.

on the basis of the arrests they did make than did officers in comparison districts. 3) There was bias in the selection of team members. 4) Crimes were more likely to be reclassified as less serious in team areas than in comparison areas when no arrest seemed likely. 5) More crimes were cleared by arrest in team areas, but the arrests were of poor quality and did not lead to prosecution. 6) Errors in computer records of offenses and arrests increased the clearance rates in team areas.

The team units were drawn from existing patrol units; the remainder of the original units, which continued to provide traditional enforcement, were used for comparison. The authors analyzed data for the crimes of robbery, burglary, larceny, and criminal trespass. Data prior to the establishment of the teams was compared to data generated during the teams' operations. The data sources included: records of offenses and police dispositions, arrest records, dispatch assignment cards and reports, and records of offenses cleared by arrests.

The study's findings clearly affect the subsequent analysis of team policing in Rochester and in particular, the interface issue of whether the increase in clearance rates was due to increased cooperation between patrol officers and investigators.

The authors concluded that none of the six explanations was sufficient to account for the significant increases in clearance rates among the teams. The authors also determined that the team members had increased their arrest rates more than comparison personnel. Thus, the authors believed that the increases in clearance rates were valid and that the Rochester project should be analyzed further in order to determine how the teams increased the rate of apprehension of robbers and burglars. In addition to the data on clearance rates, the authors also examined data on crime reports. It was determined that in comparison to the rest of the city, the reported crime rates for burglary and larceny decreased markedly in the team areas; the crime rates for robbery increased the same amount for both the team areas and the rest of the city and the crime of criminal trespass decreased about the same amount for both the team areas and the rest of the city.

Boydstun, John E., San Diego Field Interrogation: Final Report, Washington, D.C.: Police Foundation, 1975.

This report presents the results of a study on the field interrogation practices of the San Diego Police Department. The study's purpose was to determine whether the benefits of field interrogation were sufficient to balance the costs of field interrogation, both in terms of patrol time and potential costs to community relations. The study's main emphases were the way in which field interrogations affect police-community relations and result in crime deterrence and arrests made by patrol officers. The

impact of field interrogations in these three areas was determined through an eight-month experiment involving three patrol areas--a Control Area where field interrogations were continued as usual, a Special FI Area where all of the patrol officers had received special training in field interrogations, and a No-FI Area where field interrogations were ceased completely.

The interface issue which the study addresses is the exchange of information between patrol and detectives and the ramifications of this information flow in meeting departmental objectives. Specifically, the author examined the degree to which patrol-generated field interrogations are of value to criminal investigators in the investigators' attempts to solve crimes.

In order to analyze this area, the author used interviews, a review of three months' of investigative supplement forms (with which investigators requested that a field interrogation be conducted in connection with a specific investigation) and a questionnaire distributed to officers in various investigative units. Of the 147 questionnaires distributed, 93 (63.2 percent) were completed. The author found that the majority of investigators thought field interrogation reports were useful in case investigations and that 37 percent reported one or more case clearances in the prior six months through the use of field interrogation information. However, the author also determined that because of the manual filing system used for field interrogation reports the use of field interrogation reports as investigative tools was limited. In the three month period reviewed, only 15.5 percent of the written field interrogation reports were examined by investigators.

In reference to the use of field interrogations by investigators, the author concluded that the benefits of field interrogation reports could be expanded through the use of a computer-based field interrogation file search system that would increase investigators' use of the reports.

Cordrey, John and Pence, Gary K. "An Analysis of Team Policing in Dayton, Ohio," Police Chief, Vol. 39, No. 8 (August 1972).

This article presents the results of a nine-month team policing experiment in Dayton, Ohio. In addition to a team structure, the experiment also included the use of Community Service Officers and Neighborhood Assistance Officers. The experiment was adopted to determine whether a team structure was more or less effective than traditional policing and whether a community-centered police structure would evolve from these innovations. One police district was used as an experimental district. A generalist/specialist concept was adopted as part of the team policing structure: the patrol officers were given the responsibility to handle all aspects of a case; if the patrol officer did not know how to proceed with an investigation, he was to call upon a team specialist for assistance.

The interface issue addressed by this article is the junction of responsibility between patrol and investigation.

Five measures were used to analyze the effectiveness of the team policing innovation: the number of dispatch calls answered; clearance rates of Part I and Part II crimes; the recovery of stolen property; the apprehension time associated with Part I crimes; and the successful prosecution of arrested persons. The data was measured and compared for eleven months prior to the program and the nine months of the program's duration; if data from the period prior to the experiment did not exist, the team results during 1971 were compared to those of other police districts in the city.

The results of the experiment were: 1) the team district handled more calls on the average than did the other districts, in spite of the team district's smaller percentage of the department's total manpower and responsibility for handling investigations; 2) clearance rates for the team district were similar to those prior to the experiment; 3) the stolen property recovered by officers in the team district was one-half of that recovered prior to the experiment; 4) the pattern of apprehension time in the team district was similar to that prior to the experiment; and 5) the record of successful prosecutions was similar to that of the entire department prior to the experiment.

The authors concluded that the measures of effectiveness were comparable to the achievements prior to the experiment.* The authors believed that, over time, the clearance rates and recovery of stolen property would improve as the officers developed their investigative skills. It was recommended that team policing be continued and possibly expanded.

Datz, David; Mark Morris; Judith Tendler, and Alan Kalmanoff. Report on the Criminal Investigation Division of the Oakland Police Department, Oakland, California: Oakland Police Department, 1973.

This report presents a general analysis of the operations of the Criminal Investigation Division and the ramifications of its operations in terms of the achievement of departmental objectives. The report's findings are not based on an experiment; rather, they represent an analysis of the operations in the Oakland, California, Police Department at the time of the study. The study's information sources include interviews, observation, data analysis and a review of police department documents pertaining to the Criminal Investigation Division.

The interface issue reviewed by this study is the junction of responsibility between patrol and investigation in meeting departmental objectives. Specifically, the authors examined the extent to which investigators were responsible for "solving" a case--i.e., were able to produce suspects and witnesses, recover property, and uncover new evidence.

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*The authors also concluded that the team district had made "notable steps" in the development of a more community-centered police department.

The report's conclusion is that the probability of solving a case does not increase with the amount of investigative time spent on it. On the basis of a sample of 47 burglaries, 20 robberies, and 21 auto thefts from November 1971 that resulted in arrests and prosecutions, the study team found that the cases were almost exclusively "solved" by patrol, rather than by investigators. The investigators' role was generally limited to the interrogation of suspects already in custody, the contacting of witnesses, and case preparation for prosecution. In the majority of crimes, the suspect was caught at or near the crime scene within no more (usually less) than eight hours of the crime. If the suspect was not apprehended or at least identified on the day of the crime, the probability of apprehension was extremely low. One factor that was identified as an impediment to the value of investigation was a large time lag between the time of the incident and the time at which an investigator would begin the follow-up investigation.

The authors identified a decrease in patrol's response time as the most productive means of increasing the percentage of "successful" cases. The next most productive measure was identified as the use of tactical groups to deal with specific problems and the deployment of investigators into the field for immediate response. The study team suggested that civilians be employed to relieve investigators of clerical duties and to attach all relevant records to the report. In return, investigators would be free to be deployed continuously in the field. The report describes a plan for the organization of investigators by specialization: field investigators, in-house investigators, and complaint investigators. The inherent assumption in the plan is that the immediate response on the part of investigators would result in increased arrests and prosecutions.

The report also contains a brief description of the extent to which the suggestions contained therein had been implemented. These "results" suggest resistance to the use of civilians and the division of investigators into teams, as well as a confusion between patrol and investigators over areas of responsibility.

Eck, J. Ernst. "Burglary Investigation Decision Model Replication: A Multi-Site Evaluation," paper presented at the Second National Workshop on Criminal Justice Evaluation, Washington, D.C., November 1978.

This report presents the results of a study which replicates the Stanford Research Institute's burglary investigation case decision model.* A case decision model assesses the information contained in a crime report to determine if the case is likely to be cleared by arrest and should therefore be investigated further or if the crime report does not contain the information necessary to case clearance, and the case should therefore be suspended. Case decision models have increasingly been used by police departments to standardize the way that similar cases are handled, as well as to increase the efficiency of case review procedures and investigative time. This study was conducted in 27 police agencies and was designed to assess the model's utility in a large number of police settings. A sample of 500 burglary cases was targeted for each participating agency. The participating departments collected their own data on the basis of a manual prepared by the Police Executive Research Forum and transmitted the data to the Forum for analysis.

The interface issue addressed by this report is the exchange of information between patrol officers and investigators.

The author found that statistically weighted felony case screening models were useful for screening cases prior to assignment to detectives. The case decision model's accuracy ranged from 79 percent to 97 percent among the participating departments that did not have their own screening procedures; the mean score of accuracy was 85 percent. However, it was determined that the model was more accurate for departments that cleared relatively few cases by off-scene arrest than for departments with a high rate of off-scene arrests. Further, it was determined that the use of the model could result in a significant loss in the number of cases cleared by arrest, due to an underestimation of cases that could be cleared with further investigation.

Errors in the case decision model were classified as either "type one" errors or "type two" errors. Type one errors were those in which the model erroneously predicted that a case would not be cleared and should therefore be suspended. Type two errors were those in which the model erroneously predicted that a case would be cleared and that a follow-up investigation should be initiated. The author found that the model was

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*Greenberg, Bernard, Oliver S. Yu and Karen I. Lang. Enhancement of the Investigative Function. Volume IV: Burglary Investigative Checklist and Handbook, Menlo Park, California: Stanford Research Institute, 1973.

more accurate than the non-statistical informal case screening used in many police departments, but contained more type one errors and fewer type two errors; the lower level of type two errors was attributed to the model's conservative nature.

The author recommended that the case decision model not be used without testing for accuracy. Testing would include an assessment of the level of type one and type two offenses, as well as an evaluation of alternate cut-off points for the suspension/follow-up investigation decision. It was noted that the manipulation of cut-off points would modify the relative levels of the type one and type two errors: the balance between the two types of errors could ultimately be manipulated to meet the preferences of police executives. The setting of the cut-off point at the most desirable level would thereby permit police executives to manage the investigative function. The author recommended, however, that it would be preferable for an individual department to construct its own statistically weighted screening model, tailored to the department's policies and operating procedures. An individualized case decision model would include the selection of information elements and weighting factors, the location of the decision cut-off point and model testing prior to implementation.

Apart from the merits of the case decision model, the author concluded that the study had demonstrated that multi-site evaluations could be relatively inexpensive and could provide more information than the same number of evaluations performed independently.

Elliott, J.F. and Thomas J. Sardino. Crime Control Team: An Experiment in Municipal Police Department Management and Operations, Springfield, Illinois: Charles C. Thomas, 1971.

This report presents a theoretical model of an "offensively deployed" police department, as well as the results of a one-year experiment in Syracuse, New York, to institute that concept in the form of a Crime Control Team. The experiment examined whether the Crime Control Team was a more effective technique for dealing with crime than conventional police operating procedures. The Crime Control Team included aspects of both team policing and the split-force concept of police patrol. As in team policing, team members were solely responsible for controlling crime in an area (through deterrence, detection, and potential as a reaction force). However, as in split-force patrol, team members did not respond to service requests; neither did they handle traffic or public intoxication. Manpower was deployed flexibly on the basis of the distribution of crimes--e.g., maximum manpower on weekend nights. Because the concept of the Crime Control Team was offensive rather than defensive, crime interception was emphasized and investigation de-emphasized. Investigation per se was not of value; cases which were not expected to be responsive to further investigation were closed. There were no investigative specialists on the Crime Control Team; it was the responsibility of the responding officer to assess

the value of follow-up investigation and, if necessary, either conduct the investigation on his own or coordinate the investigation team. The team leader was chosen through a lengthy selection process; it was assumed that the choice of team leader would be fundamental to the outcome of the experiment. Team members were chosen on the basis of above-average quality and relative inexperience (the assumption being that younger, more inexperienced officers would be more amenable to change).

The interface issues addressed by this study are: 1) the junction of responsibility between patrol and investigation; 2) the exchange of information between patrol officers and investigators; and 3) deployment on the basis of crime data information.

Data analysis was based primarily on reported crimes and cleared crimes. These measurements were used to analyze the Crime Control Team's success in reducing crime and in apprehending offenders.* The authors compared the Crime Control Team's beat with each of the other twenty-two beats; the other beats were also compared among themselves. The authors sought to determine three major factors: the percentage of conventional units to which the Crime Control Team was superior; the risk of implementation; and the probability that, when implemented, the Crime Control Team would perform better than the selected percentage of the conventional units. A secondary analysis involved cumulative distribution curves and the use of control beats.

The study's findings were: 1) the Crime Control Team beat's performance was superior to the majority of other beats, regardless of the measures used for comparison; 2) although a few beats in the city matched or outperformed the Crime Control Team beat for a specific measure, no beat performed as well in all three areas (the reduction of all crimes, the reduction of Part I crimes, the clearance of all crimes) as the Crime Control Team; 3) within the assumption that sociological conditions remain constant, there is little risk in implementing the Crime Control Team method of operation and a high probability that the method would significantly improve a department's performance.

