EVALUATION OF POLICE PATROL OPERATIONS

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INTRODUCTION

Several attempts have been made in recent years to measure police system response times and, in one case, to study the effects of these times on the outcome of calls for police service. For instance, Larson sought to measure patrol unit travel times with the City of New York Police Department; Isaacs arranged an experimental design which sought to demonstrate that the probability of arrest is directly proportional to the immediacy of response. However, no study to date has illustrated a cause and effect relationship between response and final disposition or outcome of a call for service. The present state of knowledge does not explain the effect of change in police personnel and hardware on police system response time nor what effect change in police system response time has on the final outcome or disposition of a call for service. This study seeks to answer some of these questions.

A measuring device, called a tachograph, was installed in a downtown patrol car and monitored for a 336-hour test period. Information obtained from the instrument included speed in miles per hour, distance in fractions of a mile and elapsed time to respond to a request for police assistance. Action taken by a police officer upon arrival at the scene of an occurrence or event was coded according to six types on an action/no action dichotomy. Communications centre response times and patrol unit travel times were correlated by occurrence and outcome types. An analysis of variance (F ratio test) was conducted to test for significant differences between police system response times and outcome types; a Scheffée post hoc procedure was used to locate the significant differences, if any, between the outcome types.

The results failed to show that police system response time has an effect on the outcome or disposition of a call for service. It is suggested that citizen reaction time or the time from the occurrence of an event till the police are made aware of a situation may be of greater importance in determining the final outcome of a call for police service.

CHAPTER I

THE POLICE FUNCTION WITHIN THE CRIMINAL JUSTICE SYSTEM

The criminal justice system has one basic aim: to protect individuals and members of society by reducing the level and effects of crime and delinquency. It is suggested that there are four basic approaches for pursuing the strategy of preventing individuals from entering into criminal activity; these are as follows (7):

1. Ensuring that laws are consistent with the values and responsive to the aspirations of society;

2. Alleviate conditions that promote crime;

3. Reduce opportunities for crime;

4. Increase the risk in committing crime.

The police component of the criminal justice system traditionally has been charged with the responsibility for enforcement of the law and maintenance of public order. This broad definition of the police function (17) may not however be a reflection of the actual duties and responsibilities. Several methods have been employed in an attempt to define the role and function of the police. These range from finding out from the public what they feel the police should do, by recording and analyzing their actual work, and finally, by using a judicial approach which defines what the police should and should not do. Within and emanating from these terms of reference, it is possible to view the contemporary role in concrete, functional terms. Enforcement of

the law is intended to eliminate or reduce incidents of crime; this primary objective may be achieved by (17)

a) the prevention of crime through
   (i) control of opportunity and the passive intimidation of potential offenders, and
   (ii) the propagation and dissemination of societal values by active participation in crime prevention programs;

b) the intervention in criminogenic situations with
   (i) assistance in conflict resolution, and
   (ii) control of human behaviour;

c) the enforcement of existing law, that is,
   (i) the detection of crime and apprehension of criminals, and
   (ii) the solution of crime through gathering evidence;

d) the development of public empathy and goodwill by
   (i) services rendered in emergencies, and
   (ii) sensitivity to public opinion.

Unfortunately, there is little empirical data to indicate whether the police function has a positive or negative effect in the attainment of the primary objective.

It has been hypothesized that criminality could be reduced by actual or seeming police omnipresence which acts as a deterrent through the potential offender's perception of an increase in risk. This police omnipresence is dependent on the manner in which policemen are deployed. For the efficient deployment of police manpower it is necessary to

predict when and where a crime is likely to occur, to calculate how far the policeman would be from the area and how quickly he is able to respond to a call for service. Manpower and budgetary limitations, however, prevent the police sometimes from being as near the scene of an event as they would like and from answering a call as quickly as they should. They are frequently forced to adopt a system of response taking the calculated risk first that a relatively minor incident would, with the elapse of a few minutes or hours, deteriorate into one of a more serious nature and second, of increasing the probability of the disappearance of both suspect and evidence. In the absence of actual omnipresence, a seeming omnipresence is created by the most effective deployment of available manpower resources. One technique developed is the current patrol system. The underlying rationale behind this system is:

a) a psychological component; there is a passive intimidation in that a randomly deployed patrol force offers an element of surprise,

b) the identification of opportunity for criminal activity by an officer who is alert to his environment,

c) the identification of actual criminal situations, and

d) the availability of a police officer near the crime scene.

All police forces usually seek to prevent and deter crime by the impression of their omnipresence, apprehend criminals at or near the scene of an offense, and perform essential public services such as responding to calls for assistance from the public (20).

Deployment of Police Forces

Basically, there are two ways in which a force may be deployed to meet these broad objectives: moving randomly about a designated area, termed preventive patrol, and responding to calls for service. Preventive patrol is seen as a police function which seeks to prevent, deter or reduce crime. An underlying assumption in deterrence is that, by increasing the threat of apprehension, the risk in committing the crime increases (that is, the probability of being caught) and so reduces the likelihood of the crime being committed (10). Assumed here is that a person, before he commits a crime, must somehow base his decision to proceed on an evaluation of three factors: a) what he has to gain if he is successful, b) the magnitude of the punishment if caught, and c) the probability of being caught (13). While the police have little or no control over the first two variables, they can create a public impression of police omnipresence through the use of preventive patrol such that potential offenders will think there is no opportunity for successful misconduct (10).

Preventive patrol constitutes touring an area by an officer who constantly views his environment. He perceives misconduct or correctable hazard and, through direct activity such as on scene arrest, citation, or other appropriate activity, fulfills his function. This may be seen as direct patrol activity. Similarly, preventive tactics are associated with the simple presence of police officers at times and areas where opportunistic crime, or more generally, misconduct is likely to happen (12). Elliott (13) sees preventive patrol as a body of police manpower which is mobile and has available large blocks of time to devote to the prevention of crime by its presence on the street, the interception of crime while it is in

progress, and the apprehension of criminals immediately after a crime has been committed.

It is believed, however, that the advantages of preventive patrol may be seriously diminished during periods of force congestion. Most cities do not attempt to maintain at least a minimal continuous level of preventive patrol (20). For example, in a study of the Oakland Police Department, completed several years ago, it was revealed that only 2% of police patrol hours were actually spent on preventive patrol. The balance of the time was spent responding to calls for service and attending to administrative functions (2). Response to calls for service may be seen as one of the most visible and important outputs of a police department. Calls may come from members of the public who consider themselves in dire need of police assistance, from members of the force itself while in the field, or from other agencies such as private police forces. These calls arrive in a variety of ways: by letter, personal appearance, telephone, radio, call box and alarm system. They come at all times and for all conceivable reasons. For example, at a recent conference, it was stated that of all police calls received, 80% dealt with social problems and only 20% were actual criminal cases (8). Statistics from the Toronto Metropolitan Police have shown this to be so (1).

Normally, there is a standard operating procedure for the police response system. It may be broken down into two main components: 1) communications centre time, and 2) patrol unit response time. Communications centre time includes that period from successful contact with the police until a decision is taken as to what is to be done until the call. This decision may be a) redirection of the call to another appropriate city or private agency, b) giving immediate direction or advice and thereby satisfactorily completing the call at that moment, c) dispatch of a patrol

unit immediately, or d) placing the call in a dispatch queue for dispatch of a patrol unit later on. Larson (20) describes the stages in this process as contact with the police, information gathering, information conversion and recording, transmittal to dispatcher, entrance to dispatcher queue and finally, dispatch of a patrol unit. Patrol unit response time refers to the time elapsed from the dispatch of a unit to an occurrence and the arrival of that unit at the scene.

Contact with the police may take one of many routes as has been previously noted; most calls for police service reach a police department communications centre via telephone. Because of the need for quick contact with the police, several police forces have instituted a common emergency number to replace a cumbersome standard one. In some cities, calls for service often exceed 1,500 calls per hour during evening hours, which necessitates a complement of more than 40 complaint clerks to process incoming calls (20); Chicago reports 8,000 calls for service per day received during the summer of 1969 (5).

Once the contact is made, information regarding the call must be gathered and recorded. This includes the time of receipt of the call, the name and address of the complainant, and the location and type of occurrence. It then becomes the responsibility of the complaint clerk to decide what action must be taken and once this decision is made, how best it could be implemented. These decisions are not without error. The complaint clerk is faced with the dilemma on the one hand of assigning a low priority, or terminating a call, which subsequently results in serious injuries, extensive property damage, or even the loss of life. On the other hand, careless screening of incoming calls could result in too many dispatches with the result that the response force becomes saturated, increasing the probability of not being able to respond quickly to high priority calls for service (20). The main purpose of the police response system

is to ensure rapid dispatch where necessary. The city of Chicago has over the past decade put strong emphasis on rapid response to any citizen request where an officer can render service or assistance (5). By so doing, it is suggested that injury and death may be avoided and property damage may be diminished which may, over time, have the positive effect of increased assistance to the police by an empathetic public.

Many methods have evolved within communications centres to facilitate the transmission of information from a complaint clerk to the dispatcher. Some departments continue to transmit this information manually with the complaint clerk handing a card directly to a dispatcher; others have made improvements to the extent of using conveyor belts. In the 911 system developed for the city of New York, a complaint clerk, while processing the call, prepares a dispatch form, a colour coded, three-part snapout, which is sensitized and requires no carbon paper. The original or white copy goes to the central report desk for record, notification and other processing; the duplicate or yellow copy goes to the ambulance dispatcher, with the triplicate or card stock going directly to the dispatcher. The report to the dispatcher is sent on a signal directly to the computer for assignment to the queue. If the call is a priority call, an override circumvents the queue, blocking out other calls and pushing the priority call through. Another capability of the data oriented system is what is termed signal redundancy in which a signal is transmitted many times per second with bursts of energy to compensate for tunnels and poor reception and transmission areas. Data oriented systems have the capability to control the area or size of radio dispatch zones; this is a computer-controlled divided or joining capacity in which radio zones are increased or decreased according to dispatcher manpower requirements. The data oriented system is useful for statistical analysis in that pertinent data is stored for future review.

Depending on the assessed urgency or priority of call, the call for service is either a) dispatched immediately to an available patrol unit, or b) entered into dispatch queue. Queuing occurs when the emergency response system reaches a saturation level; this can occur in two ways. Firstly, dispatcher saturation (20) is a state in which incident reports or complaint cards arrive at such a rate that a dispatcher cannot physically process them. The other aspect of response system saturation, and probably of greater consequence, is patrol force saturation (20). This situation occurs when all eligible units are busy at the scenes of incidents. It becomes essential therefore to place the dispatch into queue. In cases of high priority calls, it may be essential to pre-empt a patrol unit servicing a call and dispatch this unit to the call of higher priority.

Availability of units to respond to calls for service is of paramount importance. Patrol units responding from adjacent zones may be in position to respond more rapidly to a call for service than the resident zone car; the resident zone car may also be engaged in which case an adjacent zone car might respond. Lipsett (21) in a study of a semi-rural police force found that a minimum 12% of all calls for service were interzone dispatches. A strategy instituted by the city of Chicago police force in 1966 to ensure maximum manpower allocation for both preventive patrol and calls for service requirements was the "split-force" concept. With this tactic, the responsive force serviced calls from the public, while the preventive force concentrated on crime preventive patrol. With this partitioning, it was theorized that the preventive force would consider crime prevention their prime responsibility (20), whereas a predetermined number would respond solely to calls for service. In so doing, it was believed that a minimum number of patrol units would be available for each type of service.

Patrol Deployment Strategies: The Theory

Deployment of patrol forces involves many strategies; a constant question for administrators is how to best realize the police function and objectives using these strategies. The literature suggests that the various methods and tactics are not mutually exclusive and that, it is only through a combination of various tactics that the police function attains optimum performance and results (6). Accordingly, manpower and equipment is distributed throughout jurisdiction according to demonstrated need in terms of time and location by adopting patrol techniques designed to most effectively meet the prevailing problems (10).

Various patrol methods are in regular use by municipal police forces. These include fixed beat patrol, magnetic beat patrol, fluid patrol, flexible unit patrol, modified flexible unit patrol, the crime control team (13), and team policing (25). Additional commentary on patrol deployment strategies are to be found in Brown (6) and Jayewardene (17).