Regarding the junction of responsibility between patrol officers and investigators, the authors concluded that the Crime Control Team's

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*The Project Director noted that, in his opinion, reported crime statistics were invalid because they were grossly inaccurate and because the quality of a police department did not affect the amount of crime reported. The Project Director noted that he based his conclusions about the Crime Control Team on the clearance measure employed in the evaluation. On the basis of a sample of clearances from the Crime Control Team beat and a conventional beat which was examined in reference to known problems with clearance data, the Project Director concluded that if the same "rigid specifications" applied to the Crime Control Team beat were applied to other beats in the city, the Crime Control Team beat would probably emerge even more favorably.

superior performance was not necessarily due to the organizational concept employed but could also have been due to such factors as the quality of the team members, superior team leadership, and the Hawthorne effect. Nevertheless, the authors concluded that the experiment had demonstrated that the effectiveness of municipal police can be significantly increased without a corresponding increase in manpower or financial resources. The authors also contended that the Crime Control Team's ability to investigate crimes (as evidenced by the team's clearance rate, the lack of complaints about the team's investigations, and the citizens' apparent satisfaction with having investigations performed by a team officer rather than a detective) contradicts the traditional notion that police departments need a special investigative unit. In spite of the team's ability to handle investigations, the authors were disappointed with the team officers' reluctance to take command of an investigation that required more than one officer. This reluctance resulted in duplication of effort, delayed investigations, and missed opportunities. The authors also criticized the team members for not viewing the community as a source of information, as opposed to the traditional reliance on informants. In addition, the Project Director noted that he had expected the Crime Control Team to effect a greater number of interceptions than was actually accomplished.

Since there were no specialized investigators within the Crime Control Team, no assessment was made of the exchange of information between patrol officers and investigators. However, the authors noted that the team developed neither a satisfactory internal communications network nor a good relationship with the rest of the department. Specifically, the poor relationship with department detectives was, in part, because the department detectives were aware that investigation, per se, was not highly valued by the Project Director.

In reference to the flexible deployment of officers on the basis of crime distribution, the authors concluded that it was possible to deploy officers non-uniformly without compromising the overall police function. However, one deterrent to flexible deployment was identified as the conflict between a rapid or short-term change and officers' part-time employment outside the department.

The authors suggested that the implementation of Crime Control Teams would have implications in the following areas: the dichotomization of departments according to function; salary increases for team members in order to attract qualified personnel and reduce the need for outside jobs; the development of leaders within the department; the attainment of professional status by officers; and the flexible deployment of personnel, which, in some areas, would necessitate changes in the law.

Greenberg, Bernard; Carola V. Elliott; Lois P. Kraft and H. Steven Procter. Felony Investigation Decision Model -- An Analysis of Investigative Elements of Information, Menlo Park, California: Stanford Research Institute, 1975.

This report presents the results of a study in the Oakland, California, Police Department, in which case decision models were to be developed for the felony crimes of robbery, assault with a deadly weapon, auto theft, and rape. A case decision model assesses the information contained in a crime report to determine whether the elements of information essential to case clearance are contained therein: if sufficient information is contained in the report, a follow-up investigation is initiated; if not, the case is suspended. This study, designed to determine whether case decision models could be developed for auto theft and crimes involving contact between a victim and an offender, grew out of an earlier study in which a case decision model for burglary was designed.* The primary objective of the study was to lessen the investigative burden of high volume felony crime reports with a low probability of clearance; the secondary objective was to identify the information elements leading to offender identification and case solution. An assessment of the contribution of computerized data banks to case clearance was also included.

The interface issues addressed by this study are: 1) the junction of responsibility between patrol and investigation; 2) the exchange of information between patrol officers and investigators; and 3) the use of computerized data for investigation.

The analysis of the Oakland Police Department's operations led the authors to conclude that patrol and investigation are not discrete functions. This conclusion was based on investigators' reliance on information supplied by patrol in order to clear cases. The authors determined that in all four felony categories a large number of cases essentially solved themselves; detectives needed only to follow routine procedures to apprehend a suspect. The robbery case decision model further demonstrated that if appropriate information was not obtained at the crime scene and the offender was not apprehended at that time, case solution was unlikely at the detective level.

The authors also determined that patrol officers, rather than investigators, were responsible for a larger percentage of cases cleared by

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*Greenberg, Bernard, Oliver S. Yu and Karen I. Lang. Enhancement of the Investigative Function. Volume I: Analysis and Conclusions, Menlo Park, California: Stanford Research Institute, 1972.

Greenberg, Bernard, Oliver S. Yu and Karen I. Lang. Enhancement of the Investigative Function. Volume IV: Burglary Investigative Checklist and Handbook, Menlo Park, California: Stanford Research Institute, 1973.

arrest; with the exception of auto theft, clearances by arrest were generally made within eight hours.

Due to the nature of the crimes studied and the policies and procedures by which cases were solved in the Oakland Police Department, a case decision model could be derived for robbery only, rather than for all four felony categories. A three-month sample of cases was used to derive the essential elements of information for successful clearance of robbery cases. Following are the elements identified as important to case solution and their corresponding weightings: suspect named (10); suspect known (10); suspect previously seen (10); evidence technician used (10); places suspect frequented named (10); physical evidence -- each item matched (6.1); vehicle registration: query information available (1.5), vehicle stolen (3.0), useful information returned (4.5), vehicle registered to suspect (6.0); offender movement description: on foot (0), vehicle -- not car (0.6), car (1.2), car color given (1.8), car description given (2.4), car license given (3.0); weapon used (1.6). If the sum of the elements was less than 10, the case was to be suspended; if the sum of the elements was 10 or more, a follow-up investigation was to be initiated. This case decision model correctly identified the cases in the sample as cleared or uncleared with 90 percent accuracy. The authors noted that the decision model contained information developed from preliminary case enrichment procedures performed by the investigative division's Crime Analysis Section; thus, this decision model was best used after basic investigative procedures had been pursued. The authors also noted that only a small number of investigative elements of information proved useful in crime solution; such elements as physical description were rejected as non-essential elements of information. The authors stressed that the case decision model was pertinent only to the Oakland Police Department as its investigative policies and procedures existed at the time of the study. The application of a case decision model was expected to be most accurate in a police department with case clearance policies consistent with the evidence leading to suspect identification, arrest and prosecution.

The authors also examined police departments' increasing reliance on computerized offender identification systems. They concluded "...that collection of unlimited numbers of information elements for computer processing is not a panacea for crime solution." The usefulness of computer systems is dependent on massive data collection which the authors suggested would be time-consuming, expensive and possibly counter-productive. In addition, they felt that a victim would be unable to respond to a lengthy list of questions, and that such a list would interfere with a patrol officer's duties. The conclusion that only a small number of variables were essential to case solution suggested that much of the data collected would be of little use. Therefore, the authors recommended that agencies with computer facilities re-evaluate policies that placed a large paperwork burden on patrol officers. Identifying a general agreement in descriptors as a prerequisite for the best use of computer technology, the report noted

that a lack of agreement in this area was evident from the variety of police incident forms employed among police agencies and the varying types of information contained in the crime reports. The offender-based computer system used in Oakland for case enrichment was determined to have produced only eight useful suspect identification leads out of 205 cases processed and only two useful vehicle identification leads out of 28 cases processed. The authors suggested that poor computer results may be due to three factors: mismatch due to old data compared with new cases; operator error in the entrance of descriptors which vary widely among police reports--e.g., hair length; and problems of design in the software program. Three critical areas to be resolved were identified regarding data collection in the investigative function: 1) the elements of information that investigators can realistically expect to obtain about a crime occurrence and/or an offender's personal characteristics; 2) the best procedures for maintaining a data base that can recall the information needed by an investigator to solve a specific crime; and 3) whether it is realistic to expect that the concept of modus operandi can be defined sufficiently for data processing systems to be able to recognize the crime of a given offender.

The authors' overall recommendation was a workshop under the aegis of NILECJ to discuss the report findings, primarily in terms of the interrelationship between investigative and patrol operations and the contribution of technology to investigation.

Greenberg, Bernard; Oliver S. Yu and Karen I. Lang. Enhancement of the Investigative Function - Volume I: Analysis and Conclusions, Menlo Park, California: Stanford Research Institute, 1972.

This report presents an analysis of the burglary investigative function in six California police departments* and the procedures developed by the authors to enhance the investigative performance of the police in response to the crime of burglary. The authors did not view investigation solely as the function of detectives. Rather, a "systems approach" was used--i.e., investigation was seen as a composite of all the individual police department operations and policies having an impact on the investigative function. The research effort focused on the development of investigative aids--a burglary investigative map, an investigative checklist, a case follow-up decision aid--partially based on a quantitative determination of the "essential elements of information" that bore directly on case solution.

The interface issues addressed by this report are: 1) the junction of responsibility between patrol and detectives in meeting departmental objectives; and 2) the exchange of information between patrol officers and detectives.

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*Fremont Police Department, Berkeley Police Department, Alameda County Sheriff's Office, Hayward Police Department, Union City Police Department and Newark Police Department.

Investigation Division of the Oakland Police Department (MAPS Project, Oakland, California Police Department) reaffirmed the clear superiority of patrol over investigation in the apprehension of offenders. The MAPS study demonstrated an apparent great waste of resources in the specialization of the investigative function.* In 1975, Felony Investigation Decision Model - An Analysis of Investigative Elements of Information by Greenberg, *et al*, similarly corroborated the lesser contribution of investigators to the apprehension of offenders.** The 1977 RAND study entitled The Criminal Investigation Process emphasized patrol's importance and reported that "...97 percent of cleared crimes will be cleared no matter what the investigators do, as long as the obvious routine follow-up steps are taken.... the thrust of our analysis is that all the time spent by investigators on difficult cases where the perpetrator is unknown results in only 2.7 percent of the clearances."***

In the face of this broad support for a negative evaluation of the investigative function relative to patrol, proposals for change have generally been confirmed to modest organizational alterations: not the types of revision and experiments that studies clearly appear to recommend (e.g., large-scale reduction in the separate investigative role). This is so even though the RAND study noted that various organizational reformations of the investigative role seem to have had little effect on arrest or clearance rates.**** Case screening and enrichment, the best recommendation to come from the research appears not to have been seriously evaluated since its implementation in some agencies. Team policing, another frequently recommended reorganization approach, has been repetitively, yet inconclusively, researched (and too often has the original research design succumbed to meddling by police management). Controlled experiments testing the actual impact of reduced specialized investigation, however, do not appear to have been attempted.

The virtually complete lack of implementation of the findings of a wide body of relatively unchallenged and important research demonstrates that police research is terribly constrained by the local, political and tradition-bound environment in which the research takes place. The lack of serious testing of findings and recommendations suggests that law enforcement practitioners have distrusted the research findings and/or had

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* David Datz, Mark Morris, Judith Tendler, and Alan Kalmanoff, Report on the Criminal Investigation Division of the Oakland Police Department (Oakland, California: Oakland Police Department, 1973), pp. 6-12, 18-27, 36-59.

** Bernard Greenberg, Carola V. Elliott, Lois P. Kraft, and H. Steven Procter, Felony Investigation Decision Model - An Analysis of Investigative Elements of Information (Washington, D.C.: U.S. Government Printing Office, 1975), p. xx.

*** Peter W. Greenwood, Jan M. Chaiken, and Joan Petersilia, The Criminal Investigation Process (Lexington, Massachusetts: D.C. Heath and Company, 1977), p. 227.

**** Greenwood, Chaiken and Petersilia, p. 227.

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3 SUPPORTING TECHNOLOGIES

by

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I INTRODUCTION

While our primary purpose is to review empirical research related to police field services, it is an inescapable fact that much of what occurs in the field is guided and constrained by various technological capabilities. Particularly for the patrol function, one sees that the very essence of patrolling has been affected throughout the years by certain technological innovations which had been created initially for application elsewhere, but eventually became standard tools for police patrol practice. Prior to 1960 the two most noteworthy technological innovations were the police car--replacing to a large extent foot patrolmen and horse-mounted patrolmen--and the two-way radio.

Since 1960 we have seen an ever-increasing number of technologies, brought about in large part by the advances in semi-conductor manufacturing, thereby leading to fast and inexpensive computational capabilities. Those organizations which generate and process information and use that information in their operations have been and are being markedly affected by this computer revolution. Police departments, though slow to adopt the computer for other than standard functions, are now being strongly affected by the recent advances in the state of the art of computer technology.

New technologies are important and relevant to police field services research for two fundamental reasons: *Innovation and Instrumentation.* By *innovation* we mean that the presence of the technology facilitates new operating procedures that were infeasible prior to the existence of the technology. For instance, few would argue that fundamental operational practices of patrol were not drastically altered as a consequence of the radio-dispatched patrol car. To the extent that new technologies arriving in the 1980's and 1990's will alter and affect police field services operations, then those technologies become very relevant in police field services research. We believe that the most important technology to affect police field services procedures during the next ten to twenty years will be the information processing and communication technologies. We feel that they are so fundamental to the essence of patrol operations today and will become even more so tomorrow that a special section of our final report shall be devoted to these technologies as they currently exist and as they may be projected. Of course, our emphasis is on the relevance of these technologies and their expected impact on police field services research.