Crime Intercept Probability

The effectiveness of preventive patrol has been questioned. What is the probability of an offense being detected using this strategy? The results to date are inconclusive. Isaac's (16) study suggested that 18% of cleared cases involved actual observation of an offense by an officer in the field. Larson (20) views the intercept probability of preventive patrol as being minimal: for instance, if a patrol car was to pass a fixed point once every hour, and it took one minute to commit a criminal act such as a street robbery, then the probability of intercepting such a crime could not be expected to exceed 1/60.

Intercept probabilities are even smaller in residential areas where patrols are much less frequent than one per hour. There are at least two implications of this result. First, the task of detecting crimes in progress cannot be assigned solely to police patrol. Cooperative citizens, alarm devices, and other detectors are required to increase detection (and apprehension) probability. Second, the crime deterrent aspect of preventive patrol is brought into question. Do infrequent patrols that are sometimes monitorable pose a true threat of detection and apprehension?

Elliott (13) estimated that the coverage time needed for a single patrol of a city is four hours and that the average time in which the patrol has an opportunity to come in contact with a Part I crime is two minutes. From this, he deduced a value of 0.0083 as the probability that a patrol will intercept a crime. He suggests that the method to increase the intercept probability is an offensive tactic called random area search by a crime control team. Random area search is an offensive tactic which describes the probability of detecting an event (a crime) that takes place within a given area by an observer (the patrol) moving continuously in the area in a random manner. Patrolling in a random manner means that there is no fixed or quasi-fixed sequence by which the patrol visits each point in the area - yet all points in the area are visited within some average time. Because patrolmen can observe up to 60% of known Part I offenses (26), it is thought probable that the Crime Control Team would make immediate arrests of persons committing such offenses.

Specifications for the offensively-deployed team are as follows:

(1) A unit of the force must pass by every point in the city with such frequency that there is a high probability of intercepting any crime that occurs in those locations where a policeman has a legitimate right to be.

(2) The patrol must not be sent on a non-criminal complaint unless there is an emergency situation. If a unit does become involved, its territory must be covered by adjacent patrol units.

(3) The force (Crime Control Team) must be deployed with due regard for the expected type and location of crime based on an analysis of previous criminal activity for the particular season of the year, day of the week, hour of the day, and so on (9).

According to Elliott, in order for the project to succeed, it is essential to use many shifts. More manpower has to be placed on the streets when the need is great and less when the need is small; they must be divested of the responsibility of automobile accidents, family disputes and public intoxication, and their investigatory function has to be drastically reduced. The Crime Control Team's modus operandi then is to try to control crime first, by preventing crime from occurring. If this tactic fails, then the team tries to intercept the crime. If both prevention and interception fail, the Team investigates (13).

The results in his experiment are not encouraging. In the city of Syracuse, the Crime Control Team performed

outstandingly, compared to the bulk of the Syracuse Police Department during the period of the experiment, regardless of the measure or combination of measures used to evaluate the performance. For example, the Crime Control Team obtained an interception rate of 3.8% during the year, which is about 6% higher than the interception rate of the regular Syracuse police patrol. This value falls far short, however, of the expected rate of 10-15% (13). This would seem to be consistent with Larson's remarks on intercept probabilities previously mentioned.

The experiment does not clearly demonstrate in fact, that the limited success was due in its entirety, or even in part to the formal organizational concept of the Crime Control Team. The performance might have been the result of using above-average policemen, superior leadership, the Hawthorne Effect (positive effect of being in an experimental setting) or a combination of these and other unrecognized factors.

Reiss (24), in an investigation of patrol activity of the Chicago Police Department, concluded in an analysis that police do not detect significant amounts of crime; the analysis found that only 2.55% of patrol time was spent handling criminal matters. Of those criminal matters processed by the patrol division, 93% were citizen-initiated. It follows from this that only a minute portion of the time on preventive patrol results in the discovery of incidents which are processed in the system of criminal justice. Further he suggests that if the productivity of some of the most highly pro-active units of the patrol division are analyzed, it will be found that that unit generates very few criminal or non-criminal incidents. Studies currently underway in Kansas City are corroborating Reiss' findings on police crime detection capabilities; as such, these findings threaten to explode traditional assumptions about moving patrols'

effectiveness in preventing crime (19). Preliminary results (22) indicate that the regular random patrolling of the streets by uniformed men in marked cars does not prevent crime. In matched sample areas over a one-year test period, there was virtually no change in the levels of reported crime using one patrol car, four or five patrol cars, and no patrol cars. These tentative findings would seem to negate the work of Elliott (13) who advocates the interception patrol concept in which police concentrate their efforts on preventive patrolling.

Measures of Patrol Effectiveness

Evaluation of patrol may be done in several ways. One method is the measurement of efficiency; generally speaking, efficiency deals with measures that are internal to a system, such as the average fraction of a patrol force that is on the streets over a stated period of time. These are input criteria. The justification for their use stems from their supposed relationship to results or output criteria such as crime rates, arrest rates, and clearance rates. These criteria can themselves be used as instruments of measurement. This type of measurement is referred to as effectiveness measurement. A third method of evaluating a patrol system is through the use of intervening variables such as the police response system, that is communications centre and patrol unit response times. Measurability of input or output criteria has several facets: the ease or difficulty in determining values of a criterion; dollar and manpower costs or obtaining and processing the information, and the frequency with which reliable measurements of the criterion value may be taken (18).

Input versus Output Criteria

Input criteria, such as the number of men or cars

on patrol or the demand for service are traditional measures of efficiency and are readily understood, measurable and statistically analyzable. However, Kakalik and Wildhorn (18) argue that output criteria such as patrol units' response times are better measures of effectiveness in that reduced response time means more effective police service by raising the arrest probability near the scene of a crime.

Several output criteria which have been suggested as measures of effectiveness for both preventive patrol and calls for service are:

(1) Patrol arrest rate, by crime category.

(2) Charging rate, by crime category, with an indication of whether the patrol arrest occurred in response to a call or during preventive patrol.

(3) Reported victimization rate, by crime category and citizen group.

(4) Reported crime, by crime category.

(5) Percentage of citizens satisfied with various aspects of patrol service.

(6) Elapsed time from a call for police service until arrival of a patrol car; measured by both the average time and the percentage or response times exceeding a specified time.

(7) Preventive patrol frequency.

(8) Hours of preventive patrol per "suppressible crime".

(9) Resources expended: total patrol budget, total patrol man-hours and total car-hours, plus a breakdown of each total into percentage allocated to each patrol function (18).

Larson (20), as well, indicates that there are several criteria for evaluating performance of the police response system including

system response time
system error probability
amount of preventive patrol
probability of criminal apprehension.

Amongst these factors, total system response time, which is the elapsed time between requesting police service and the arrival of that service, is an important measure of police accessibility and responsiveness and can be seen as an output criterion.

Clearance rates, a standard measure of patrol effectiveness is normally rejected as an output criterion. because of its susceptibility to bias and the pressure it places on police officers to bargain with offenders. Clearance rates may be defined as the fraction of crimes reported to the police that the police claim to have solved (14). Similarly, suggested output criteria for measuring the effectiveness of preventive patrol include:

. Number of crimes (reported, true, prevented).

- Percentage change in number of crimes (reported, true).

- Victimization rate, or its rate of change.

- Public attitudes and cooperation.

- Social and economic costs of crime.(18)

However, until the difficulties in measuring true crime, true victimization and the social economic costs of crime are resolved,[1] proxy measures such as the number of arrests by patrol and the charging rate resulting from patrol must be utilized, with charging rate appearing to be the most useful measure of effect (18).

Greenwood (14) (1970) in conjunction with the city of New York Police Department conducted a two-phase study designed to a) develop rational criteria for evaluating the effectiveness of apprehension programs and operating units, and b) to apply these criteria to existing programs.

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[1]The author recognizes that the preventive and deterrent effect of patrol cannot, in itself, solve the crime "problem". This is borne out to a large extent by Frasier in his thesis, Crime and Punishment: A Systems Dynamics Analysis, when he states that an increase in police manpower was not effective in eliminating the continual rise in crime because of the relative attractiveness of other variables. For example, without changes in the overall criminal justice system, the increased fear of arrest in the short run through additional manpower is more than counteracted by long run system variables and interactions such as the increased numbers of free criminals, increased probation (as a result of larger percentages of guilty pleas, shorter effective average prison sentences and reduced probability of prison). Recognizing this, it is the purpose of this research to look only at the relative effectiveness of one component of the criminal justice system, police patrol.

It would seem, according to Greenwood, that there are several schools of thought as to what constitutes a measure of patrol effectiveness. A supporter of the Due Process Model would hold that, all other factors being equal, an arrest that leads to conviction is more valuable than an arrest that does not, since only in the former is legal guilt established and the criminal sanction properly applied. A more extreme proponent of the Due Process Model might even argue that an arrest that does not lead to conviction inflicts a net cost on society since the defendant is liable to feel some undesirable effects even though he is not legally guilty. Crime Control advocates would agree that an arrest that leads to conviction is likely to engender more powerful deterrent and rehabilitative effects than is mere arrest. They would not agree that arrests without conviction are valueless, because the simple act of arrest carries some deterrent and punitive effects, and their faith in the system would often lead them to attribute factual guilt to the arrestee, even if legal guilt could not be proven. They would therefore view the effects as deserved and desirable, not the reverse.

Greenwood in his discussion as to what constitutes a measure of effectiveness suggests that since the relative weighting between these two types of arrests is a matter of subjective judgment, the number of arrests and the percentage of convictions must be reported separately, so that an evaluator can apply his own weighting, rather than accept some formal scheme that obscures these figures. This view is substantiated by an analysis of court proceedings in which significant charge reduction occurred in every case which resulted in a guilty plea or a verdict. As such, this charge reduction process should be examined in much greater detail before the usefulness of court findings as a measure of police performance can be determined. Greenwood summarizes his study by stating that the probability of arrest differs

vastly between the crimes of passion - homicide, rape, and assault - and the crimes of profit - robbery, burglary, and larceny. This probability is high for crimes of passion; and the study of assault showed that the probability increases as more effort is devoted to each case. For crimes of profit the probability of arrest is extremely low (0.06 robbery, 0.01 for burglary, and 0.02 for grand larceny), nor does it appear to increase if more effort is devoted to each case. In fact, the vast majority of arrests for property crimes are pickup arrests made near the scene of the crime or as a result of evidence that is readily apparent at the time the crime is reported.

Review of Research

O.W. Wilson (27), at the First National Symposium on Law Enforcement Science and Technology, made reference to studies measuring patrol effectiveness some 29 years before. He states that

> A study made 29 years ago indicated that if the police could respond to an emergency call within 30 seconds, there was a 76% chance that they would apprehend the criminal. If they delayed longer than 90 seconds, the chance of apprehending the offender at the scene fell to 26%. A recent study by the President's Crime Commission produced similar results.

Isaacs (16) in 1966 conducted a study of communications, dispatch and response times, in conjunction with the city of Los Angeles Police Department. While the study is often cited as a clear demonstration that the probability of arrest is directly proportional to the immediacy of response, a critical inspection of the research indicates

severe limitations. For example, the entire data base upon which the analysis was completed consisted of Code 6 messages - that is, limited data were collected only in the instances in which an officer relays his arrival time to the dispatcher. In reviewing the work of Isaacs, members of a task force within the Kansas City Police Department (23) state that the response time data used in the study were eight-month old communication data, not specifically gathered for statistical analysis; similarly, they state that the study fails to illustrate a cause and effect relationship between rapid response, per se, and subsequent arrest. Finally, the members of the Kansas City Task Force state that a portion of the arrests used as statistical evidence were the result of direct observation rather than police response to a call for service.

The Kansas City Police Department, in July 1968 introduced a computer-based crime analysis program termed LEMRAS (Law Enforcement - Manpower and Research Allocation System) whose objective was to forecast when and where patrolmen will be needed to combat crime and answer calls for assistance. An important statistic coming from this study was that the metropolitan police solve two-thirds of the crime which they can respond to within two minutes whereas less than 20% of the crimes were solved for which the response time was delayed more than five minutes (28).