By *instrumentation* we mean the mechanisms utilized to collect data in empirical field services research. This is the standard use of the term instrumentation that one often finds in the literature on experimental and quasi-experimental design. Examples of new instrumentation capabilities include accurate measurement of various components of response time, made possible by Computer Assisted Dispatch (CAD) systems, and accurate positional monitoring of police patrol cars in the field, made possible by Automatic Vehicle Location (AVL) systems. By providing new instrumentation capabilities for police field services researchers, these

advance could thereby result in innovation as discussed above. A second example is from the area of police resource allocation, in which, during the 1970's, several important scientific computer programs were written and disseminated to assist police patrol commanders to allocate in a more systematic and scientific manner their field services resources; examples include the PCAM and Hypercube programs. Thus, we see that software technologies can affect not only minute-to-minute operations, but also longer-range planning operations.

Due to the fundamental role that hardware and software technologies play in police field services, this section of our final report is focused on those two kinds of technologies. In Section II, we first describe the major hardware technologies which are affecting police field services operations and police field services research. They are: Computer-Aided Dispatch (CAD) systems, Automatic Vehicle Location (AVL) systems, Nine-One-One (911) emergency telephone systems, and Mobile Digital Communication (MDC) systems. Following a description of the various technologies, we discuss their potential for use in police field services research, focusing both on innovation and instrumentation. In Section III of this part of the final report we discuss various software technologies, in particular patrol resource allocation software technologies. This section will include a brief review of the PCAM and Hypercube Models and an overall discussion of patrol allocation research. But since our overall emphasis is on empirical research, it is not our intention in the following sections to exhaustively review the literature, or to recreate its evolution on an hypothesis-based approach,

technologies are playing a role analogous to that of new measurement devices in a biologist's or physicist's laboratory. In particular, there have been some especially difficult research questions that have remained largely unanswered due to the lack of appropriate instrumentation that would facilitate accurate recording of data. One may hope that using some of the new technologies to collect heretofore unavailable data, one may begin to answer some of the more difficult and illusive research questions.

In considering technologies, one should not limit one's attention to hardware technology (e.g., computers, radios, automatic car locator systems). But so-called software technologies are also now quite important for affecting police field services and police field services research. By software technologies we mean various automated or semi-automated procedures for collecting, processing, and analyzing data. For instance, many, if not most, police departments have now automated most of their file look-up procedures, say for wanted persons or stolen automobiles. But the software technologies extend way beyond simple file maintenance functions. The potentially most far-reaching software technologies build on scientific programming to provide procedures or "algorithms" to do things that have not been done before. An example would be an "intelligent" CAD system in which an algorithm predicts for a particular type of call the anticipated delay until arrival of a police vehicle; then the police telephone complaint clerk could advise the caller of the likely delay, thereby reducing to practice a research recommendation of several recent police field services studies. Such an algorithmic

analogous to that used in our patrol section. Rather, our focus is on the evolution of hardware and software technologies which are currently affecting police field services and how that continued evolution may affect--and perhaps should affect--police field services research.

II. HARDWARE TECHNOLOGIES: IMPROVING THE POLICE DISPATCHING PROCESS

Our focus in this section is on four hardware technologies which fundamentally affect the manner in which information is collected from callers requesting police assistance and how that information is processed and handled, eventually leading to the dispatch of one or more police vehicles. It is vital to recall that the dispatcher is the primal decision-maker for patrol units in the field, i.e., it is the dispatcher who decides which car or cars go to which calls for service. And since calls for service quite typically consume 50 percent or more of a patrol unit's time, it is the dispatcher who decides what patrol cars do for that extent of time.

As mentioned above, in the following section we will discuss computer-aided dispatch systems, automatic vehicle monitoring systems, 911 emergency telephone systems, and mobile digital communications systems. For each technology, we will first describe the technology, briefly review the history of the development of the technology, then provide a thumb-nail sketch of the use of that current technology.* Then for each technology, we discuss its potential relevance for police field service research with a section on innovation and then one on instrumentation.

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*In regard to those technologies that relate to police communications, command, and control we refer the interested reader to the more comprehensive PSE Final Reports, K.W. Colton, M.L. Brandeau, J.M. Tien, "A National Assessment of Police Command, Control, and Communications Systems," Final Report, August, 1981.

2.1 COMPUTER-AIDED DISPATCH (CAD)

DESCRIPTION

CAD is an application of computer hardware and software to the police dispatching process. Its purpose is to provide faster and more reliable processing, provide more information on a timely basis that is applicable during the dispatching process, automatically process incident reports, and provide formatted data that is useful to the patrol officer, patrol supervisors and police management.

Typically, the system provides a keyboard and display for each complaint clerk/evaluator and a keyboard and two displays for each dispatcher. When a citizen places a call to the police department to report a criminal incident a complaint clerk/evaluator receives the call and will request the address (or location) of the incident, type of incident, caller's name and telephone number and any descriptive message (e.g., "There is a three-car accident and there appear to be injuries"). For systems having geographic files (computer listing of all known addresses in the jurisdiction), the computer will (or will not) validate the address given, usually before the telephone call is completed. If not validated, the citizen can be asked again for the address (including street spelling). After entering the data, the complaint clerk/evaluator depresses a function key to transfer the data to the computer file (usually a disk file). The computer then adds additional information including incident number, date, time, terminal, operator ID, the patrol

area of the incident, and a list of several preferred cars for dispatching. The computer then notifies the appropriate dispatcher that a new incident is in queue awaiting his/her action.

If the dispatcher has the normal two displays, one is formatted for the incident information, containing the data taken by the complaint clerk/evaluator plus the computer-aided information; and the other contains status information supplied by the computer, usually consisting of a list of all patrol cars in the dispatcher's area and their status (available for call, servicing a call, or otherwise not available for call) and a list of one-line incident summaries showing those not assigned and those still active. The dispatcher keyboard is used for entering data into the incident format such as the car (or cars) dispatched, the time of dispatch, arrival at scene, and, again, when the cars are available for calls. The incident display/keyboard may also be used to acquire information (e.g., license plate of stolen cars) through computer-to-computer interface with local, state, or federal computer files. It is considered good practice to provide remote incident display terminals (e.g., at district stations and management offices). Remote terminals should be able to select a number of different formatted displays such as a listing of one-line incident summaries for the past hour, shift, or day for a particular district, precinct or beat, or a list of calls for service by patrol officers, or the number of calls serviced and the average time for servicing a call for each officer in a district, etc. A printer should be available to make permanent records of desired formats.

HISTORY OF DEVELOPMENT

The early CAD concepts appear to have been initiated by the President's Crime Commission as reported in "Science and Technology," (1967). Their task was to generate an awareness of technologies developed in the post-war period which might be applicable to law enforcement agencies and contribute to reducing crime through deterrence and increased apprehension of criminals. The task force's analysis "...suggested that the best allocation of resources would be in automating the communications centers operations by such means as using computers to perform some of the dispatching functions...."

Shortly thereafter, the Dallas Police Department initiated a program to develop such a system conceived as a simple dispatching assistance tool. The design was done in-house with some consultant support. System testing began in 1969, and the system became operational in 1970. It has been under continuous design change to improve performance and capabilities, so today the system is the heart of a technologically updated communication center which is believed to be one of the best in the country.

In 1971, the LEAA funded a program to develop a computer-assisted dispatch capability for the police department in Charlotte, North Carolina. This design was developed jointly by police department personnel and the Systems Development Corporation. It became operational in 1974 but required another year of debugging, training, and confidence building among the operators before it was acceptable. Since that time, the model has been used in a number of other cities, some successful and others not.

During the 1970's, private industry became interested in the potential value of such systems, and perhaps as many as ten companies initiated programs to develop and market CADs. Such high order of industry interest developed competition with high exposure, starting a trend of system acceptance by public safety agencies.

USAGE

Operational systems became a significant factor by 1975, according to a mid-1975 study by the Jet Propulsion Laboratory (Sohn, 1975), showing 10% of 135 police departments in jurisdictions over 100,000 with CAD. Later studies by Public Systems Evaluation (PSE, Colton, 1981) showed 50% of cities over 250,000 having CAD in 1979, 20% of medium-sized cities (100,000 to 250,000) and less than 1% of cities under 100,000. Approximately 70 CAD systems were in operation in 1979.

INNOVATION (RESEARCH IMPACT)

To date, CAD systems have had limited innovative effects on police operations. Most initial installations of CAD systems were designed to computerize manual procedures which had remained essentially unchanged since the 1930's. In fact, critics of such unimaginative computerization of manual techniques have labeled many initial CAD installations as "expensive, electronic conveyor belts." The innovative effect of CADs up to this time most often has been limited to rapid and systematic call processing and dispatching. That is, most CADs have facilitated doing things as they have been done for the past several decades, but perhaps doing them more efficiently and effectively. This usage does not really qualify as "innovation," as we have defined the term as relevant for police field services research.

The future may hold an entirely different story for CAD, however. CAD systems have at their core a modern digital computer whose on-line computational capability potentially provides enormous decision-making assistance to telephone complaint clerks, dispatchers, and even radio-dispatched patrol officers. Thus, once designers and consumers of CAD systems realize that the computer can be used for other than file handling and straightforward information transferral of functions, and in particular can be programmed with sophisticated scientific algorithms, we then may see the era of "intelligent" CAD systems. Such systems would bring with them a strong innovative component relevant to police field services research. As we have already mentioned in the introduction to this entire section, an intelligent CAD system could be programmed with an algorithm which would estimate the response delay for a particular call from a particular location. The Kansas City Response Time Studies, PSE's Wilmington studies, and PSE's study in Worcester, MA have indicated that citizen satisfaction with police response time depends more on expectation than on magnitude of the response delay. If citizens are alerted to a delay of, say, twenty (20) minutes, forty (40) minutes, or even an hour, these studies have shown that citizen satisfaction is not impeded by these delays (unless, of course, the delays occur for urgent or very high priority calls). Such delay advisory algorithms could be programmed into CAD systems currently, thereby implementing a first-step toward an intelligent CAD system. However, PSE is aware of only one implemented system--the NC4 system in Newark, NJ--which is programmed with such a delay advisory algorithm and that system's capabilities are not used to maximum potential.

A fully intelligent CAD system could provide a general real-time structure for a comprehensive police Management of Demand (MOD) system. By MOD we mean correct prioritization of a call, determination whether to handle the call over the phone or send one or more response units, and if to send response units, whether to send them immediately or to enter the call in queue to be handled at some later time. MOD might also mean scheduling the call response, for instance on the following day. Implementation of a truly comprehensive MOD system could result in reducing the volume of peak-period demands by rescheduling some responses to off-peak periods; having a greater fraction of calls handled by the unit assigned to the beat, by deliberately delaying the call so that the beat unit can respond; increased satisfaction by citizens because of awareness of anticipated response delays; reduced total in-field workload due to handling a very large fraction of calls on the phone; more rapid response to high-priority calls due to a higher probability of availability of cars when they are needed; and more management-type information produced by the system in order to better deploy scarce system resources. Implementation of an intelligent CAD system could drastically change a police department's assigned role to the dispatching function, essentially upgrading it to one that recognizes that dispatching is the careful and systematic assignment over time and space of scarce and valuable police resources. Utilization of the on-line computational capabilities of computers should enable such a change. Police dispatching would then resemble less the dispatching of taxi cabs or pizza trucks and resemble more a complex on-line resource management system not unlike what one sees in air traffic control systems. Such innovation, if it occurs during the 1980's, would certainly be relevant to police field services research.

INSTRUMENTATION (RESEARCH IMPACT)

The most obvious instrumentation impact of CAD systems is in the accurate recording and timely analysis of police response time data. As any reader of this report should know by now, there are many different components of police response time: time from incident occurrence to incident reporting to police; time from attempted reporting until initial contact with police; telephone conversation time; internal police information processing time; queueing delay in the dispatcher's queue; and travel time delay until the responding vehicle arrives at the scene. With the exception of the initial delay--the reporting delay--each of these response time components can be more accurately obtained from a CAD system than from a manual system. Most manual systems relied on a dispatch ticket on which various time elements were recorded either by hand or by electronic clock stamp. The usual times were the time that a call was received, the time that a patrol car was dispatched, and the time that the patrol car arrived at the scene. But even these times were ambiguous in that the time a call was received was most often recorded after the termination of the telephone conversation with a caller; this could be minutes, in fact, after the actual call was initiated. In such systems response time inaccuracies were inherent: the clock time was sometimes not recorded on or stamped in a uniform or consistent manner relative to the actual time of occurrence; many clocks in various positions were not always set to the same time; and a notification by voice radio from the patrol officer upon arrival of the scene could be delayed or even omitted due to voice congestion on the radio channels or due to officer indifference. To make matters worse for researchers the dispatch tickets typically

would be picked up daily and then entered into a lengthy process of keypunching and computer analysis, whose entire duration might last weeks or months. On the other hand, such problems are not likely in a CAD system: the time the telephone is answered by the complaint clerk/evaluator is automatically recorded from an internal master clock when the phone is answered; the time a car is dispatched is automatically recorded when the dispatcher keys in a car number; but the time of arrival at the scene of the incident could be subject to the same delay, error, or omission as in a manual system if voice radio was used. However, CAD systems can now be equipped with an interactive mobile-to-base digital code system, which permits the officer to transmit a short duration code ("Arrived at the scene") that the computer responds to directly and with little or no delay and without operator interface. Also, response time results in other reports are available on demand--after each tour of duty, each day, or whenever decided. For researchers this allows more timely response time information than for manual systems.