The Operations Research Task Force of the Chicago Police Department (5) came into being in February of 1968; its purpose was to demonstrate how operations research could in fact improve efficiency in allocating patrol resources. For example, while the city-wide average indicated that the ratio between response activity and preventive patrol activity may be about 60:40, the actual distribution of activity is such that the units have time for little but response during the busy periods such as evening shift. Similarly, the

Task Force reported that entire districts found themselves with no units available to handle emergency calls; this situation was only partially resolved by drawing units from other districts which resulted in longer response times and a severe maldistribution of resources.

Bottoms (5) states that there is considerable evidence that probability of arrest is directly proportional to the immediacy of response. Consequently, he concludes that one important measure of effectiveness is elapsed time, the time from the occurrence of the criminal event until the response unit arrives. Similarly, other measures of effectiveness of the response unit are those involving quality of police service and thoroughness of the case for follow-up when arrest does not follow directly from the response.

The results of the Chicago Task Force study are interesting. For example, the modal value for Communication Centre response time is about 90 seconds with the average being three minutes as measured by response to robbery complaints. Similarly, the total police response (communications centre plus patrol unit) time had a modal value of four minutes and an average of about nine minutes.

In 1969, the Edina Police Department (Minneapolis, Minnesota) conducted a research project (3) designed to develop a system of random patrol that would reduce the time required for a police officer to respond to a call. It was hypothesized that if the patrol areas are assigned to cars on a random basis, probability theory predicts that patrol cars will be closer to the point of need when they are requested than under any other system of patrol assignment.

The results are interesting, for several reasons. Firstly, it was demonstrated that cars assigned on a random basis were closer to the point of need when requested. Thus,

according to the report, the primary goal - reduction of average response time was achieved. There was, however, no corresponding difference in response time between random patrol and routine patrol, probably due, it is thought, to the intense competition between those officers who were on routine patrol and those on random patrol. Of special importance to this present study were the results obtained for response times. Comparing the test period (April 1968 - March 1969) with a control period one year prior, the authors claim that the average time decreased by 40% from 7.05 minutes to 4.22 minutes - this in spite of a 19% increase in calls for service. These results were further tested by introducing random patrol in all zones for one quarter (April - June, 1969); during this period, response time decreased to 3.74 minutes. During the final quarter (July - September, 1969), random patrol was terminated in all zones; the average response time rose approximately 8% - from 3.74 to 4.03 minutes.

This study is noteworthy in that statistical analysis was conducted on a large sample ($n = 14,500$); in addition, the design was longitudinal and introduced control zones. Whether the decrease in average response speeds was due to random patrol or the Hawthorne effect (the effect of being in an experimental situation) is open to question. However, the research design failed to empirically establish why decreased response speeds was important. While the researchers were able to zero in on the areas of greater criminality from an analysis of the reports, and thus assign patrol units to zone areas equal in crime potential, they failed to correlate the effect of decreased response time with a decrease in crime or whether response time is critical by offense type.

Larson (20), in conjunction with the New York City Police Department conducted a two-week data gathering

experiment in 1969 which focused on the delay between receipt of a call from the public at police headquarters and the arrival of a patrol car at the scene of the incident. During a two-week period from February 17th to March 3rd in 1969, an analysis was made to determine empirically the operating characteristics of the radio-dispatched patrol force, including the percentage of time spent on various activities, the response time to calls for service, the spatial distribution of the force, the dispatching algorithm, and similar issues. From this study, the following results were obtained:

> The time between receipt of a call by telephone operators at 911 and dispatch of a patrol unit to the call ranged from 2.4 minutes to over 15 minutes. The median value was 5.8 minutes. The larger delays occurred when the dispatcher was forced to enter some of the arriving incident reports in queue. Time for the dispatched patrol unit to travel to the scene of the reported incident ranged from 3.6 minutes to 9.8 minutes, with a median value of 6.2 minutes. The larger travel times are usually associated with precincts which have relatively large sectors and/or which have relatively large workloads. Average travel distance ranged from 0.78 miles to 2.91 miles, with a median value of 1.62 miles. The larger distances were usually associated with precincts in which the "density" of "available" cars (i.e., average number of "available" cars per square mile) was relatively low.

The work of Larson is commendable because it is a mathematical statement about the operating characteristics

of a radio-dispatched patrol force. The work of Larson would seem to meet the criteria set out by Kakalik and Wildhorn (18) who argue that intervening variables such as patrol unit response times are better measures of effectiveness; it is their contention that reduced response time means more effective police service by raising the arrest probability near the scene of an occurrence. However, Larson, as well as Kakalik and Wildhorn, fail to prove that this relationship does in fact exist; they both fail to test the hypothesis that decreased response time increases the rate or probability of apprehensions, and for which types of offenses, if any, is response time critical. According to a critique of the work of Larson by the Kansas City Task Force (23), the majority of efforts to develop response time formulae through computer simulations of the patrol response system have accepted intuitive judgments and assumptions underlying traditional police operations; they are not however, grounded in empirical research that seeks to validate the framework on which the models are based.

Lipsett (21) of the National Research Council conducted a computer simulation and analysis of the patrol operations of a semi-rural police force near Ottawa, Ontario. Briefly, data provided by the Township of Gloucester were used to determine parameters for simulating patrol operations by computer. In the simulations, the average time between calls for service, number of cars, types of zones and dispatch and reassignment policies were varied. By means of these simulations, results were obtained for patrol time, workload, response time, queuing and other parameters.

The intent of this work was not to measure the effectiveness of police patrol as such, but to analyze the interactions of patrol variables. Consequently, hypothetical response speeds and response times are employed in order to assess the effects of maximum and minimum variables on the dynamics of a patrol system. Suggested response speeds

were 50, 40, and 30 miles per hour for priority 1, 2, and 3 calls respectively. These speeds were not the results of empirical testing, however, nor was any attempt made to measure patrol effectiveness by correlating response speeds with apprehension rates.

In August of 1973, the Kansas City Police Department was awarded a grant of $530,656 by the Law Enforcement Assistance Administration of the U.S. Department of Justice to determine a) when response time is a critical factor in combating crime, and b) to recommend what police departments can do to reduce response time when it is a crucial factor.

The 30-month Kansas City project (23) is divided into two phases: (1) Independent observers will gather pertinent data at the scene of the crime, then conduct follow-up interviews with the police officers involved and with the victims. (2) The data will be analyzed and procedures developed to implement fast response time for crimes which the data indicate need swift police action.

The following hypotheses have been stated for the purpose of measurement:

A. Preventive Patrol

1. Crime, as reflected by victimization survey and offenses known to the police, will not vary by types of patrol.

2. Citizen perception of service will not vary by type of patrol.

3. Citizen cooperation in processing of incidents will be greatest in the reactive sub-area.

4. Citizen complaints about police service will be greater in the proactive sub-area.

5. Citizen fear and behaviour, as a result of fear, will not vary by type of patrol.

6. There will be no variation in the types of calls for service by type of patrol.

7. Traffic accidents will increase in the reactive areas.

8. Traffic violations will increase in the reactive areas.

B. Response Time

1. As response time increases, on-scene apprehension of offenders will decline.

2. As response time increases, the extent and nature of injuries to victims will increase.

3. As response time increases, the availability of witnesses will decrease.

4. As response time increases, citizen dissatisfaction with police service will increase.

5. As average response time in an area decreases, the incidents of predatory street crime will decrease.

It is the belief of this task force that it probably would not be beneficial to reduce response time for all crimes from 10 minutes to 6 minutes; however, arrest is more likely if response time can be reduced so that officers arrived while a crime was in progress. It is their hypothesis that response time also is critical in providing non-criminal emergency services, such as aid at the scene of an automobile accident.

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CHAPTER II

THE EXPERIMENT

The literature on the police patrol system reviewed in Chapter I indicates that traditionally police efficiency and effectiveness have been measured by two sets of criteria, system input and system output. System input criteria are the number of policemen on duty, the number of cars in service, the hazard/workload formula and the like, whereas system output criteria are represented by crime rates, arrest rates, clearance rates and so on. The use of either depends on a series of assumptions which link the criterion utilized with the objectives of police work. Police work is traditionally defined as the maintenance of law and order and commonly interpreted as the prevention, detection and investigation of crime. However, in the final analysis, it consists of responses to calls for service of a varying nature. These responses involve a procedural nexus on which the input-output relationship is dependent. Once an incident is identified by the public as one calling for police intervention, there is the call to the police, the transference of this call to a patrol unit for action, the arrival of the patrol at the scene of the incident, and the action taken by the officer at the scene. Each of these procedures is dependent on a number of variables. Thus, the call to the police depends on the nature of the communications system in society, the transference of the call for action on the availability of police personnel and hardware, and the arrival at the scene on the initial patrol location and the speed at which the patrol travels.

The study of the effect of input variables on output suggests that the relationship is dependent on a number of intervening variables, such as citizen reaction time, police system response times, and patrol unit response speeds. Police system response time is defined as the elapsed time from initial

PROCEDURAL NEXUS FOR INPUT-OUTPUT VARIABLES

INCIDENT OCCURS — TIME OF INCIDENT

CITIZEN REACTION TIME

1. Interpretation of event as calling for police action by the public.
2. Contact with the police dependent upon
   a) distance to police station
   b) nature of communication system

CALL TO POLICE — TIME OF CALL

POLICE SYSTEM RESPONSE TIME -

COMMUNICATIONS CENTRE TIME

1. Receipt of the call by the police.
2. Contact with patrol unit dependent upon
   a) other calls waiting in queue
   b) availability of personnel
   c) availability of hardware

TRANSFERENCE OF CALL TO PATROL UNIT — TIME OF DISPATCH

PATROL UNIT TRAVEL TIME

1. Rapidity of response dependent upon
   a) position of patrol unit
   b) speed of travel
   c) distance to location of incident

ARRIVAL AT SCENE OF INCIDENT — TIME OF ARRIVAL

SERVICE TIME

1. Investigation
2. Action - disposition or outcome of call

SERVICE COMPLETED — TIME CLEARED

contact with the police until arrival of that service at the scene of an occurrence or event (schematically presented on Page 30). Patrol unit response speed is the rate in miles per hour at which the responding unit travels in order to arrive at the location of an event. Both of these have special significance for police work. Among the assumptions related to the concept of deterrence on which the validity of the traditional measures of police efficiency rests, the rapidity of police response plays a crucial role. In addition to this, there are recent findings that public satisfaction with police work is dependent, not on the long range effects of police work reflected in crime rates, but on a feeling of security sponsored by the ready and rapid availability of the police in time of need.

Attempts have been made to study the effect of each of the procedural steps outlined above on the output of the police, but no studies have been conducted to relate input to output through the intervening variables. The present state of knowledge does not tell us what changes in police personnel and hardware result in what changes in police response time, and what effect changes in police response time has on the final outcome or disposition of a call for service. This study is designed to provide answers to some of these questions. What is specifically seeks to do is first to relate the final outcome or disposition of a call for service to patrol response time and then to relate patrol response time to the availability of police personnel and hardware if it is found that the final outcome of a call for service is dependent on patrol response time. The purpose of this study is to provide empirically derived information which will permit the police to more effectively organize the deployment of their personnel and hardware. The first part of the study consists essentially of monitoring patrol cars over a period of time for the collection of data which will permit the comparison of response times with the action taken and the second part the comparison of

response times with the deployment procedures utilized during the period of study.

The design of this study necessitates the collection of three types of information which could be, for convenience, identified as input, intervening and output variables. Input criteria used for the evaluation of a police force, such as the number of patrol cars available for dispatch, the number of men to staff the cars and perform beat duties, the area of zones to be patrolled, and the locations, frequencies and types of calls for service are readily available. These data could be utilized on a collective or an individual basis. For example, the sum total of all men and cars over a period of time could be used, or if it be so desired, the man/car hours of work by zone could be calculated and utilized. Their collection presents no great difficulty.