The lack of accurate response time data has impeded numerous studies in the police field services area. The researchers who conducted the Kansas City Preventive Patrol Experiment (KCPPE) reported that their omission of response time data from the communications center was due to accurate data not being available from that center. Another researcher from the 1960's, under contract to the President's Commission on Law Enforcement and Administration of Justice, collected extensive response time data from the City of Boston. These data, recorded as usual on dispatch tickets, were flown out of town and analyzed on a distant computer system. One of the conclusions of the analysis was that the communications center delay between receipt

of a call of a robbery in progress and the dispatch of a responding patrol car to that robbery in progress was in the order of seven minutes; however, it turned out that the seven minute delay which was the computed average from several different dispatch tickets bore no resemblance to the reality of police response to a robbery in progress. A robbery in progress, in fact, in Boston at that time, would necessitate switching the caller directly over from the complaint clerk/evaluator to a dispatcher who would dispatch a car to the scene while simultaneously talking to the caller. The complaint clerk/evaluator would have already time-stamped a card for time of arrival of the call, but in the ensuing confusion and high priority response within the communications center, the dispatch card was the last thing that anyone considered. Thus, after the confusion was over and preliminary reports from the scene were available, someone in the communications center at that time would then ask where the dispatch card was, and at that time place the next time stamp on it, which had nothing to do with the time of the dispatch of a car to the scene. Clearly this data-recording mechanism was grossly inaccurate and led the researcher in question to equally inaccurate conclusions. Again we see the instrumentation benefits of the CAD system for recording response time data.

Other instrumentation capabilities of a CAD system involve the possibility of a call-oriented data handling system, in which a researcher could trace the progress of a call all the way from the initial contact to the police to final disposition. The instrumentation capabilities would also involve the analysis of a comprehensive management of demand system, which if installed, could be the subject for one or more future police field services researchers. Since all of the management of demand decisions would be made via the computer, the computer then would have available a complete trace of these decisions over time, thereby facilitating the research analysis.

2.2 AUTOMATIC VEHICLE LOCATION (AVL)

DESCRIPTION

An AVL system displays vehicle location estimates on a real-time basis, usually superimposed on a street map of a city using a Cathode-Ray Tube (CTR). The system must have location accuracy and sufficient frequency of updating to be of value to the user. The system may also process the status of the vehicle in addition to its location, in which case it is known as Automatic Vehicle Monitoring (AVM).

For police application, AVL's objectives were initially conceived as (1) reducing response time by providing location information to the dispatcher to enable "closest-car dispatching," and (2) increasing officer safety so that, in times of emergency, the officer can activate an emergency button which alerts the dispatcher visually and audibly and shows the officer's location, permitting the rapid dispatch of other police vehicles. More recent objectives include new deployment strategies where the dispatcher's knowledge of vehicle location makes it possible to direct the dispatch of vehicles more effectively and efficiently than the traditional all-points bulletin (APB) for in-process events such as robberies, pursuits, etc,; improved supervision of the patrol force because the officers know their location can be monitored, resulting in better behavior; and new management reports which can show miles driven per car, per shift and other relevant data [G. Larson, 1976 and G. Larson and J. Simon, 1978].

A number of location technologies have been developed and/or are in use, of which three types have been implemented for police application. A signpost/proximity type has low-power coded radio transmitters located at intersections throughout the jurisdiction; vehicle location is determined when the vehicle passes or comes within proximity of the signpost; the

vehicle picks up the coded signal on its radio receiver and periodically transmits these codes to headquarters for display. Accuracy as well as cost increases with the density of signposts. A second system is the dead-reckoning type which uses instruments within the vehicle (odometer for distance, and magnetic compass for direction) to determine location; incremental distance and direction of travel are periodically transmitted to headquarters, processed by the computer and added to the previously known position for display. Errors, however, can accumulate to cause the vehicle to become "lost". To make accuracy acceptable, the computer is programmed to keep the vehicle on the mapped streets, to correct distance errors when a corner is turned and, by means of a few automatic signposts that are strategically located in the area served, relocate the vehicle (that has accumulated error) as it passes the signpost. Tests on such a system have shown 90% of the accuracy measurements with essentially no error, and 10% with 450 feet average error. The third system in use is a pulse-trilateration type which uses the propogation properties of radio waves as the means for locating a vehicle; a synchronized transmitter in each vehicle sequentially transmits a short pulse of energy that is picked up by three or more satellite receivers strategically located throughout the area; the difference in reception time between the three (or more) receivers is used by the computer to locate each car. System tests show that 95% of the vehicles have location errors of 300 feet or less.

HISTORY OF DEVELOPMENT

The need to know one's location is an ancient requirement which is best illustrated by ships at sea that used the sun and the North Star as reference. After the discovery of radio, it was soon learned that radio

waves had propogation and direction characteristics that could be useful as navigation aids. This led to the development of Loran A (in the 1930's) and the longer range and more accurate Loran C (in the 1940's) which to this day is the principal means of navigation for transatlantic ships and aircraft. An even longer-range Omega system, having worldwide coverage, was developed and implemented in the 1960's and 1970's.

Within the past ten to fifteen years other applications began to emerge. The President's Crime Commission report "Science & Technology," 1967, recommended the development of automatic car locators (along with automating the communication center with CAD). They recognized that AVL would make possible closest-car dispatching which in turn would reduce response time, result in increased apprehension rate, and deter crime. The Department of Transportation (DOT) has long recognized the need for AVL* for improved schedule adherence on established routes and for control and improved scheduling on random routes. In 1975, DOT conducted a competitive field test in Philadelphia involving four different AVL systems and in 1977-78, another test in Philadelphia, again involving four AVL systems, to determine the winner of a Los Angeles contract covering a schedule adherence system and a random route control system--which system is now being implemented. Perhaps the biggest undertaking is by the US Army to develop a Position Location Reporting System (PLRS) for accurate location, under tactical conditions, of all their vehicles, including boats and aircraft and even key personnel. The type of system is pulse-multilateration (similar to pulse-trilateration but using four or more satellite receivers) using transmissions that are cryptographically secure. Development was initiated in 1976.

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*The Chicago Transit Authority implemented a crude vehicle monitoring system in 1935, and replaced it with a more sophisticated system in 1971-72.

The impact of such widespread government interest, as indicated above, was the development of a large number of AVL and AVM systems by ten or more private companies, using mostly private funding. The obvious motivation for these firms was the acquisition of AVL/AVM system contracts--funded by the government. To date, the return on their investment has been small.

USAGE

At the close of the 1970's only three cities were equipped with AVL systems--each employing a different technology. Huntington Beach, California has a signpost/proximity system implemented by Hoffman Electronics (now Gould) in 1976. It has seen only limited use because of technical problems, caused in part by improper interface with their CAD system. Also, because of the small size of Huntington Beach, the dispatchers feel they know where the patrol cars are and AVL does not materially improve the dispatching process.

St. Louis, Missouri is the only large metropolitan area with a fully implemented AVL/AVM system. The system, a computer-assisted, dead-reckoning type (from Boeing, Wichita division) was implemented first in one district (1974) and then city-wide (1977). This system, too, encountered technical problems causing poor reliability that resulted in lack of confidence by the dispatchers and officers. Operationally, the vehicles in the system became "lost" too frequently, requiring excessive reinitializations and added workload for the dispatchers and officers. Another important factor was the system's failure to meet the two most important objectives: reduced response time and improved officer safety. Evaluation studies [G. Larson, J. Simon, 1978] showed no significant change in average response time and the effectiveness of the emergency feature was impaired by the technical problems. The Boeing Company has diligently pursued correcting the technical problems and improving the system. In 1979, approximately 15 automatic signposts were added in one of

nine districts; when a vehicle passes a signpost, its location is automatically corrected (if it was in error). In 1980 approximately 85 more signposts were added city-wide. Performance, including accuracy and frequency of lost cars, is now claimed to be satisfactory.

Dallas, Texas has a trilateration type AVL/AVM (installed by the Hazeltine Corporation, 1978), implemented in one of five districts and fully integrated with their CAD system (giving visual indication to the dispatcher of the normally preferred 4 or 5 available cars plus the cars closest to the incident). This system appeared to work well, almost from the moment it was activated--but then it, too, developed a technical problem (oscillator drift) that reduced its effectiveness.

INNOVATION (RESEARCH IMPACT)

AVL systems have the potential of providing a multitude of innovations, most of which probably are beyond our imaginations at this time. They could markedly alter the ways in which high-speed chases are undertaken and areas are searched following major crimes. They could facilitate the implementation of truly fluid directed patrol, with the patrol supervisors watching and monitoring the locations and status of the patrol units under their jurisdictions. Even general supervision of the patrol force could be significantly affected, since AVL, for the first time, provides position and status information to patrol supervisors, where previously a spatially distributed patrol force represented a very large labor force essentially unobserved by supervisory personnel. Because the three police departments that currently have AVL installations--St. Louis, MO; Dallas, TX; and Huntington Beach, CA--have experienced technical and other problems with their AVL systems, implementation of substantial innovations made possible

by AVL remain in the future. The one exception is in the St. Louis Police Department where accurate AVL in one district facilitated deployment of an open-beat patrol concept for over a one-year period. As will be discussed below, it has also facilitated a novel set of trial police patrol experiments. But widespread implementation of AVL in police departments probably awaits another breakthrough in technology which would reduce AVL costs and simultaneously increase accuracy and reliability, thereby making it attractive to the majority of police departments.

INSTRUMENTATION (RESEARCH IMPACT)

Of all technologies, AVL probably provides the most revolutionary instrumentation capabilities for police field services researchers. Prior to AVL, no study of police patrol forces included a monitoring of patrol location and status. This particularly impeded those studies which attempted to vary the levels of patrol presence in various locations and times of day. Thus, in the Kansas City Preventive Patrol experiment, for instance, the researchers were never quite sure about the level of patrol activity in each of the three designated experimental zones: control, proactive, and reactive (Larson, 1975). Substantial evidence from such reports (e.g., frequency of patrol initiated activities) indicated that patrol visibility in the depleted zones (i.e., the reactive beats) was much greater than that designed by the experimenters. However, with an AVL system any violation of experimental conditions could be quickly determined and corrective steps taken. In that way the integrity of experimental conditions would be maintained.

Currently PSE is conducting a set of trial runs in the St. Louis Metropolitan Police Department using their AVL system to validate the concept of AVL as an experimental monitoring tool. In many ways AVL could provide the urban researcher with the same capabilities, although on a much different scale, as the microscope provides for the laboratory biologist. Instead of looking at mutant versus normal cells, the urban researcher would look at data on crimes and police patrol cars.

In addition to monitoring the integrity of deliberate manipulations of patrol deployments, AVL also has the potential for facilitating various unobtrusive experiments in police field services. An example would be the study of the statistical relationship between the location and time of a crime and the locations of the nearest police cars. Any statistical dependence could be detected with a carefully arranged study of crime locations and simultaneous recording of nearby police car locations, and then by performing appropriate statistical tests on the resulting data.

As indicated, however, AVL is not widely implemented in United States police departments. Thus, the instrumentation potential of AVL will be limited to the capabilities of currently implemented systems until and unless new AVL technologies become available that other police departments find desirable to purchase and install. Until that time, there was less than a handful of police departments whose AVL systems provide at least a limited version of the potential instrumentation capabilities of AVL for police field services research.

2.3 NINE-ONE-ONE, EMERGENCY TELEPHONE NUMBER (911)

DESCRIPTION

911 is intended as a nation-wide emergency telephone number for citizens to access Public Safety Agencies (PSE). This one telephone number serves police, fire, and medical emergencies, and its principal purpose is to reduce the time required to report an emergency* to a PSA. A three-digit number is easy to remember; the call is automatically routed to the proper Public Safety Answering Point (PSAP); and the call can be dialed from pay-phones without coins. It is likely that the PSAP will be located in the police department, where all calls including fire and medical emergencies may be processed with complainant information into a CAD system, or the PSAP may transfer fire and medical calls to their respective agencies.

Many jurisdictions that have implemented 911 have simultaneously added other technical advances to further reduce delays in the response system: an Automatic Call Distributor (ACD) for complaint clerk/evaluators that sequentially advances successive incoming calls to the next operator and where the call is frequently answered before the caller hears the first ring; and an automatic signal to visually and audibly alert supervisors that incoming calls are in queue for more than 5 or 10 seconds.