The measurement of intervening variables such as police system response times and patrol unit response speeds is, however, more problematic. Larson (1972) in his work with the New York Police Force attempted to measure these variables by designing an EX 1 form to be used by officers in two-man patrol cars. This form was completed by the officer who was not operating the vehicle and gave the following information:

a) radio run number (radio run is a dispatched call for service)

b) occurrence type

c) priority of call

d) time in minutes and seconds at beginning of each run

e) initial odometer reading in miles and tenths

f) time of arrival at incident

g) final odometer reading

From this data, average response times and speeds were calculated. There are limitations to the use of this method. For example, not all municipalities use two-man patrol cars as is the case with the city under study. One man cars render the Larson Ex 1 system impractical because an officer cannot perform his primary function as a peace officer while actively participating in an experimental situation of this type. The other flaw with the Ex 1 system is human error and bias. It is possible that an unintentional error is made in recording or that the entries are willfully manipulated for self-enhancement. For these reasons, a method in which the human factor was reduced to a minimum appeared desirable. Such a method comprised the use of the tachograph.

The tachograph (Figure 1) is an electronic recorder used by highway fleet operators to monitor the movements of vehicles. The instrument automatically records the following data:

a) elapsed time between two points or locations,

b) speed of vehicle in miles per hour

c) distance travelled between two points or locations

d) maximum speed reached.

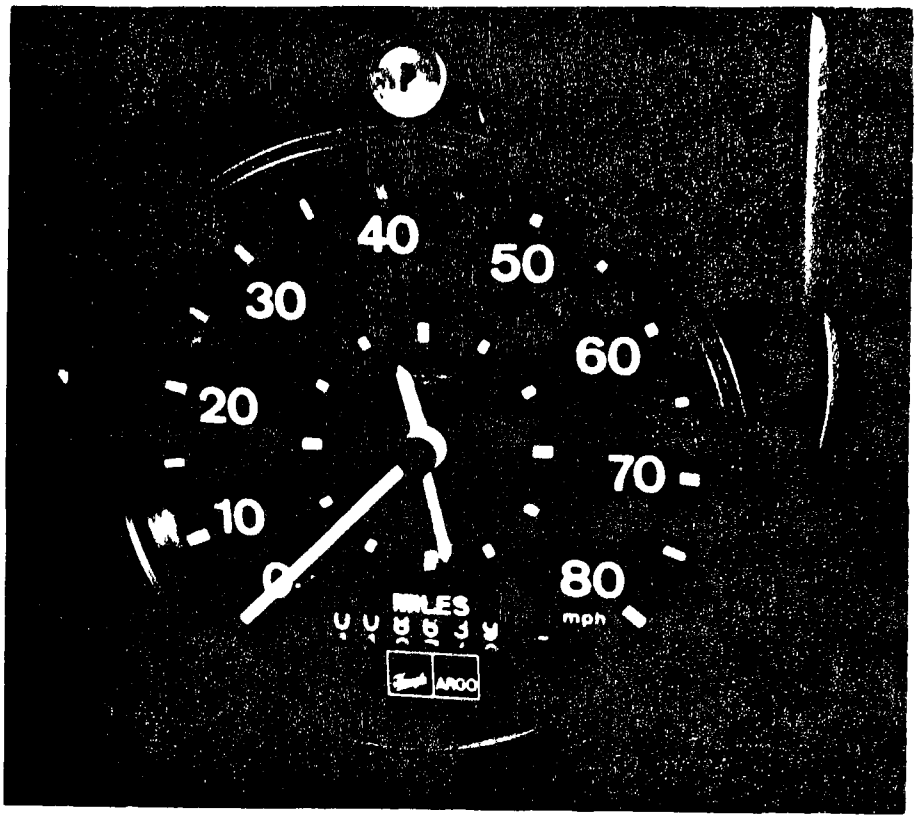

Fig. 1 The tachograph mounted in patrol car.

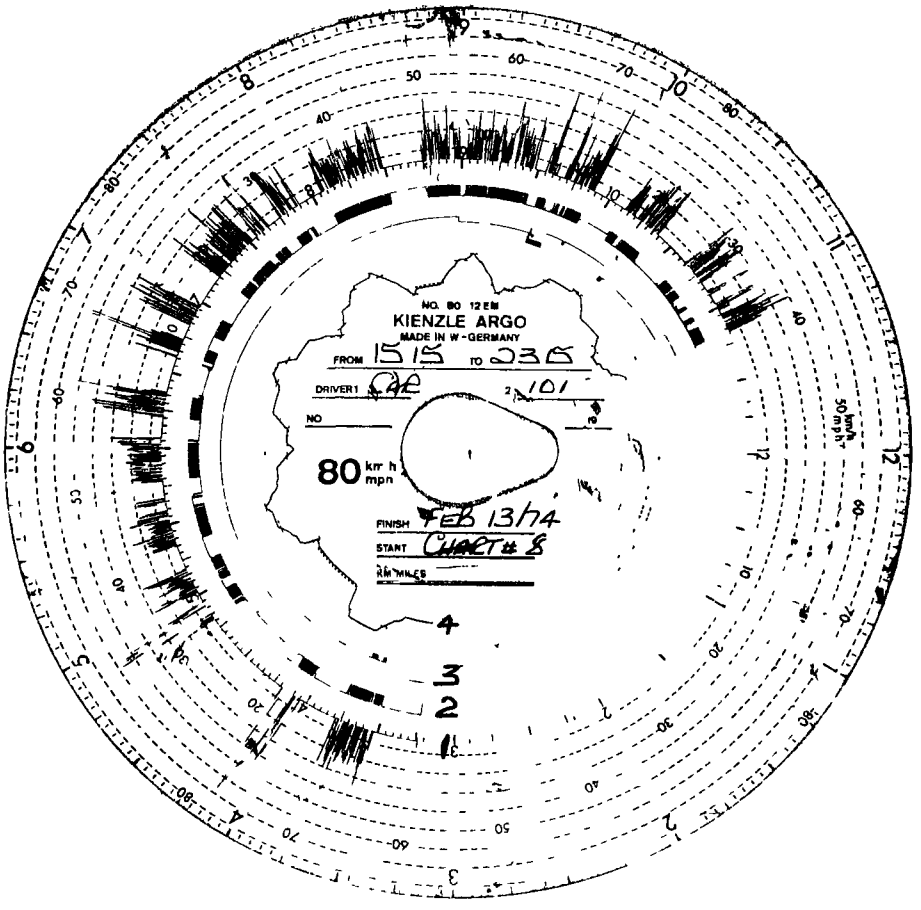

Fig. 2 The tachograph card showing readings for one 8 hour shift.

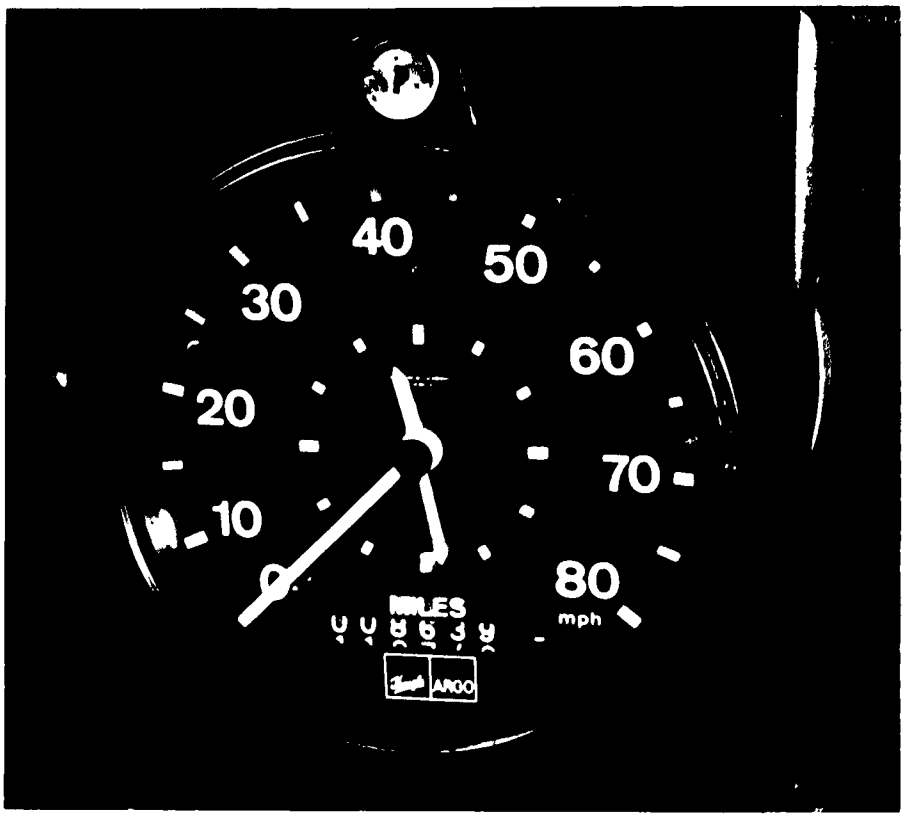

Fig. 1 The tachograph mounted in patrol car.

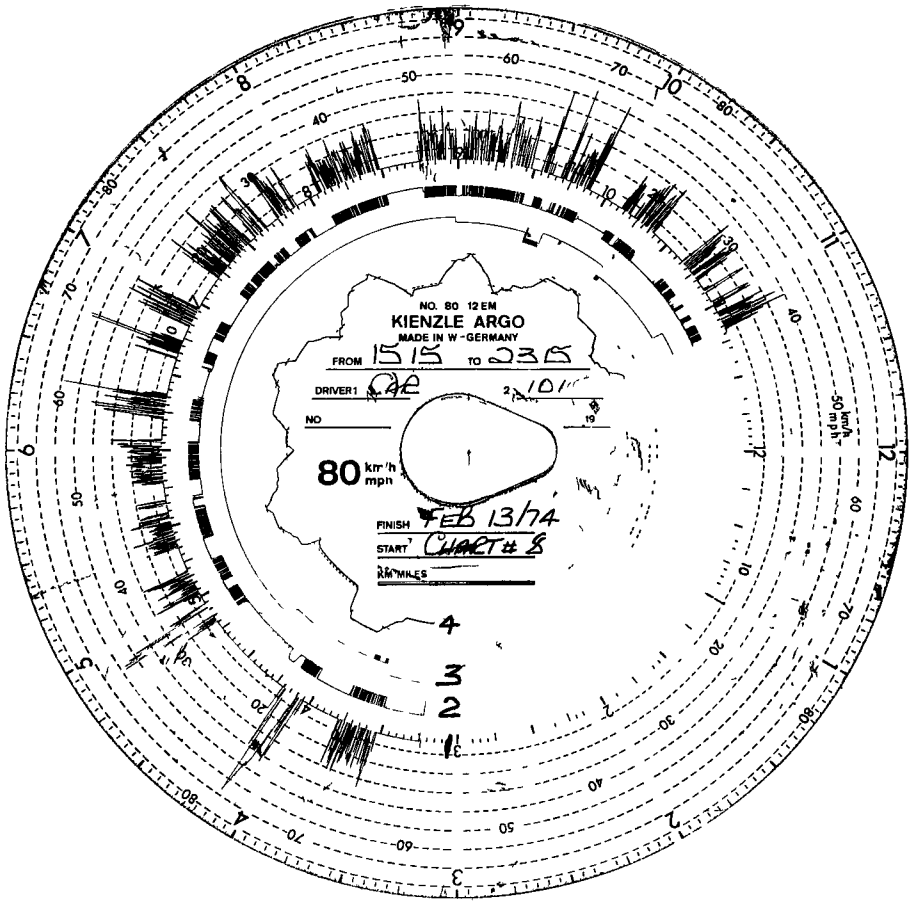

Fig. 2 The tachograph card showing readings for one 8 hour shift.

This information is recorded on a tachograph card (Figure 2) by means of four styli (Figure 3) within the tachograph. Stylus 1 records speed in miles per hour; stylus 2 shows when the car is moving or stationary; stylus 3 indicates when the officer is responding to a call for service, and it is activated by a remote dash switch (Figure 4). Stylus 4 records distance travelled while elapsed time is shown by the markings on the periphery of the disc. Tachograph cards are available to record time periods of 8, 12 and 24 hours; because the police system functions on an eight-hour shift basis, twelve-hour cards were used to record one complete shift and to allow a continuation of data collection should the shift extend beyond the normal eight-hour period. The tachograph has many advantages. Its cost is minimal at approximately $300 per unit installed. It has an automatic recording mechanism which makes it possible to deploy a one-man car, thus eliminating the disadvantages found in the Larson Ex 1 self report form previously described.

A series of tests were conducted to test the degree of error in the instrument. These included a bench test to determine the error between times measured by stopwatches and those recorded by the tachcard; these times fell in the 15 seconds to 7 minute range. Similarly, a road test was conducted to determine the degree of error between measured road distance and recorded tachcard distance; these distances fell within the $\frac{1}{4}$ to 2-mile range.

Thirty time periods in the range from 15 seconds to 7 minutes were selected from a random numbers table. The bench test consisted of one technician measuring consecutive time periods with two stopwatches according to the random times while an assistant activated a switch similar to the dash-mounted response switch which activated the stylus recording the time. At the end of the bench test, the assistant read the tachcard times and compared these with the random

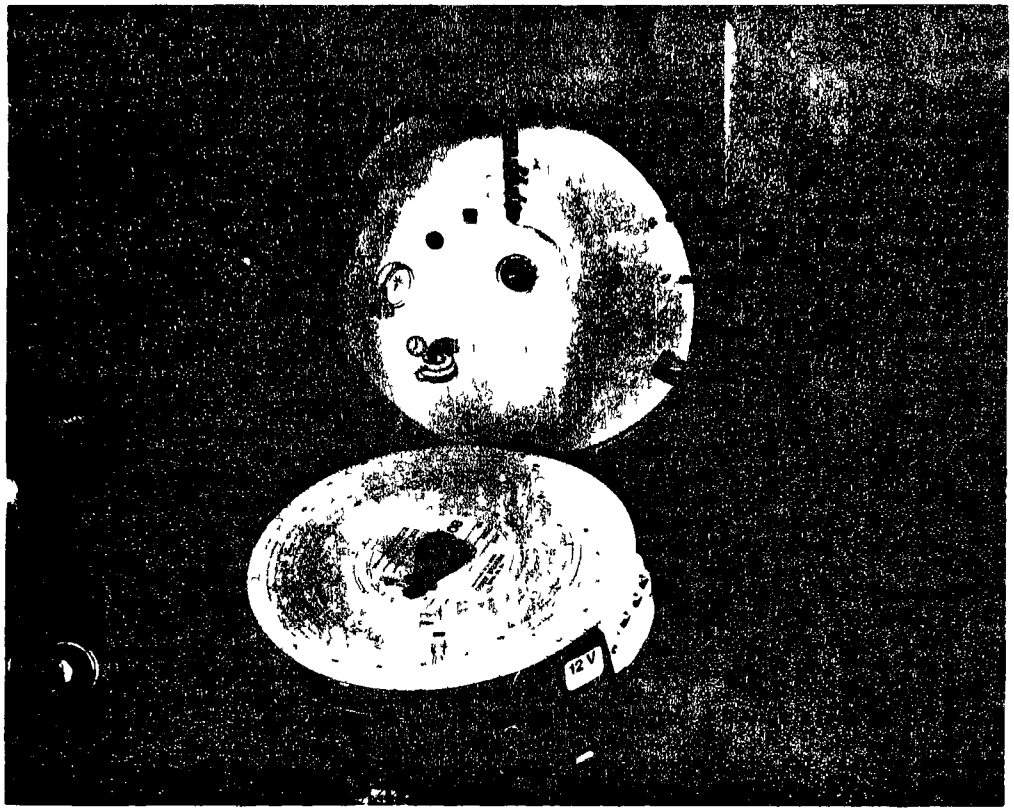

Fig. 3 Four styli operating within the tachograph.

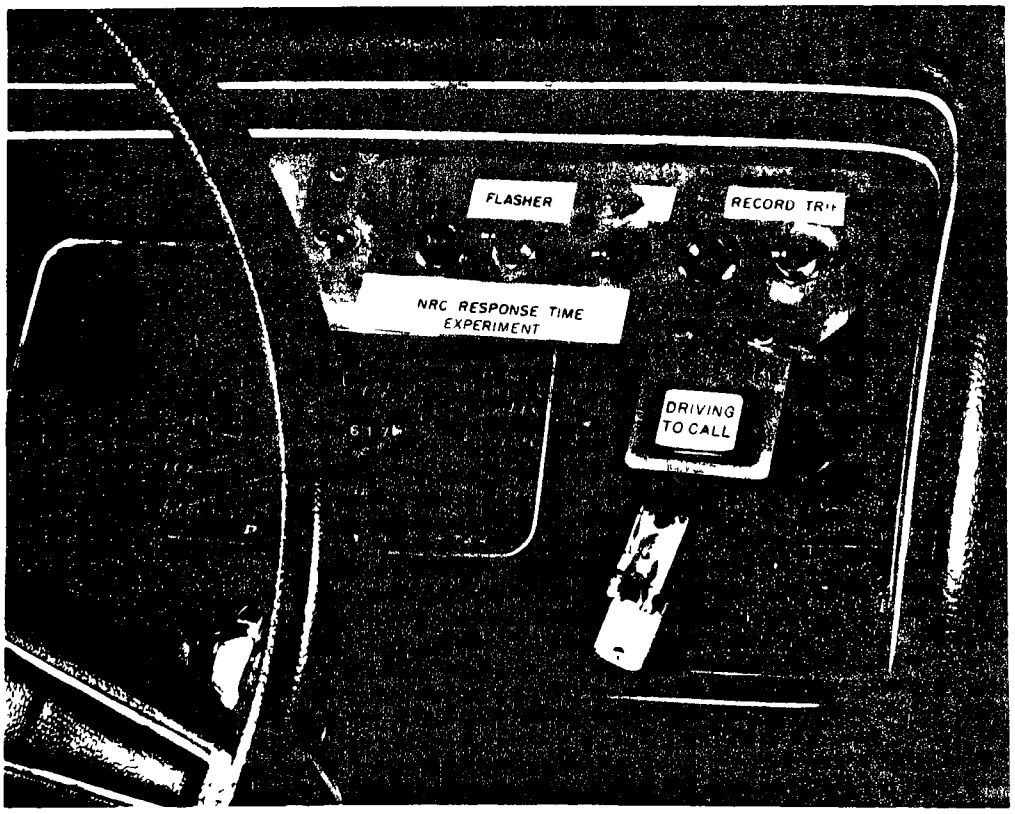

Fig. 4 Dash mounted response switch

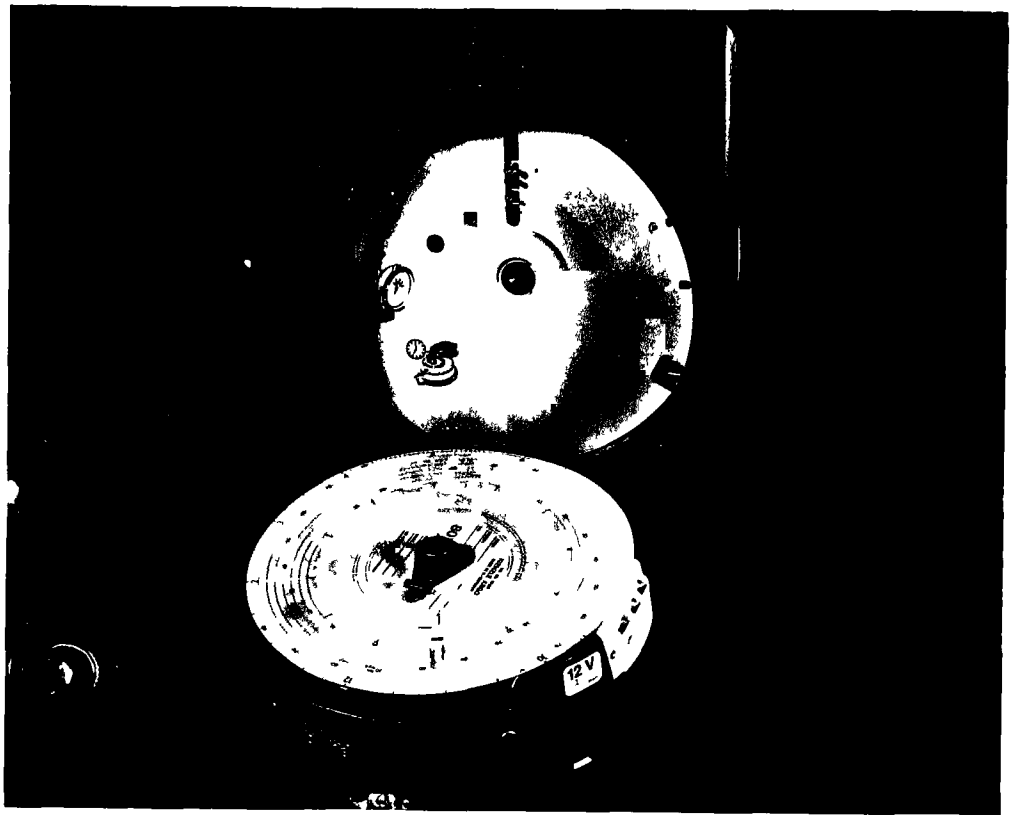

Fig. 3 Four styli operating within the tachograph.

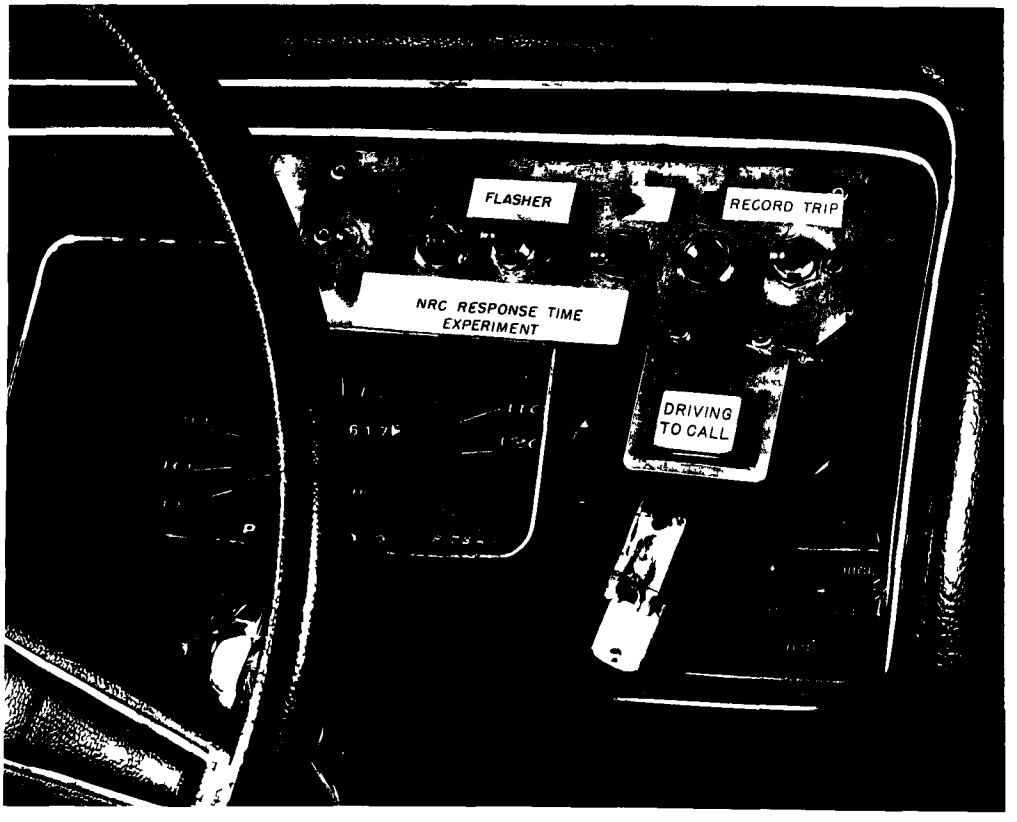

Fig. 4 Dash mounted response switch

number times. The results are shown in Table I. The mean difference between random number time and recorded tachograph times for a random sample of thirty time periods was ±12.6 seconds which is sufficiently accurate for the purpose of this study.