An advanced 911 system can have additional features. Jurisdictional Selective Rounting (JSR) routes all calls originating within a jurisdiction to the PSAP representing that jurisdiction. With a memory of all telephone numbers in the jurisdiction, this feature uses a telephone computer to route the calls. In conventional systems a central office (CO) routes calls, and CO's may cover more than one jurisdiction, causing calls to be routed to the

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* Emergency reporting time can be a substantial part of the total response time. See Marvin L. Van Kirk, "Response Time Analysis," Kansas City, Missouri Police Department, 1977.

wrong PSAP. Automatic Number Identification (ANI) displays the telephone number of the incoming caller on the complaint clerk/evaluator's handset from the telephone computer used in selective routing. This feature identifies the caller, permits callback if necessary, and speeds the processing time. Automatic Location Identification (ALI) displays the address where the telephone is located (not necessarily the incident address); its information is derived from another computer containing a geographic address file, having the function of an inverse directory.

HISTORY

911 is a concept which involves telephone companies and requires participation by their personnel to make such a system possible. In 1968, the American Telephone and Telegraph Company (ATT) announded that 911 had been reserved as the all-purpose emergency number in the U.S. During the following ten years approximately 800 jurisdictions implemented it (representing about 25% of the population). Acceptance by many larger cities was slow, perhaps because of the need for Jurisdictional Selective Routing (JSR) to assure correct routing of all calls to the proper PSAP. By 1978, two large areas, Chicago, Illinois and Alemeda County, California had implemented systems with JSR and other advanced features.

USAGE

After the ATT announcement of the 911 concept in 1968, a large number of smaller jurisdictions implemented systems, but many larger cities and metropolitan areas appeared to be delaying the implementation decision. The need and availability of JSR is one factor affecting the delay. Another less obvious, technical reason is the requirement for at least one electronic switching center in the jurisdiction to make the advanced 911 economically feasible. It is understood that center conversion to electronic switching is planned

as a continuous, long-range program by the telephone companies, but a number of years may be required before advanced features can be economically implemented in all jurisdictions desiring them. Other reasons preventing more rapid 911 expansion involve cost (particularly for the advanced system), the reluctance of some PSA's to share the common 911 number and PSAP (fire departments in particular seem to prefer to answer their own emergency calls), and political factors which give higher priority to other programs and considerations.

INNOVATION (RESEARCH IMPACT)

Standard 911 implementations provide only limited forms of operational innovation. They provide more accurate data on the time delays involved in answering 911 calls and the fraction of calls which are lost due to impatience of the caller created by excessive delay in answering. Those standard 911 systems with automatic call distributor systems also facilitate the balancing of workloads among the various telephone complaint clerk/operators. Thus, there is certainly the potential for a more systematic set of procedures for answering the calls for service and for analyzing the performance of the operators in carrying out their duties. However, these current uses for 911 do not really qualify as innovations as they are discussed in this report.

ANI and ALI 911 systems, however, could bring about significant innovation. Certainly such systems would speed response to calls. They could also significantly decrease the frequency of false alarms, due to the threat of immediate apprehension and prosecution of those causing the false alarms. Linked to an intelligent CAD system, ANI and/or ALI could provide the dispatcher and responding officers with information about the location of the call, perhaps related to police hazards that have occurred there in the past or other special public safety conditions that may exist at the scene.

INSTRUMENTATION (RESEARCH IMPACT)

Standard 911 implementations usually include call-counting devices which allow accurate counts of callers who have experienced delays (say, 15 to 30 second delays), or who have hung up due to excessive delay. This kind of instrumentation has not been available in most pre-911 systems.

ALI and, to some extent, ANI could provide the unique capability of demographic analysis of callers for social science researchers of police field services. Since addresses of callers would be known, it would be possible to conduct an analysis of callers by such demographic variables as income level, race, sex, educational level, and other demographic variables usually available from census data. Such a capability would allow researchers to ask questions whether certain segments of the population request a particular type of police service more than other parts do; it would also allow researchers to determine whether callers from certain demographic groups are more likely to be answered or more likely to be screened out by the police in their response. One might anticipate some research along these lines in the mid to late 1980's, once ANI and ALI become more widely established. Of course, extremely careful attention would have to be given to the privacy of callers, and any research results would have to be averaged over broadly defined demographic groups and not individual citizens.

2.4 MOBILE DIGITAL COMMUNICATIONS (MDC)

DESCRIPTION

MDC is a communication system between mobile (patrol car) and base (dispatcher), usually using binary-coded signals and serving as a supplement to voice communications. There are two types of systems in general use: one that transmits "status only" messages using a small encoder terminal

with a few buttons in the vehicle and a small digital light emitting diode (LED) display at the dispatcher location to identify the vehicle number and the message code sent; the other has a full alphanumeric capability for transmitting and receiving written messages (as well as status codes) where both mobile and base are equipped with terminals consisting of a typewriter-type keyboard and an electronic type display such as a CRT or a thin plasma screen, or sometimes a mechanical unit for hard copy. Both types of MDC require vehicle identification by the dispatcher. This is usually accomplished by a short duration (one-quarter second) digital burst at the outset of each mobile transmission; it also serves to identify each voice communication. Usually, the MDC transmissions and receptions are on the voice radio-channel with the speaker automatically muted for the digital signals.

Both the status and alphanumeric type systems save air time because of digital transmission speed versus voice transmission speed and, in fact, the digital transmissions can be sent at any time without waiting for a pause in the dispatcher dialogue--using the separate mobile-to-base channel (which is less frequently busy). Thus, voice congestion is eased, and the mobile-to-base communication is seldom delayed. Also, status signals ("arrived at scene," "available for call," etc.) can be tied directly to CAD systems, inputting data that the dispatcher would otherwise have to handle.

The alphanumeric digital terminal serves two primary purposes: first to process regular dispatches instead of using voice, and second to make information inquiries (e.g., license plate numbers of stolen cars) directly into the local, state, and federal computer files. When used for dispatching, the formatted incident data on the dispatcher CAD display can be transmitted instantly by

simply pressing a function button; it can be sent automatically to the selected patrol car (or cars), using the ID capability for selective calling; and the same message may be automatically sent to 4 or 5 other vehicles in the vicinity for information and possible back-up purposes. Thus a new process for dispatching is created: one that is more accurate (written in place of verbal), faster, automatic, and involves only those patrol cars which are selected for dispatch or may have an interest to know (rather than all cars in the dispatch area, as with voice). Additionally, the mobile terminals have buffer memories for handling several dispatches (or other) messages which the patrol officer can recall for display when desired.

HISTORY

Experiments using alphanumeric terminals have been in process for ten or more years--generally with mixed to unsatisfactory results. The early units were mechanical (producing hard copy), and were generally unreliable requiring excessive maintenance. They also required too much space and were difficult to operate, particularly when the vehicle is moving. The newer units are all electronic, smaller, more reliable and are now being accepted by the users.

USAGE

Alphanumeric MDC systems appear to be gaining acceptance faster than the "status only" type. During the late 1970's, a total of 24 cities have partially or fully implemented the alphanumeric type and by late 1979, an additional 5 cities had ordered systems; approximately two-thirds of these cities have CAD systems, which may indicate an interactive application. Two cities have "status only" units which are integral with their AVM systems. The trend, particularly for the alphanumeric type, appears to be on the increase.

INNOVATION (RESEARCH IMPACT)

Current MDC systems facilitate more rapid and accurate communication between the dispatcher and the police patrol car. Logic suggests that digitized communication would also greatly reduce the number of transactions monitored by general citizens or would-be criminals. Due to pre-coded status buttons, a useful by-product of MDC systems can also be the reduction in the perceived service time of police patrol units because the officer in the car no longer has to wait to gain access to a radio channel in order to advise the dispatcher of his availability for subsequent dispatch; rather he can just press the MDC button that advises his current availability. It is conceivable that in the future considerably more information could be sent by MDC to responding officers, for example special situations at the scene of which they should be alerted.

One might speculate that by the 1990's there might evolve MDC applications in the police field services area that we hardly imagine today. Particularly if the police car had its own microprocessor, MDC could be used for communications from the police car to other computers either in the police department's central headquarters or in a district station house or computers situated elsewhere. The possibilities are far-reaching, but we will have to wait to see what important applications will evolve.

INSTRUMENTATION (RESEARCH IMPACT)

MDC provides limited new instrumentation capabilities for police field services researchers. Clearly, a researcher could have the full file of digital radio communications between the dispatcher and the patrol car for research purposes. Moreover, in any particular research project, it could be possible to designate one or more status codes in the police car as special information codes for research purposes. An example might be a status code to be depressed each time a police car passes a particular address.

III SOFTWARE TECHNOLOGIES: PATROL RESOURCE ALLOCATION

"Resource allocation" has always been an important concern to police administrators. O.W. Wilson (1963) emphasized the need for effective resource allocation strategies in his classic text. Given the impetus provided by the President's Commission on Law Enforcement and Administration of Justice (1967), there has been a considerable amount of patrol methodology development and implementation in resource allocation during the past 14 years.

In terms of cost consequences alone, the need for effective resource allocation methods is apparent. A round-the-clock, two-officer patrol unit costs from $150,000 to $350,000 per year to operate. Patrol costs typically consume 45 to 50 percent of a police department's budget, and salaries, pensions and fringe benefits usually account for more than 90 percent of a police department's total budget. Since the patrol force has prime responsibility for responding to calls for service, for deterring and preventing crime, and providing general public safety services, effective allocation of resources is necessary to achieve these goals within reasonable cost constraints. The ultimate goal of virtually all of the empirical research we have have reviewed elsewhere in this report is the improved allocation (by numbers and tactics) of police field resources.

3.1 WHERE WE ARE

During the past 14 years activities in patrol resource allocation can be roughly categorized as follows:

1. Methodology development;
2. Patrol deployment implementation experience;
3. Experimentation with patrol operating procedures.

We briefly discuss each of these in the following paragraphs.

METHODOLOGY DEVELOPMENT

INTRODUCTION

The state of police patrol resource allocation techniques through 1975 is best summarized in Rand's LEAA-funded study (Holliday, 1975). Related useful overview material is contained in Mathematica's study funded by NSF/RANN (Gass, 1974). However, as will be discussed later, considerable additional work has occurred since 1975.

The formal, mathematically-based patrol allocation methodologies could be categorized according to complexity of implementation:

A. Simple, "back-of-the-envelope" models (to provide general guidance and improve intuition);

B. Computer-based analytical descriptive models;

C. Computer-based analytical optimizing models;

D. Computer-based simulations.

Examples of back-of-the-envelope models are found throughout Larson's book, Urban Police Patrol Analysis (Larson, 1972), and were used in a review of the Kansas City Preventive Patrol Experiment (Kelling, 1974, Larson, 1975). Such models predict, for instance, that police travel time varies inversely as

the square root of the patrol density (i.e., patrol units per square mile), or that the fraction of dispatches that are inter-beat approximately equals the average fraction of time that a unit is unavailable for dispatch. While the results of these simple models are expressed as formulas, a police planner can obtain considerable insight from the models without being able to recite the formulas. Their purpose is to enhance understanding and improve intuition in the complex process of analyzing resource allocation alternatives.

Examples of computer-based analytical descriptive models are the Hypercube model (Larson, 1974, 1975) and Rand's differential equation model for considering time-varying demands for police service (Kolesar, 1974). With such models, the user prepares a fairly detailed data base describing certain aspects of police patrol operation in a city or any part of a city. The computer is programmed with a set of equations that must be "solved," usually iteratively. The user then asks a sequence of "what if" questions, each question specified by a particular selection of decision variables used with the city-specific input data. The computer solves its pre-programmed equations for each selection of decision variables, thereby predicting the operational consequences of each "what if" question. These consequences are expressed as numerical values of selected performance measures, such as mean response times, patrol unit workloads, patrol frequencies, number of inter-beat dispatches, etc. Given each "answer" to the "what if" question, the user must weigh the advantages and disadvantages of each proposed resource allocation alternative, taking into account subjective, nonquantitative factors as well as the quantitative measures calculated by the model. In this way the user's detailed knowledge of the city is combined with the

computer's computational power to reach a "reasonable" resource allocation strategy. A police department must have access to a computer to use such computer-based resource allocation tools.

Examples of computer-based analytical optimizing models include Rand's PCAM model (Chaiken, 1974), Heller's (1973) LEAA-supported scheduling algorithms, and IBM's LEMRAS package (1969, no longer available). Here the computer is again pre-programmed with a set of equations which are to be "solved," often iteratively. However, rather than solving the equations for one pre-specified set of decision variables, the computer optimizes (minimizes or maximizes) some performance measure, thereby determining an "optimal" set of values for certain decision variables. Usually the optimized decision variables are patrol levels, either by hour, by district, or apportioned in some other way. Thus, if a user has access to a computer and is willing to accept a computer-generated "solution" to his resource allocation problem, such optimizing models provide an efficient means for allocating resources.

Finally, examples of computer-based simulations include Larson's police patrol and dispatch sumulation (1972), its Canadian version (Lipsett, 1974), and Rand's patrol simulation (Kolesar, 1975). Here the police planner wishes to explore a sequence of "what if" questions such as done in category (B) above, but the alternatives to be considered are so complex they cannot be specified by a set of mathematical equations that can be solved iteratively. Thus, Monte-Carlo simulation is used, whereby the detailed events occurring in the actual system are simulated in a step-by-step fashion in the computer. Statistical randomness (or unpredictability)

resembling the unpredictability of the actual system is achieved by using a "random number generator" in conjunction with subroutines for sampling from arbitrary probability distributions. Simulation is a last resort, and is used only after model alternatives (A), (B), and (C), have been exhausted. This approach is usually used to study fine-grained changes in dispatch and patrol deployment strategies. Unfortunately, it requires considerable computer time, in addition to that spent in the original programming and debugging, and suffers from the fact that statistical fluctuations in the output performance measures often make interpretations of results difficult.