Of prime importance was the question whether the tachograph was capable of measuring distances accurately. In order to test this, a "5th wheel" measuring device, coupled to a dash-mounted digital readout was installed in a patrol unit. A 23-mile section of paved highway under construction was selected as the test location. Distances in the range 0.35 to 5.0 miles were selected according to a random numbers table; these were converted to feet for purposes of reading the digital readout which recorded distances travelled in feet. For example, a random number such as 0.45 when converted to feet would equal 2,376. After setting the digital recorder at 0, the driver began to drive the random test distance while at the same time switching on the record trip switch to indicate the beginning of the run on the tachcard. Speeds were varied between 20 and 50 miles per hour to simulate operating conditions. When the digital readout reached 2,376, the car was stopped and the record trip switch shut off. This procedure was followed to check all the random distances. The results are shown in Table II.

The results indicate that the mean or average difference between a random selection of test distances and distances as recorded by the tachograph to be ±0.14 miles, or 750 feet. The use of the tachograph thus would introduce no appreciable error as far as this research is concerned.

Output criteria depend upon what the police seek to do. Crime rates, arrest rates and clearance rates become output criteria only when it is assumed that people can be deterred from committing crime, that the effectiveness of deterrence is dependent on the certainty of punishment and

Table I TEST FOR ERROR IN READING TACHOGRAPH TIMES

Random Number Time	Time As Read From Chart	Difference (in seconds)	Mean Error $\bar{X}=\frac{\Sigma xi}{n}$
1:06	1:0	-6	
1:11	1:15	4	
0:45	0:45	0	
0:27	0:15	-12	
6:53	7:00	7	$\bar{X}=\pm\frac{380}{30}$
1:0	1:18	18	
6:15	6:30	15	$=\pm 12.6$ seconds
0:36	0:30	-6	
2:44	2:45	1	
2:42	3:0	18	
4:56	4:30	-26	
2:31	2:30	-1	
3:18	3:0	-18	
2:44	3:0	16	
5:48	6:0	12	
3:21	3:15	-6	
5:10	4:51	-19	
1:12	1:30	18	
3:05	3:15	10	
2:07	2:0	-7	
4:18	4:45	27	
2:20	2:00	-20	
6:56	7:00	4	
1:18	1:0	-18	
2:0	2:0	0	
4:42	4:30	-12	
3:32	4:00	28	
3:14	3:00	-14	
1:10	1:30	20	
6:17	6:00	-17	

Table II TEST FOR ERROR IN READING TACHOGRAPH DISTANCES

Test No.	Test Distance (miles)	Tachcard Reading (miles)	Mean Error $\bar{X}=\frac{\Sigma xi}{n}$
1	1.0	0.60	
2	2.0	2.2	$\bar{X}=\frac{3.55}{25}$
3	3.74	4.0	
4	1.32	1.2	$=\pm 0.14$ miles
5	0.86	1.0	
6	4.6	4.65	
7	2.60	2.50	
8	0.35	0.5	
9	0.45	0.33	
10	1.80	2.10	
11	0.94	1.0	
12	3.9	3.9	
13	2.9	3.0	
14	0.38	0.30	
15	2.29	2.60	
16	1.27	1.15	
17	2.1	2.1	
18	3.45	3.5	
19	2.37	2.40	
20	4.54	4.30	
21	0.48	0.35	
22	5.0	5.4	
23	0.63	0.65	
24	2.88	2.9	
25	0.75	0.90	

that the certainty of solution of the case is dependent on the rapidity of police response. These criteria are, however, too far removed from the event for meaningful analysis. A more immediate output criterion is the type of police action of which there are apparently six:

1. Suspect/vehicle gone on arrival: no police action possible.

2. All in order: no police action possible.

3. Settled on arrival: police action - advise.

4. Settled by warning: police action - ticket or warning issued.

5. Settled by charge: police action - arrest or summons to appear.

6. Further investigation necessary: police action: investigation initiated, report.

A further problem encountered in data collection related to the postulate that the relevance of response to the final disposition of the call was dependent on the nature of the call. This required the classification of calls. A classification of occurrence types has been developed for a concurrent computer simulation of the patrol operations of the city under study. The occurrence types (Table III) are derived from the 10-code system of the police department, with additional subgroups added to more clearly define the specifics of each occurrence. When a call for police service

is received by a police department, it is described in different ways by each member according to his interpretation of the events. For example, a dispatcher defines an incident as a 10-10 Disturbance. The responding patrolman may more clearly define the call as a 10-10 Fight. Similarly, a 10-30 Theft as transmitted by dispatch may turn out to be a 10-13 Damage to Property, when the officer investigates the complaint. Thus, an accurate categorization of the incident can be obtained only by an inspection of patrol log sheets for correct occurrence and outcome type.

Experimental Procedure

The experiment consisted of monitoring the movements of a downtown patrol car over a period of 336 hours during which the necessary data was collected. A downtown patrol car was selected because it was felt that the core area presented the greatest challenge in terms of the number of calls and the shorter times and distances to both the officer operating the vehicle and the instrument recording his activities. A period of one week was selected for the experiment as it coincided with the individual officer's tour of duty as well as monitoring the fluctuations in the types and number of calls for service; the remaining 168 hours of the test period were used as a check on the original week and as a source of additional data. It would have been possible to equip several cars with the instrument, but if the instrument proved to be unsatisfactory, a considerable amount of money would have been wasted; consequently, to minimize cost and to maximize gain, one instrument was used.

Each officer using the car during the experimental period was briefed on the purpose of the experiment, as shown in Appendix A, and he was given a set of instructions which described the operation of the instrument and the completion of the log sheets; this is described in Appendix B.

Table 111 OCCURRENCE TYPES

10-Code Number	Description of Occurrence	Project Code Number
10-10	DISORDERLY, DISTURBANCE, ASSAULT, ETC	601
	Fight	602
	Loud Parties/Noise	603
	Juvenile Loitering, Disturbances	604
	Landlord-Tenant Dispute	605
	Public Mischief/Neighbourhood Trouble	606
	Indecent Assault	607
	Morality	608
10-11	DOMESTIC TROUBLE	609
	Husband-Wife	610
	Boyfriend-Girlfriend	611
	Unwanted Person	612
10-12	DRUNKENESS	613
	Breathalyzer	696
10-13	DAMAGE TO PROPERTY/VEHICLES	614
	Damage to Buildings	615
10-14	BARKING DOG	616
	Dogs at Large (D.A.L.)	617
	To Shelter (P.U.D.)	618
	Injured, Sick or Dead	619
	Bite	620
10-15	SUSPICIOUS CHARACTER	621
	Walking, Loitering	622
	Vehicles	623
	Noises	624
10-16	PEEPING TOM	625
10-17	FIRE ALARM	626
	False	627
10-20	SEE COMPLAINANT	628
	Obscene or Threatening Phone Calls	629
10-21	INDECENT EXPOSURE	630
10-22	PERSON USING FIREARMS	631
	Explosions	632
	Other Weapons	633
	Bomb Scare	698
10-23	GAS SICKNESS, ASPHYXIATION	634
	Gas Leaks, Smells	635
10-24	DRAGGING	636
10-25	PERSON SICK ON STREET, PUBLIC CONVENIENCE, ETC.	637
	General Medical Emergency	638
	Heart Attack	639
	Suicide Attempt	640
	Slumper	641
	Death	642
10-26	TRAFFIC ACCIDENT, PERSON INJURED IN FALL, ETC.	643
10-27	HIT AND RUN DRIVER	644

10-Code Number	Description of Occurrence	Project Code Number
10-28	OBSTRUCTION LANEWAY, SNOW CLEARING, ETC.	645
	Private Parking	646
	Municipal Parking	647
10-29	DOMINION SIGNAL	648
	False Alarm	649
	Burglar Alarm	650
	Property Check/Insecure	693
10-30	THEFT (MISCELLANEOUS)/NON PAYMENT BILL	651
	Bogus Bills/Forged or NSF Cheque/Stolen Credit Cards	652
	Recovery of Property	653
10-31	SHOPLIFTING	654
10-32	PURSE SNATCHING	655
10-33	STOLEN AUTOMOBILE	656
	Recovered Automobile	657
	Confirm Stolen Automobile	658
	Removal of Abandoned Autos	659
10-34	SHOPBREAKING, HOUSEBREAKING (BREAK & ENTER)	660
	Shopbreaking (in progress)	661
	Housebreaking (in progress)	662
10-35	HOLDUP, ROBBERY WITH VIOLENCE	663
10-36	RAPE	664
10-37	MURDER	665
	Lost or Missing Persons	666
	Adult or Teenager	667
	Child	668
	Found Lost or Missing Person	669
	Elopee/Institution	670
10-43	ASSISTS	
	Officer in Trouble	694
	Other Forces (Criminal)	687
	Other Agencies	690
	Private Citizen in Distress	691
	PATROL - Initiated Calls	671
	Walk-Stop	672
	Car-Stop (Car Check)	673
	Property Checks/Water Patrol	674
	CPIC Checks	675
	Traffic Events	676
	Serving Warrants	677
	ADMINISTRATIVE	678
	Meals	679
	Refuelling	680
	Repairs	681
	Courier Service/Deliver Message	682
	Transfer of Persons	683
	Transfer to Station	684
	Directing Traffic	685
	Traffic Signal Problem	686
	Court	689
	Escort (Funeral, V.I.P's)	692

Statistical Procedures

Several approaches were used to analyze the data. These included frequency distributions and histograms for the graphic presentation of the data. In order to test for significant differences between two or more groups, an analysis of variance computation was used followed by a Scheffée post hoc test (1). The analysis of variance (an F ratio test) is a statistical procedure to test whether two or more samples come from the same population. The F test establishes the presence of significant differences by comparing two or more estimates of population variance to determine the probability that such a variation in size could occur by chance. Application of the F test to this experiment was used to determine whether there were significant differences between the response times for outcome types A, B, and C. That is, were police system response times where police action was taken significantly different from those times where no action was taken or possible? An F ratio test indicates whether significant differences do or do not exist between the means of two or more groups; it does not however establish which means or pairs of means differ from one another. To locate the significant differences, a Scheffée test is used. The Scheffée test is a complex contrast test which assumes the following about the treatment or outcome groups:

a) it is not affected by questions of normality of sample, i.e. $n \leq 30$

b) can be used for paired contrasts

c) is not affected by hetrogeneity of variance

d) can be used with unequal cell numbers.

The general formula for the Scheffée test is as follows:

$$M_k - M_n \pm \sqrt{MS_e \cdot \frac{C1^2}{n1} + \frac{C2^2}{n2} + \frac{C3^2}{n3} \cdot K-1(1-a)K \text{ Ratio}}$$

The hypothesis is that there are differences in the following:

$$H: \mu_1 \neq \mu_2 \neq \mu_3$$

Because the purpose of this research is to specifically test for significant differences between outcome type A, and outcome type B and C taken together, the hypothesis may be shown as follows:

$$H: \tfrac{1}{2}(M2+M3) \neq M1$$

In order to establish whether police system response time was critical for specific occurrence types, an action/no action dichotomy was established for each occurrence type where data were available and sufficiently large to analyze; a t-test was then conducted to test for significant differences.

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CHAPTER III

RESULTS

During the 336-hour experimental period, the downtown patrol car under test responded to a total of 235 calls for service, or an average of less than one call per hour. Of this total, 40 calls or 17% of the total were concerned either with police administrative matters (4 calls) or with infringements of municipal bylaws, such as parking and traffic accidents (36 calls). 132 calls for police service or 56.2% of the total number of calls for the week could be classified as criminal events. This category included assaults (32 calls), thefts (21 calls), break and enter (19 calls), drunkeness (16 calls), domestic trouble (15 calls), suspicious character (13 calls), stolen automobiles (12 calls), and property damage (4 calls). 51 calls for police service, or 21.7% of the total were of a non-criminal nature and included "see complainant and advise"* (21 calls), general medical emergencies (12 calls), burglar alarms or Dominion Signal** (12 calls), responses to fire calls (4 calls), and recorded patrol-initiated (2 calls). 12 calls for police service, or 5.1% of the total, were of a miscellaneous nature (Table IV).

During the experiment, 31 calls for police service (13.1% of the total) were classified by responding officers as outcome type A (a combination of 1 and 2). These were requests for assistance to which the downtown unit was dispatched, but where the officer was unable to take action

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*See complainant and advise calls are defined as requests for police assistance of a general nature, or those in which the caller chooses not to disclose the details of the need to the complaint clerk, or dispatcher.

**Dominion Signal refers to a private security service which offers electronic anti-burglar protection on a contract basis.

Table IV — DISTRIBUTION OF CALLS FOR SERVICE AND OUTCOME TYPES BY MAJOR CLASSES - DOWNTOWN PATROL CAR

CLASS		OUTCOME TYPE: A	B	C	NUMBER OF CALLS	PERCENT.
Admin.	(10-)	0	4	0	4	17.0
Traffic	(26)	2	10	9	21	
Parking	(28)	3	11	1	15	
Totality		5	25	10	40	
CRIM.						
Assault	(10-10)	3	26	3	32	56.2
Domestic Trouble	(11)	1	12	2	15	
Drunks	(12)	5	11		16	
Prop. Damage	(13)		1	3	4	
Suspic. Char.	(15)	7	5	1	13	
Theft	(30)	2	2	17	21	
Stolen Auto	(33)	1	2	9	12	
Break, Enter	(34)	1	3	15	19	
Totality		20	62	50	132	
NON-CRIM.						
Fire	(10-17)	1	2	1	4	21.7
See Compl.	(20)	1	12	8	21	
Medic.	(25)		5	7	12	
Dominion Sig.	(29)	3	7	2	12	
Patrol Unit	( )		2	0	2	
Totality		5	28	18	51	
Others		1	8	3	12	5.1
GRAND TOTAL		31	123	81	235	100.0

because the suspect or vehicle was gone on his arrival or all was in order. When the type of call is considered, it is found that the responding officer took no action in 12.5% of all administrative, parking and traffic occurrences, in 15.1% of all criminal events, and in 9.8% of all non-criminal events. Police action was taken in 204 calls. This means that, on an average, 86% of the total calls for police service during the experimental period resulted in police action of one form or another being taken. The officer took action in 87.5% of all administrative, parking and traffic occurrences, in 84.8% of all criminal events, and in 90.1% of all non-criminal events.

Because acts of a criminal nature are of special concern to the police, a closer examination of the disposition or immediate outcome of calls for police service seems warranted. In the case of assaults, police action was taken in 90.6% of the cases. Similarly, police action was taken in 86.6% of all domestic trouble calls, in 68.75% of all calls concerning drunkeness, in 100% of all cases dealing with property damage, in 46.15% of all suspicious character calls, in 90.4% of theft calls, in 91.6% of stolen auto calls, and in 94.7% of all requests for police service involving break and enters. Dominion Signal and "See complainant and advise" calls for police service may be the result of criminal activities; the results indicate that police action was possible in 75% and 95.2% respectively of the calls to which a patrol unit was dispatched.

Police system response time as defined by Larson (1972) and used in this study is the elapsed time between the request for police service and the arrival of that service. This period is made up of two components: communications centre response time and patrol unit travel time. The results of the 336-hour experimental period indicate that 37.5% of all dispatches handled by the communications centre were completed within one minute. This is the mode (the most

frequent grouping). The mode for patrol unit travel times was in the 2-3 minute range, and constituted 22.5% of all responses to calls for service. The results are given in Figure 5. The modal period for police system response times fell in the 3-4 minute range; this represented 21 (11.5% of all calls) during the 336-hour test period. Approximately 137 (75% of all calls) were dispatched and responded to within ten minutes. These results are shown in Figure 6.

The distance to be travelled in responding to calls for service is of prime importance. The distance between the location of an incident or occurrence and the position of a patrol unit at the time of dispatch will directly affect the rapidity of response. The results from the experiment show that the modal or most frequent distance travelled by a downtown patrol car, was in the 3/4-1 mile range (30% of all calls). The distribution of the distances travelled is shown in Figure 7. From the distances travelled and the times taken, average travel speeds for the experimental downtown patrol car can be calculated. The mode fell in the 14-16 mile per hour range. Average travel speeds do not however completely portray the operations of a responding patrol unit. Because of traffic conditions, there are wide fluctuations in travel speeds ranging from maximum speeds approaching 70 miles per hour to complete stops. The most frequent maximum travel speed was between 28 and 30 miles per hour. These results are shown in Figures 8 and 9 respectively.

Service time is defined as elapsed time between the arrival of police service at the scene of an occurrence and the moment that the unit is back in service to respond to another call for service, or to commence preventive patrol. The results of the experiment indicate that modal service time was between two and four minutes (13.5% of all calls). Also 52.8% of all calls had a service time of less than 10 minutes. These results are shown in Figure 10.

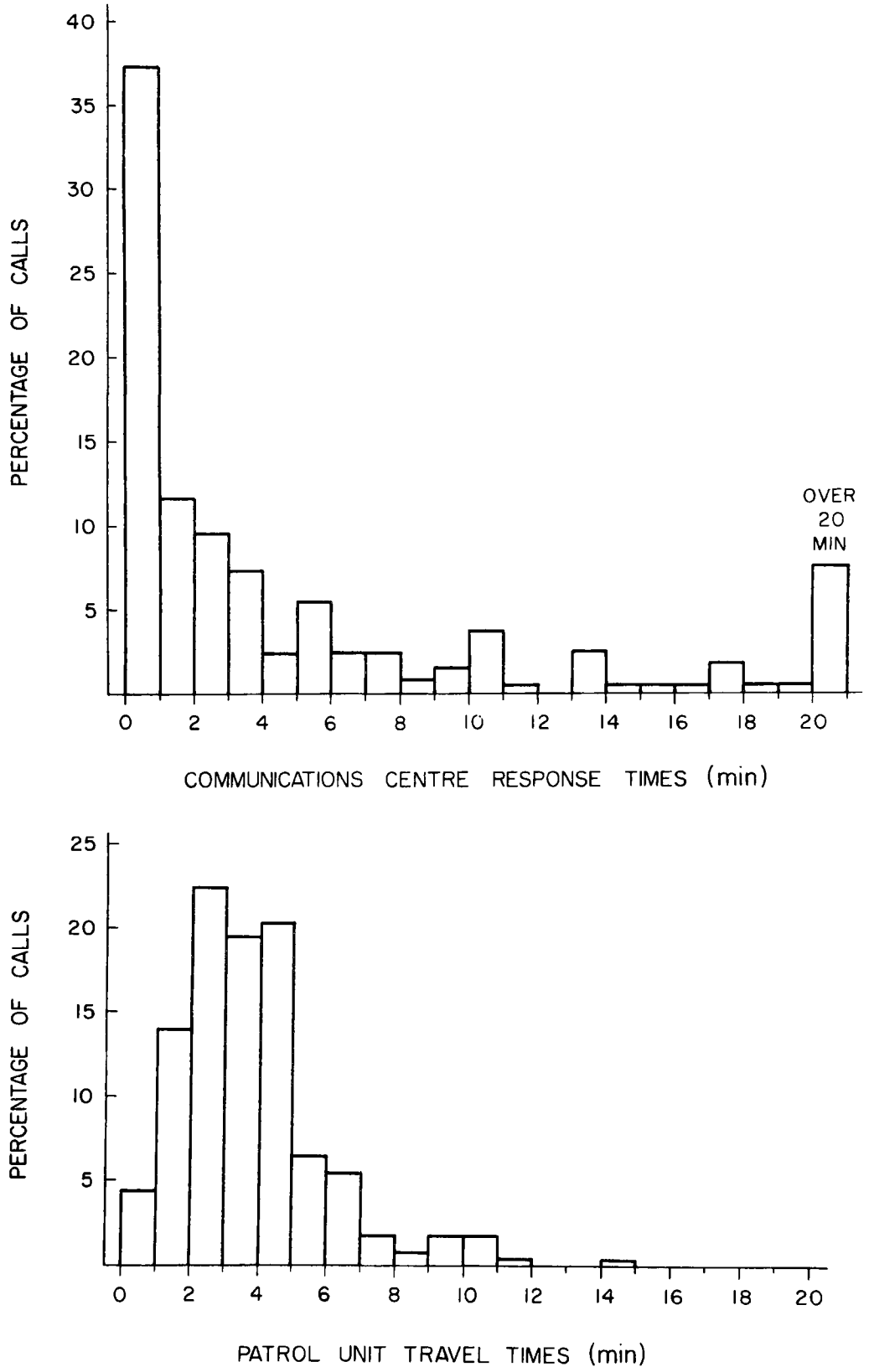

Fig. 5 Percentage of calls by time - communication centre response and patrol unit travel times.

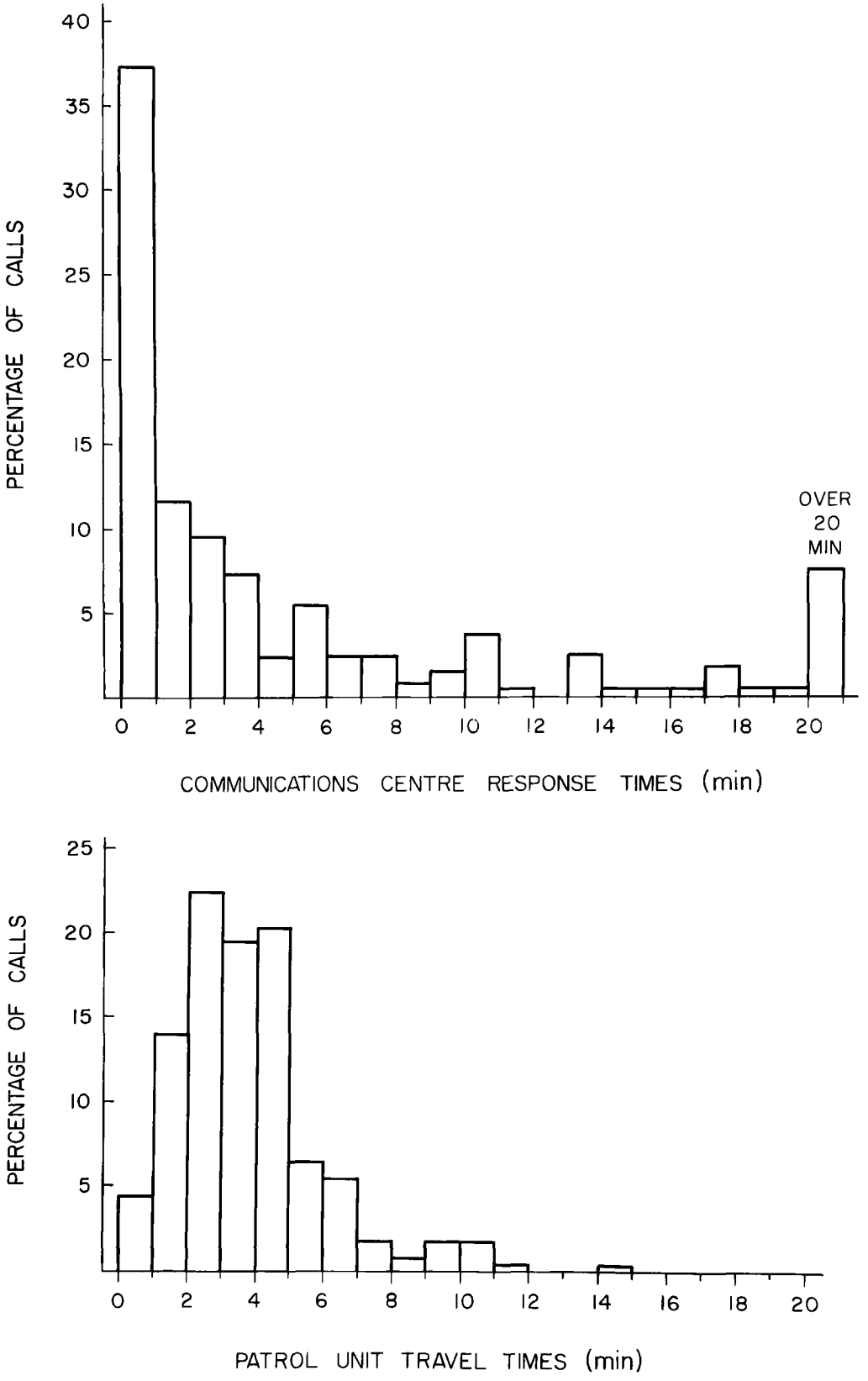

Fig. 5 Percentage of calls by time - communication centre response and patrol unit travel times.