With the exception of "back-of-the-envelope" models, each of the techniques cited above (See Table XIV) require computer implementation.

Additional insight into available patrol allocation methodologies can be obtained by categorizing the hierarchy of resource allocation decisions and indicating which models are to be used to attack which problem type. Referring to Table XV, back-of-the-envelope models have been used to provide insight into problem types 3, 5, 7, and 8. As for computer-based analytical descriptive models, the Hypercube model can be used to study problem types 5 and 7, and to some extent 2, 3, and 4. Rand's differential equation model is used primarily for problem types 2 and 3. As for computer-based analytical optimizing models, LEMRAS, PCAM and Heller's scheduling algorithms are to be used to attack problem types 2 and 3, and to some extent 6 and 1. Computer-based simulation

Table XIV

Major New Police Patrol Resource Allocation Methodologies

1. Back-of-the-Envelope Models

Urban Police Patrol Analysis, R.C. Larson, MIT Press, Cambridge, Massachusetts, 1972.

2. Computer-Based Analytical Descriptive Models

Hypercube Model

Rand's Differential Equation Model

3. Computer-Based Analytical Optimizing Models

LEMRAS

Rand's PCAM Model

Heller's Scheduling Algorithms

4. Computer-Based Simulation Models

Larson's Patrol-Dispatch Simulation

Rand's Patrol Simulation

Table XV

Hierarchy of Types of Patrol Resource Allocation Problems

1. Determine authorized strength of patrol force.

2. Determine number to have on duty by time of day and day of week.

3. Determine number to have on duty in each geographical command or district.

4. Determine assignment of patrol officers to vehicles (e.g., one officer versus two-officer units).

5. Design patrol beats and patrolling patterns.

6. Determine rules of priority-oriented dispatcher queueing discipline.

7. Determine which patrol unit to dispatch to which type of call.

8. Determine rules for repositioning of available units into temporarily saturated areas.

models can be used to study any of the problem types, but are usually used for types 6, 7, and 8. Thus, new methods are available to help in the analysis of virtually any one of the resource allocation problems usually confronted by an urban police department.

PCAM AND HYPERCUBE

Prior to about 1974, considerable preliminary work had been done by a number of researchers on various aspects of police patrol allocation and deployment. These works were summarized in technical reports, journal articles, and one or two books available at that time. However, none of this research was reduced to a practical form which was accessible to a large number of police departments. The results existed only as equations and other technical procedures in reports and publications, but no resource allocation tools or products existed for police department personnel before 1974. Thus, those police departments which did use formal methods quite often relied on O.W. Wilson's (1963) hazard formulas and their variations. An excellent history of patrol deployment procedures up to this time is available in the paper by Chaiken and Dormont (August 1978).

During 1974 and 1975 which may be called the preliminary years in the field, the results of the previous 5 or so years of research began to bear fruit. Two models, PCAM and Hypercube, became available for public use and have since been used widely by police departments in the U.S. and in other countries. They are still available in the public domain, and their designers still support the systems which implement the models. To our knowledge, these are the only two models related to police deployment

problems that have the characteristics of availability in the public domain and are currently maintained by the model designers. Thus, it seems appropriate to review in some detail the capabilities of these two models.

PCAM, or Patrol Car Allocation Model, was developed by Jan Chaiken and his colleagues at the Rand Corporation, building on earlier, similar deployment models by R.C. Larson (1972) as well as Urban Sciences Inc. and researchers at the New York City Rand Institute. The purpose of the PCAM model is to assist patrol administrators in the deployment of patrol resources by police district and police tour of duty. A district is an administratively distinct unit representing a particular part of the city and usually has a district station house to which police officers report; in many ways each district of a city operates independently of the other districts, even though patrol cars in all districts are usually centrally dispatched from a communications and dispatch office. A city the size of Boston, for instance, has approximately 12 districts and New York has over 60 districts, or precincts. The major purpose of the PCAM model is to help the patrol administrator determine the total number of units needed in each district or precinct; PCAM offers the additional feature of time-of-day variation. A police tour of duty usually lasts 8 hours and represents the amount of continuous time that a patrol officer is on duty. Many police departments have precisely three tours of duty, splitting the 24 hours of a day into three 8-hour tours. Others have implemented overlapping tours, in which four or more tours of duty are designed over a 24-hour period, with three or more of the tours overlapping each other. PCAM helps the patrol administrator determine not only the total

number of units for each district, but also the number of units to have in each district by tour of duty. The tours can be organized in such a way that the week is split into 21 or more tours. That is, different numbers of individuals may be required on Tuesdays versus Saturdays during the same hours of the day. PCAM even allows a limited overlap in tour design capability.

The data required by the PCAM model are essentially the following:

1. An estimate of the hourly rate of calls for service by district and by priority levels and by tour of duty;
2. The average patrol service time for each priority of call;
3. Patrol unit response speed by priority;
4. The square mileage in each district;
5. The speed of a patrol unit performing preventive patrol;
6. The patrollable street miles in each district;
7. Limited technical data with regard to the frequency of police patrol initiated activities (i.e., activities undertaken by a police patrol unit which remove the patrol unit from dispatchable status and which are not assigned by the central dispatchers)
8. Weighting factors indicating the relevant importance of delay in each of the priority levels.

In using PCAM, the standard mode of operation is to attempt to optimize some critical patrol system performance measure, subject to a number of constraints which represent target levels for performance in each of the districts. An example of a constraint would be the maximum allowable average travel time to urgent calls in each district; this might be set equal to 5 minutes. One could put other constraints on the frequency of preventive patrol passings at various points in a district, on the average queueing delay by priority of call, on the total response time by priority of call, or on a number of other operational quantities. In this mode of operation the PCAM model first determines the minimal number of patrol units to have on duty in each district in each tour of duty in order to satisfy all the constraints imposed for each district and during each tour of duty. This gives a base level distribution of patrol units. If there are any other additional patrol units that may be allocated throughout the city, and which are not needed solely to satisfy constraints, then the PCAM model allocates these additional cars to districts and to tours in a way which optimally satisfies the stated city-wide objective. A most often used city-wide objective is the weighted average city-wide response time to calls for service, weighted according to priority level. There are other modes of operation as well, and these are discussed in the excellent and thorough documentation of the PCAM model (Chaiken and Dormont, 1975, 1978).

The Hypercube model, developed by R.C. Larson in the early 1970's (1974, 1975), assumes that the patrol administrator has already determined the total number of patrol units to have on duty in a particular district during a particular tour of duty. Thus, in planning time sequence, one assumes use of the PCAM model first, followed by the Hypercube model whose purpose is to study more fine-grained deployment options within a police district, e.g., designing police beats or sectors, selecting preferable dispatch strategies,

deploying relative amounts of preventive patrol efforts, deploying sergeants' and other specialty cars (perhaps in overlapping beats), and even evaluating the effect of a new technology such as an Automatic Vehicle Location System. The Hypercube model is intended to replace ad hoc manual beat design procedures, which have been available since the 1930's, and to extend the beat design problem into an integrated structure of related problems. After using the Hypercube model, the police planner usually has available an acceptable beat design with accompanying dispatch procedures and perhaps integrated deployment of supervisory and other support personnel in overlapping beats.

The Hypercube model assumes that the district being examined is divided into a number of geographical "atoms" or statistical reporting areas. Each "atom" or reporting area usually comprises four to six city blocks, known in St. Louis, Missouri as "Pauly Blocks." A typical city may have anywhere from 200 to 2,000 reporting areas, but in using the Hypercube model any particular district typically has 50 to 200 reporting areas, and use of the model becomes cumbersome if the number exceeds approximately 250 reported areas. Like the PCAM model, Hypercube requires estimates of the hourly rates of calls for police service, but in this case one requires those estimates from each of the reporting areas in the district. Also needed are estimates of the travel times from each reporting area to all other reporting areas in the district. In most cities these travel times are difficult and expensive to obtain empirically, so the Hypercube model has programmed within it certain approximate formulas to allow the planner to automatically generate approximations to these travel times. The Hypercube user can also provide as input data the relative amounts of time that each unit spends on preventive patrol in each of the reporting areas in its beat(s); the model

allows as a default option that this time will be adjusted directly proportional to the call-for-service volume from each reporting area, thereby eliminating this data burden from the model user. Also, like the PCAM model, the Hypercube requires that the user specify the service time required for each call and the response speed of responding vehicles. Certain data regarding dispatch policies are also inputted by the user. The Hypercube model, as developed in 1974-75, and as available in the public domain as a deployment product, assumes that precisely one unit is dispatched to each police call for service.

A diverse and interesting set of performance measures are produced by the Hypercube model:

1. Region Wide. Mean travel time, average workload and workload imbalance, fraction of assignments outside a unit's primary response area.
2. Response Unit Specific. Workload (measured in fraction time busy servicing requests), mean travel time, fraction of responses outside the unit's primary response area.
3. Primary Response Area Specific. Internally generated workload (which is an input measure), mean travel time, fraction of requests for service by other than the primary response unit.
4. Atom Specific. Internally generated workload (which is an input measure), mean travel time, fraction of requests serviced by each unit n where n ranges from unit 1 to unit 2 up to N, the total number of units.

If the user desires, the Hypercube model can also calculate the frequency of preventive patrol passings in each of the geographical atoms.

Both the PCAM and Hypercube models are available in various programming options. For instance, both models are available in either time-sharing mode or in batch processing mode. PCAM is programmed in FORTRAN, whereas Hypercube has various versions in PL/1 and COBOL. Technical details are available in the respective users' manuals (Chaiken, 1975, Larson, 1975).

RECENT WORK

PCAM and Hypercube successfully incorporated most of the useful and substantiated police patrol research results that were relevant to patrol deployment up to 1974 and 1975. However, since 1975 there has been considerable additional work done, much of it spawned by the original PCAM and Hypercube models. It is the purpose in this section to briefly review this work and indicate its relevance to the currently existing patrol deployment models. With regard to recommendations for police field services research, it is noteworthy that all of the results in the past six years exist essentially as stand-alone pieces and technical documents and none of them has been incorporated into a new publicly available patrol deployment tool, even though the entire volume of useful research results since 1975 far exceeds the total volume prior to that time. (This can be verified by examining the references at the end of this chapter.)

During the mid 1970's it became apparent that automatic vehicle location systems were being seriously considered for implementation by a number of U.S. police departments. At that time, the cities of St. Louis, Missouri, Dallas, Texas, and Huntington Beach, California, were in the process of implementing AVL systems, and PSE had been hired by the National Institute of Justice to formally evaluate the St. Louis experience. In response to this interest and activity, R.C. Larson and his associates at MIT made the decision to generalize the Hypercube model and allow the user to model

police dispatch and district operations under the assumption of AVL dispatching, i.e., a dispatching situation in which the dispatcher always assigns the closest available response unit, and does not make errors by estimating the locations of the units as is common with most manual dispatch systems. This research, with Evelyn Frank, resulted in a complex set of mathematics, which was implemented into the publicly available version of the Hypercube model and is reviewed in a loose-leaf enclosure to the Hypercube user's manual (Larson, 1975, 1978). This generalization of the Hypercube model represents the only basic mathematical generalization to the model that was first released in 1975. All subsequent research results that bear on the Hypercube model and the PCAM model have basically existed by themselves, not implemented into either model.

One major limitation of the Hypercube model, which the PCAM model was more successful in circumventing, was the assumption that precisely one response unit was dispatched to each call for service. Recently, Chelst (1981) developed the mathematical results for allowing multiple unit dispatching within the Hypercube context. Chelst's empirical studies seem to suggest that the predictive capability of the model is comparable in accuracy (typically between one and two percent of exact models) to that obtained by Larson with his approximate form of the Hypercube model (Larson, 1975).

Another major limitation of the original Hypercube model was the assumption that a police response unit can be in only one of two states: either responding to a call for service; or available for dispatch, performing preventive patrol. This assumption ignores the reality in many cities that a patrol unit can be in a third state, namely on a self-initiated or patrol initiated activity (as discussed above). Recent research by Larson and McKnew has resulted in a new set of procedures and equations for modeling police patrol initiated

activity within a Hypercube framework (Larson, 1981). Their empirical analysis with this model also shows high predictive accuracy, comparable to Larson's original work (1975).

Another limitation on the Hypercube model was the assumption that if the user did not provide an empirical travel time matrix, the travel times would be computed according to a formula which assumed that total travel distance was the sum of the east-west and north-south distances. This assumption is the so-called rectilinear, or right-angle, or Manhattan travel metric. But research in the borough of Manhattan itself, in the late 1970's, revealed the inadequacy of the Manhattan distance metric due to barriers to travel, such as Central Park. Thus, it became necessary to provide computerized techniques for making more accurate travel distance matrices without imposing a huge data burden on the user. This led to additional mathematical work by R.C. Larson and Victor Li on finding minimum rectilinear distance paths in the presence of barriers to travel, a paper originally motivated by their police work in New York in the late 1970's, to appear in Networks (1981).

Recently, a considerable amount of work has been done (Larson, Sadiq, Berman, to appear in Operations Research) on combining queueing theory and the theory of optimal location of facilities and response units. Again, much of this research was motivated by the original Hypercube model, and much of it has led to very interesting and potentially useful results. It is not our intention here to go into technical details, but merely point out that, again, new research results are available which have not be implemented in a user-accessible police field service resource allocation product.

Some of the police users of the Hypercube model have complained that the model is merely descriptive in that it does not recommend the proposed new beat designs. In response to this comment from users, several researchers have developed algorithms or procedures (Chelst, 1975; and Bodily, 1976) for the computer to automatically generate improved beat designs. Like the other relevant Hypercube work, these procedures and methods have been implemented in a publicly available version of the Hypercube model.

Additional, potentially relevant work for both the Hypercube and the PCAM models has been done by Jarvis (June, 1975), who studied the optimization of dispatch policies and district boundaries in urban emergency services; by Halpern (1977), who validated the accuracy of a service time estimation technique that is used by Hypercube and can be used for the PCAM model; and by Olsen and Wright (1975), who developed models for better allocating preventive patrol efforts. The correct allocation of preventive patrol coverages throughout a beat and a district is a potentially important problem for patrol administrators but has never been addressed within either the PCAM or the Hypercube framework.

Limited implementation experience with these models and with subsequent research results seems to suggest that the research results will never be used on an operational basis unless and until they are available in a user-accessible package such as PCAM and Hypercube. Thus, there appear to be considerable research results available which are waiting compatible installation in a revised and updated package or set of packages.

In summarizing the technical developments in police patrol deployment in the last 14 years we might note the following:

1. The majority of methodologies are computer based, requiring access to computer hardware.

2. Most are designed for use by a central police planner, and ignore other police decision makers, such as district captains, dispatchers, and roll-call sergeants.

3. Most were developed assuming "standard" patrol operations, where one patrol car is assigned to one beat; each car performs both preventive patrol and call answering duties; and queueing delays are minimized by allowing frequent inter-beat dispatching. (As previously discussed, the Hypercube model does allow overlapping beats.) But most models that have been analyzed are not suited to other types of patrol operations, perhaps involving the split-force concept, team policing, scheduling of demands, etc.

4. Most require data that are routinely available only in large police departments with substantial computer support.

5. Most were developed by operations researchers, who focused on quantitative performance measures while ignoring many subjective concerns.

During the course of the development of the methodologies discussed, there have been implementation experiences in patrol experiments that have altered our thinking about "standard" patrol operations. These are discussed in the following sections.

PATROL DEPLOYMENT IMPLEMENTATION EXPERIENCE

In the mid-1970's, several case studies involving the implementation of new patrol resource allocation methods were carried out by Colton and Hebert (1978), by the Rand Corporation (Holliday, 1975, Chelst, 1975), the Research Triangle Institute (Plotecra, 1974), and by Heller et. al, (1977). In addition, Colton's analyses of the impact of computers on U.S. police departments has added to our knowledge in this area (Colton, 1972 and 1974). Also, Chaiken has attempted to monitor the implementation impact of PCAM, Hypercube, and Rand's differential equation model (Chaiken 1978).

There are some general conclusions we can draw from these analyses of the implementation process:

1. In a significant fraction of cases, a police department attempting to implement a computer-based resource allocation methodology eventually "gave it up," and resorted to familiar manual methods.

2. Usually, the "success" or "failure" of an innovative resource allocation project critically depended on one key (sympathetic) contact person within the police department. His or her promotion or removal would often mean doom for the project.

3. On several occasions, the patrol-dispatch operating procedures assumed by the methodology changed before or shortly after implementation of the methodology, thus invalidating the assumptions of the underlying model and making its utility for resource allocation limited.

4. Focussing the work with one or a small number of departmental personnel often created resentment, hostility, and apprehension in other resource allocation decision makers, (e.g., district captains, roll-call sergeants, dispatchers). They often misunderstand the purposes of the new resource allocation tool, feared that their own decision-making power would be supplanted by the computer and/or a police planner, and lacked the necessary technical background to grasp the conceptual elements of the method.

5. The "optimizing" type of resource allocation method, due to data or methodology limitations, often calculated obviously poor recommended resource allocation decisions. This tended to reinforce the negative attitudes of those who were already opposed to the method.

6. On occasion, a department would try a new police deployment policy (say team policing) in one area of the city, only to find that their new resource allocation methodology was too inflexible to adapt to the new procedures. Thus, as with many current CAD systems, acceptance of a resource allocation methodology tended to "lock in" a department to its current patrol procedures.

These problems seem to clarify that new procedures must be sought in implementing formal resource allocation methodologies in the future.

EXPERIMENTATION WITH PATROL OPERATING PROCEDURES

During the period of development of the new resource allocation methodologies, several major experiments and innovations in policing have been tried and are discussed in detail elsewhere in this report. As a result of knowledge gained from these experiences, patrol policies throughout the nation are likely to become more flexible and resemble less the traditional beat-oriented, response-time minimization policy popular in most cities for many years. Such flexibility will require concomitant flexibility in resource allocation methodologies.

Perhaps the key experiment performed during this period was the Kansas City Preventive Patrol Experiment (Kelling, 1974). While critics have questioned the precise interpretation of the experimental results (Larson, 1975, Davis, 1975), there is fairly general agreement that a district captain or roll-call sergeant has much greater flexibility in spatially deploying his units through the district than previously thought. Thus, if certain precautions are taken (Larson, 1975), spatial assignments of units (resource allocation problem type 5) may vary by tour of duty more frequently, thereby affecting the selection of units to dispatch

(decision type 7) and any repositioning strategies (decision type 8). It is important to bear in mind that these revised decisions will be made more frequently than decisions made by a police planner and that they will be made by non-technical field personnel.

A second key experiment is the Kansas City Response Time Experiment (Van Kirk, 1977), which suggests that response time minimization is not nearly as important for the majority of calls to the police, as previously thought, thus reducing the need to deploy patrol resources in a way which minimizes response time. With this result, still greater flexibility is possible in allocating resources, and resource allocation methodologies that focus solely on response time minimization will have limited use.

With such added flexibility, police departments are now trying new operating procedures involving team policing (Hebert, Colton, 1978); split patrols (where the "responsive force" answers calls for service and the "preventive force" performs directed crime preventive patrol) (Tien, 1976); and police service aides (civilians) for responding to low-priority calls, thereby freeing up the regular patrol force for robbery/burglary investigative duties (Tien, 1976). Future resource allocation methodologies should be flexible enough to adapt to such changing operational environments.

With the increased use of split patrol forces and other concepts that result in crime-directed patrols, resource allocation methodologies will have to be broadened from their earlier focus (often on calls for service and response time minimization) to explicitly include preventive patrol and the allocation of preventive patrol effort. Some recent work based on search theory (Koopman, 1956-57, Stone, 1975) has shed valuable light on the allocation of preventive patrol (Chelst, 1975; Barnett, 1974; Elliott, 1973; and Olson, 1975), but much more has to be done. This could involve

the processes and feed-back of crime data within a 24-hour period so that based on the most recent crime patterns, patrol strategies (and most likely beat coverages) would be affected the following day. By allowing simultaneous consideration of patrol coverages and call-for-service operations, any degradations in call-for-serivce performance due to revised crime directed patrol strategies could be determined with a combined resource allocation methodology; thus, the police user would have to consider the tradeoffs in performance in the two areas to select the "most reasonable" combined resource allocation strategy.

As a result of the installation of new hardware systems, many departments are revising aspects of their resource allocation policy, perhaps initially as experiments and now as standard operating systems. These especially include CAD and AVM systems. CAD systems often incorporate in the computer software a "dispatch preference" matrix that suggests to the dispatcher which patrol unit to dispatch, given the location of the call and the current availability of units. This matrix, if not easily adaptable to change, can "freeze" a department's dispatch policy (resource allocation decision type 7) and--even more critical--its patrol beat design (resource allocation decision type 5). Most currently existing CAD systems have this undesirable side effect.* Just as it is important to remove this constraint from CAD systems, it is also desirable to remove it from resource allocation methodologies.

*Newark's NC-4 system does not; it allows day-to-day changing of the dispatch preferences.

AVM systems, by providing the dispatcher with current estimates of patrol locations, will result in a revision of dispatch strategies (decision type 7). While AVM systems are most often thought of as response time minimizing systems, they could also be used to assign a specialty unit (e.g., family dispute unit (Bard, 1970), bilingual unit) to an incident requiring specialty assistance; the real-time location feature could be used to perform an instantaneous tradeoff of response time (associated with the closest unit) versus on-site specialty capabilities (which would most likely require a greater response time). Whatever a department's use of AVM, it will affect dispatching strategies in some way (decision type 7) and perhaps other components of the resource allocation hierarchy (perhaps 4, 5, 6, and 8). Thus, future resource allocation methodologies should be sufficiently adaptive to allow for such changing policies based on new technologies. One illustrative step in this direction is the aforementioned methodological work on the Hypercube model which generalized the model to allow for "closest-available-car" dispatching (Larson, 1978).

Perhaps most critically for the 1980's is the realization that fiscal constraints place severe limitations on total numbers of personnel available to perform police services in U.S. cities. The standard response in the past of simply adding personnel to respond to increased demands for service from the public is no longer acceptable nor feasible. More likely, in many cities personnel levels are being cut even in the presence of steady or increased demands for police services. Thus, resource allocation methodologies of the 1980's and 1990's must focus on efficient and effective ways to use limited and costly

police resources. An example of such an approach, and mentioned elsewhere in this report, is a broadly based management of police demand system in which the police department attempts to quickly screen out unnecessary calls; handle a larger fraction of calls on the telephone; prioritize calls so that only urgent calls are handled with deliberate speed; advise the caller of anticipated delays in the response; and dispatch units having only those skills necessary to service the incident (e.g., non-specialist officers, or even civilians, may be sufficient to handle a significant fraction of calls for police service). As far as we are aware, there exists no resource allocation methodology suitable for integration with a comprehensive management of police demand system.

3.2 WHERE WE SHOULD GO

Given the developments cited in the previous sections, future methodology development in the patrol resource allocation area should have the following properties:

1. To the maximum extent possible, any new resource allocation methodologies should be flexible enough to adapt to a department's changing operating policies, whether the new policies are motivated by new police research results, changing patterns and levels of demands for police service, changing priorities within the city, restricted budget levels, or new technologies.

2. New resource allocation methodologies should explicitly consider crime-directed patrol and alternative patrolling strategies. This would broaden the previous methods' narrow focus on calls for service and response time minimization and would provide valuable guidance in this relatively new area of patrol decision-making.

3. The resulting techniques should be largely accessible to small and medium-sized departments, and the insights generated by utilizing these techniques should be obtainable without requiring access to a mainframe computer.

4. Those techniques that must be computer-based should be available on a readily accessible time-sharing system, preferably allowing natural language interaction with the user. To the extent possible, the various computer packages should be compatible (at least in the sense of utilizing standard definitions, the same computer language, and perhaps the same "master" data base).

5. Whatever resource allocation methodologies are are developed or revised, they should be accessible to all decision makers in a police department. This does not necessarily mean that every district captain, roll-call sergeant, or dispatcher would have a computer terminal or set of formulas at his side. However, he should be allowed and encouraged to acquire the insights obtainable by use of the methodologies, particularly as they pertain to resource allocation decisions in his domain. Accomplishing this would include the generation of "rules of thumb" for guidance in his decision; such rules could be obtained by exhaustive analysis of complex models, but they must be translated into language understandable to the appropriate decision maker.

6. Special effort should be directed at gaining a broad base of support for any new resource allocation methodology within a department. This would reduce the chance of failure due to change of status of one or a small number of influential personnel. It will require intensive effort in the area of model-user interface, particularly for non-technical users.

7. New academic disciplines, especially those associated with the behavioral area, should be brought to bear on the resource allocation problem. For instance, behavioral scientists (especially organizational theorists) focusing on implementation as a special case of

organizational innovation, could perhaps shed light on the difficult implementation problems encountered in police departments. Perhaps economists focussing on social losses due to crime and on inequities in the distribution of police services could contribute to new resource allocation methodologies. Or decision theory, with its new results in multi-attribute utility functions (Keeney, 1976) and multi-decision maker models (Bodily, 1976), could play an important role. Whatever the selection of disciplines, the narrow focus on easily measurable operational quantities must be broadened to encompass other important concerns--both quantifiable and nonquantifiable. One potential research program having the properties cited above is outlined in the Appendix.

APPENDIX A

OUTLINE OF A RESEARCH PROGRAM

APPENDIX A: OUTLINE OF A RESEARCH PROGRAM

One reasonable research program implementing the results of the section on resource allocation would involve a three-phase program:

Phase I: Needs of Municipal Police Departments in the 1980's

Phase II: Methodology Development

Phase III: Test and Implementation

Each of these phases is discussed briefly in the following paragraphs.

PHASE I: NEEDS OF MUNICIPAL POLICE DEPARTMENTS IN THE 1980's

This first task would survey a stratified sample of U.S. police departments to discover their technical capabilities and perceived needs in patrol resource allocation. The stratification would be by city size and technical capability (computer and otherwise). The survey would include questions on the following:

1. Resource allocation data currently available within the department (separating departments with CAD systems and categorizing data whether it is machine-readable). This would also include sample sizes, levels of geographical aggregation (e.g., whether the department has a beat-design independent small area reporting system), and timeliness of data.

2. In-house analytical capabilities (e.g., computer systems, computer programming, operations research, statisticians, systems analysts). Position in the hierarchy of the police organization of any technically trained personnel.

3. A listing of current resource allocation decision making, both "formal, and "informal," by type of personnel making the decision (see Table 1), by type of decision made (see Table XV, p. 37), by frequency of decision (see Table 2), and by type of data and/or methodology used, if any, in making the decision.

4. A listing of the types of patrolling methods now used or contemplated that would be assisted with improved resource allocation methodologies. These types of patrol, in addition to standard patrol, could include team policing, split patrols, partially civilian patrols, variable beat boundary patrols, AVM dispatching, selective stacking, family dispute units, crime-directed patrol, detective patrols. For each, the rules under which they operate, including who determines allocation decisions such as the types listed in Table 2.

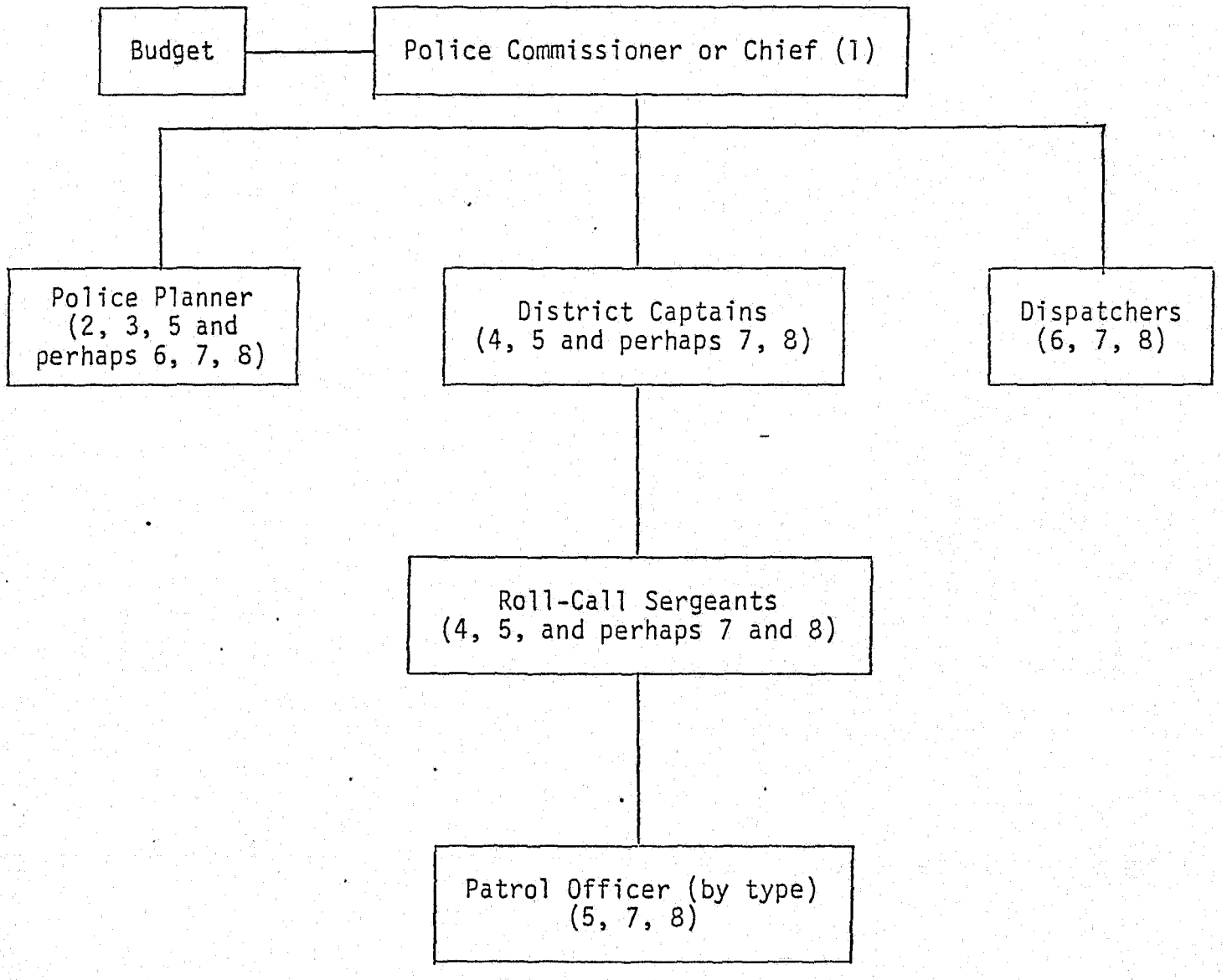
5. A listing of the types of quantitative performance measures that decision makers find useful in comparing resource allocation alternatives. These might include, but are not limited to, workloads, response times, patrol frequencies, numbers of cross-beat dispatches, crime interception probabilities, fraction of calls of a certain type handled by a patrol specialty unit of a certain type, citizen complaints about patrol coverage, officer complaints about resource allocation methods, apprehension probability, number of self-initiated activities, patrol miles driven, etc.

6. A listing of the types of qualitative issues that are important in implementing and sustaining a new resource allocation method. These might include comprehensibility of the method's write-up, the need for on-site personal instruction, the steepness of the associated learning curve, the ability of the method to assist rather than dictate decision-making, the flexibility of the method to adapt to changing environments, the comprehensibility of the method when explained to citizens' groups, etc.

Table 1

Hierarchy of Command

(and of Resource Allocation Decisions)*



* Numbers in parentheses refer to types of patrol resource allocation problems dealt with in some manner by each type of personnel.

Table 2

Typical Frequencies of Resource Allocation Decisions by Personnel Type

Personnel Type \ Resource Allocation Problem*	1	2	3	4	5	6	7	8
Police Commissioner or Chief	annually	-	-	-	-	-	-	-
Police Planner	-	annually or by season	annually or by season	-	annually or by season	annually	annually	annually
District Captain	-	-	-	as often as daily	as often as daily	-	annually or by season	annually or by season
Dispatcher	-	-	-	-	-	often subjectively reused in real time	each dispatch decision	minute-by-minute
Roll-Call Sergeant	-	-	-	each 8-hour tour	each 8-hour tour	-	as often as each 8-hour tour	as often as each 8-hour tour
Patrol Officer	-	-	-	-	minute-by-minute	-	each dispatch (may volunteer	each dispatch (may voluntarily reposition)

* Summarized as follows: 1) authorized strengths; 2) scheduling decisions; 3) allocation by geographical command; 4) assignment of officers to vehicles; 5) design of patrol beats and patrolling patterns; 6) rules for priority-oriented dispatching; 7) selection of unit(s) to be dispatched; 8) repositioning of available units

In addition to surveying police departments, a somewhat modified survey along the lines described above could be administered to a sample of those individuals and organizations that provide technical services (in the resource allocation area) to police departments.

As a result of these surveys, and in conjunction with whatever related work is occurring or has occurred recently (see, for instance, (Plotecra, 1974; Colton, 1972; Stenzel, 1977), additional recommendations regarding required methodology development for Phase II would be generated.

RECOMMENDATIONS FOR PHASES II, III

The information from Phase I would be used in conjunction with recent published materials in resource allocation and related areas to arrive at a detailed set of recommendations for Phases II and III. Additional sources to be consulted would include Rand's book on their work with the New York City Fire Department (1979), MIT's final report of the NSF-sponsored IRP Project (Larson, 1978), and Colton's final report on his LEAA-funded project on the impact of technology on U.S. police departments (Colton, 1978).

Moreover, attempts would be made to discover the reasons for success or failure of not unrelated technology transfer and technology assistance programs, such as LEAA's aborted "Pilot Cities Program" (Murray, 1975), or the programs of Public Technology, Inc., (Fox, 1973), or Stenzel's work in California, (1977).

In addition, new results from new disciplines would be brought to bear on the problem. In the behavioral science area, the research area of innovation as an example of organizational change is discussed in (Colton, 1978), and contains useful information for our purposes. In the area of economics, recent works such as Municipal Output and Performance in

New York City (Graytak, 1976) would be consulted. The research team should include one or more individuals from the behavioral science or economics area.

Attempts would be made to extrapolate from the results of the Kansas City Preventive Patrol Experiment (Kelling, 1974), the Kansas City Response Time Experiment (Van Kirk, 1977), the Worcester Impact Program (Tien, 1975a), the Wilmington Split Patrol Project (Tien, 1976b), the St. Louis ARAC Project (Larson, 1976), and other new experiences in patrol operations. Also, reference would be made to LEAA's recent Phase I evaluations of patrol programs (Schell, 1976).

From all of these materials a detailed list of tasks and schedule of activities for required methodology development (Phase II) would be produced.

PHASE II: METHODOLOGY DEVELOPMENT FOR THE 1980's

While it is too early to outline specific elements of this second phase, it can be stated that the purposes of this phase would be four-fold:

1. To modify, generalize, make compatible, and otherwise change existing resource allocation methodologies to reflect the findings and recommendations of Phase I.

2. To incorporate the input of behavioral scientists (especially organizational theorists), economists, and others to arrive at a recommended process for institutionalizing change in the form of new methods of resource allocation in police departments.

3. To develop entirely new resource allocation methodologies that cannot be constructed simply by modifying currently existing packages.

4. To develop user-accessible resource allocation packages analogous to the 1975 Hypercube and PCAM packages.

MODIFICATION OF CURRENTLY EXISTING METHODOLOGIES

Work on this task could include, but not be limited to, rewriting computer programs in other languages (e.g., FORTRAN to COBOL), redefining program data to facilitate data compatibility, writing user-oriented documentations and other instructive materials, modifying data formats to be compatible with CAD systems, etc. In addition, it most likely would include a non-technical writeup or "rules of thumb" that can be derived from analysis of currently existing techniques. Perhaps several different sets would be documented, one for each major type of decision maker.

INPUT OF BEHAVIORAL AND OTHER SOCIAL SCIENTISTS

The goal here is to extrapolate from only partially successful or totally successful projects of the past and from knowledge in the behavioral sciences to arrive at a recommended process for implementing new resource allocation methodologies. Recommendations would be made regarding dissemination (e.g., using NTIS, NCJIS, PTI, IACP, ICMA, and other organizations); instruction and education, (e.g., incorporating resource allocation materials in LEEP-sponsored courses); outside technical assistance (i.e., consultants); incentives and reward structures; internal flow of information within a police department; continued learning and updating of the methodology to reflect current operating policies and procedures, etc.

DEVELOPMENT OF NEW METHODOLOGIES

Here new methods would be developed to assist in those resource allocation situations not adequately covered by existing methods even when modified. The work most likely would be focused on resource allocation in various specialty patrol situations, perhaps involving team policing, split patrols, selective stacking, AVM dispatching,

variable beat patrols, detective patrols, etc. and require the input of behavioral scientists, economists, and other social scientists, in addition to that of the methodologist.

DEVELOPMENT OF USER-ACCESSIBLE PACKAGES

Experience with PCAM and Hypercube has shown that police administrators will use only formal resource allocation techniques if they are available in a user-accessible package. Thus, whatever new methodologies are developed in the early 1980's, they should be packaged with the results that have appeared in the literature since 1975 in a new set of resource allocation programs to meet the needs of the 1980's. In particular, it seems that such programs could focus on cost constraints that many cities face today, and at the same time concentrate on increased flexibility and management of police demands. The developed packages should be as fully documented and maintained as the PCAM and the Hypercube programs. It also would be advisable to conduct formal workshops or seminars in the newly developed procedures within the police user community.

PHASE III: TEST AND IMPLEMENTATION

Work in this final phase would test the resource allocation methods and implementation processes developed in Phases I and II in two or more operating environments. The primary purpose of the phase is to verify the results and recommendations of Phases I and II and, where necessary, revise and update them to reflect operational realities. Although it is too early to specify details for Phase III, the implementation process most likely would not be in the form of demonstration projects which in the past have involved out-of-state consultants who left when the project was completed. These demonstration projects, as they are commonly known, also had short time deadlines, interaction was with only

one or a small number of departmental staff, and other activities occurred that did not fit in with the regular workings of the department. It is hoped that these causes for failure could be avoided in Phase III.

The implementation approach may be viewed as one that tries to build up a "constituency" of the resource allocation method within the department prior to implementation and that allows the natural course of events to lead to continued, sustained implementation. The constituency may be brought together in sponsored workshops, courses or lectures. Perhaps videotapes would be made to introduce the new concepts of resource allocation, or presentation of the new methods would be made in IACP-sponsored workshops. Whatever the choice, it is clear that considerable effort must be directed toward establishing methods according to their intended utilization.

APPENDIX B

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