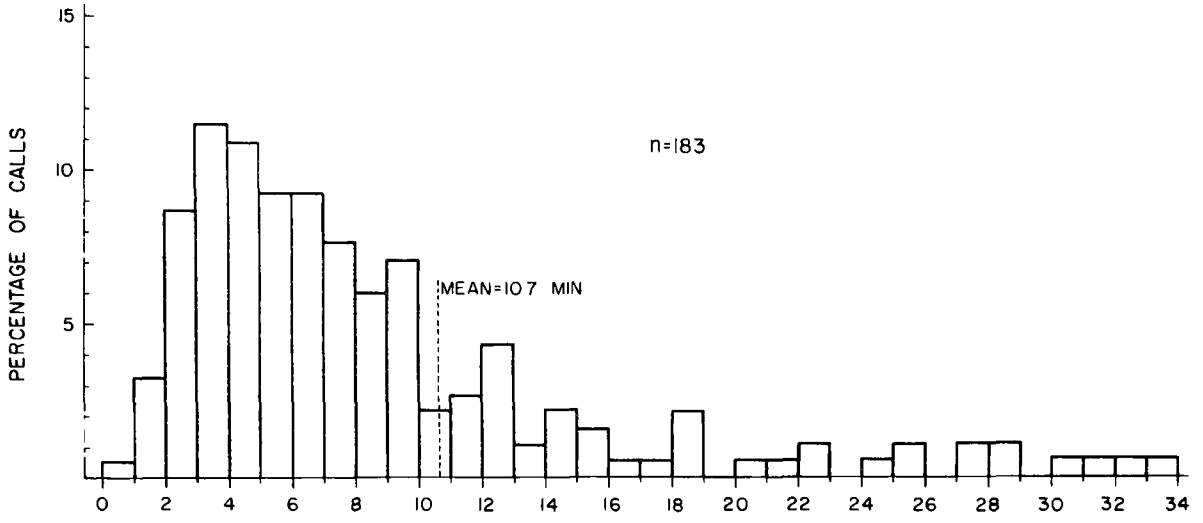

Fig. 6 Police System response time

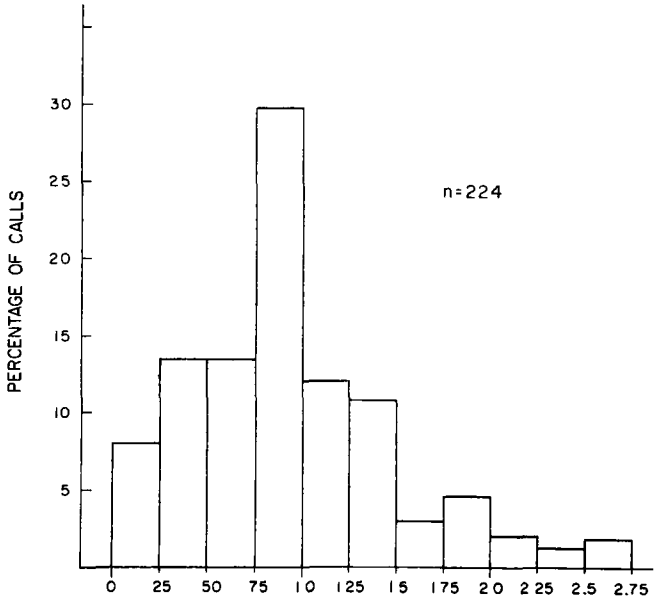

Fig. 7 Distance travelled

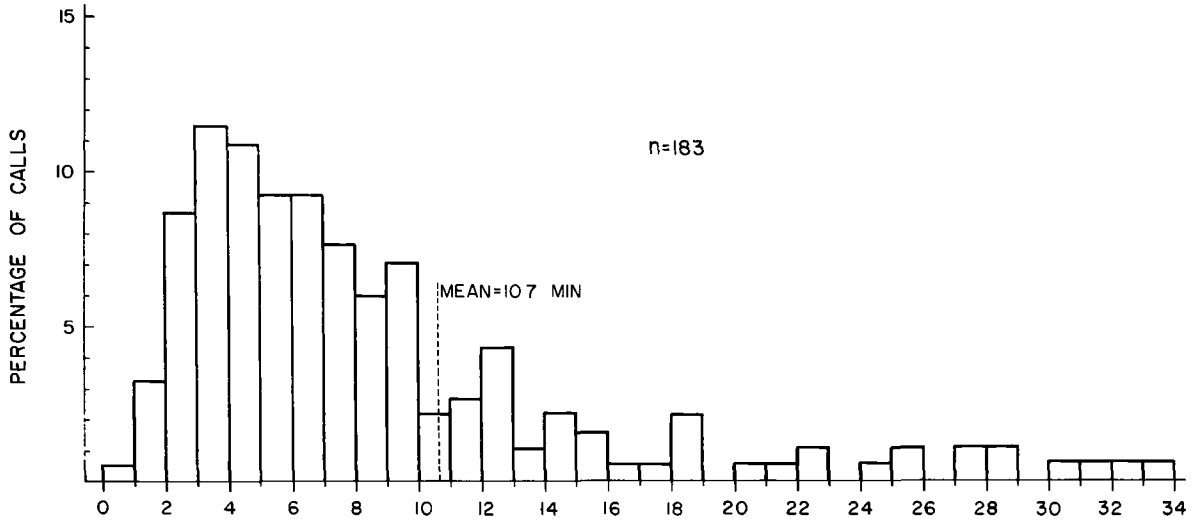

Fig. 6 Police System response time

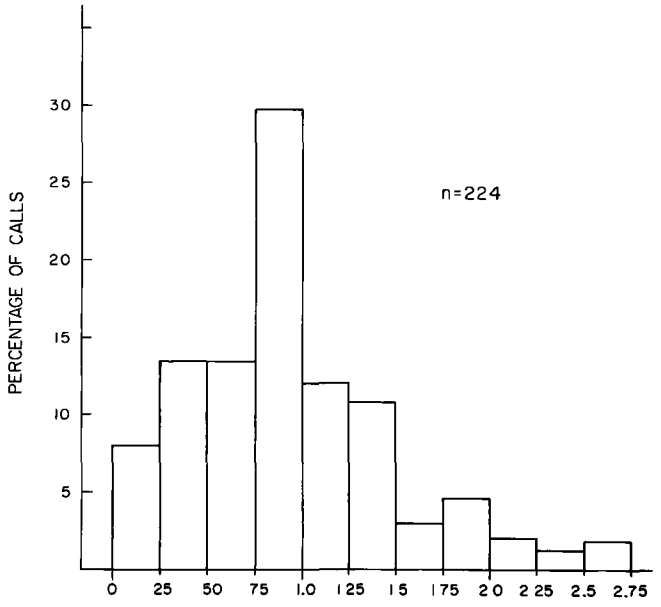

Fig. 7 Distance travelled

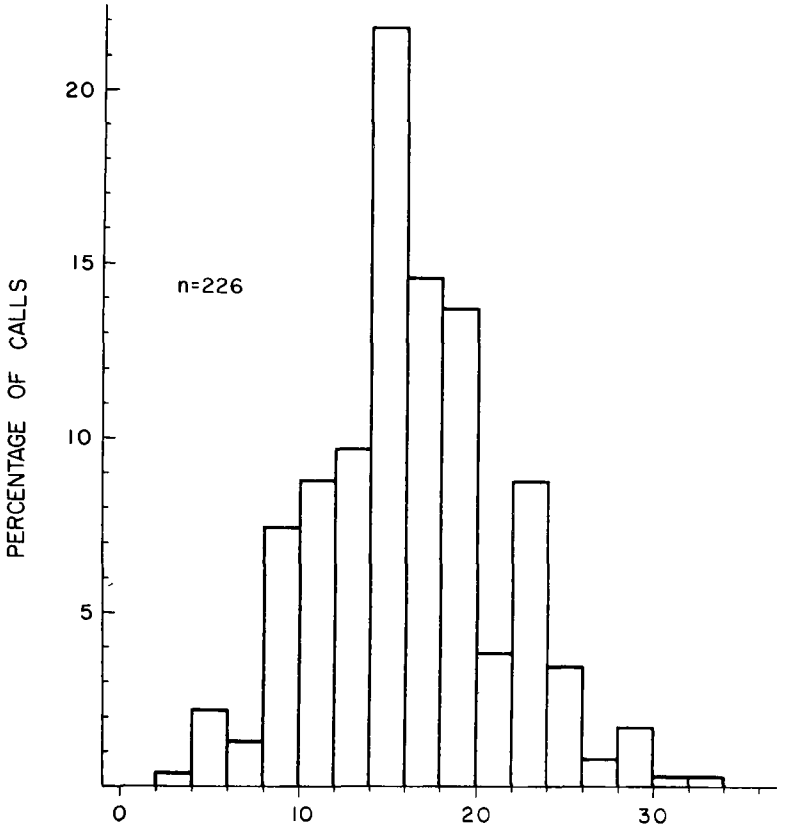

Fig. 8 Average travel speeds

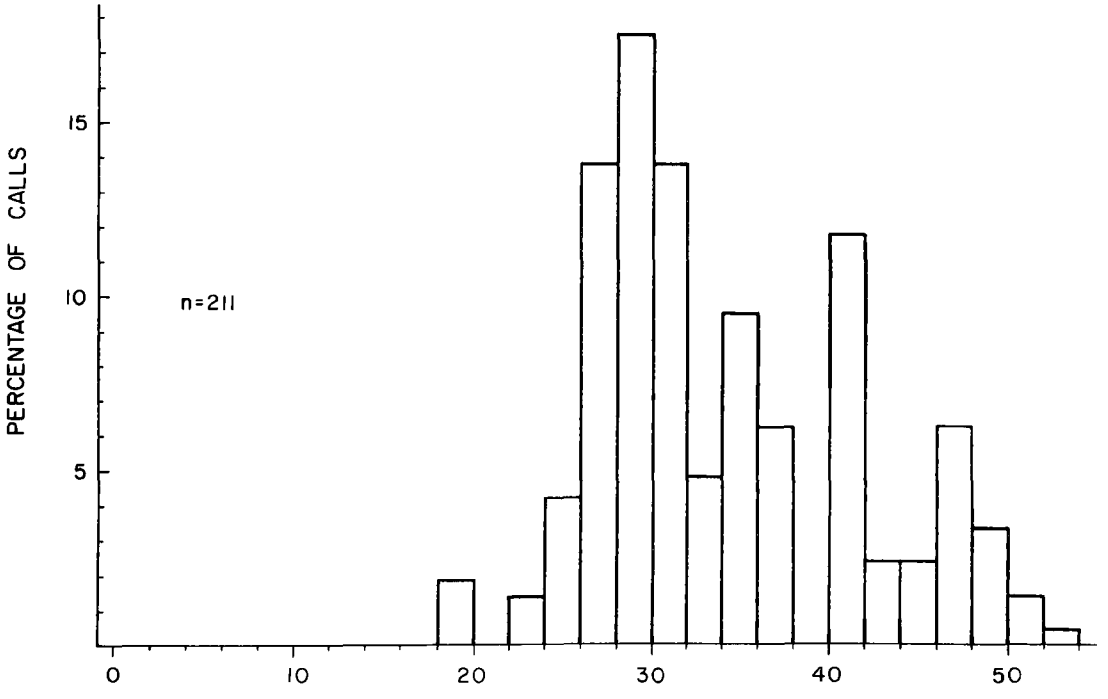

Fig. 9 Maximum travel speeds

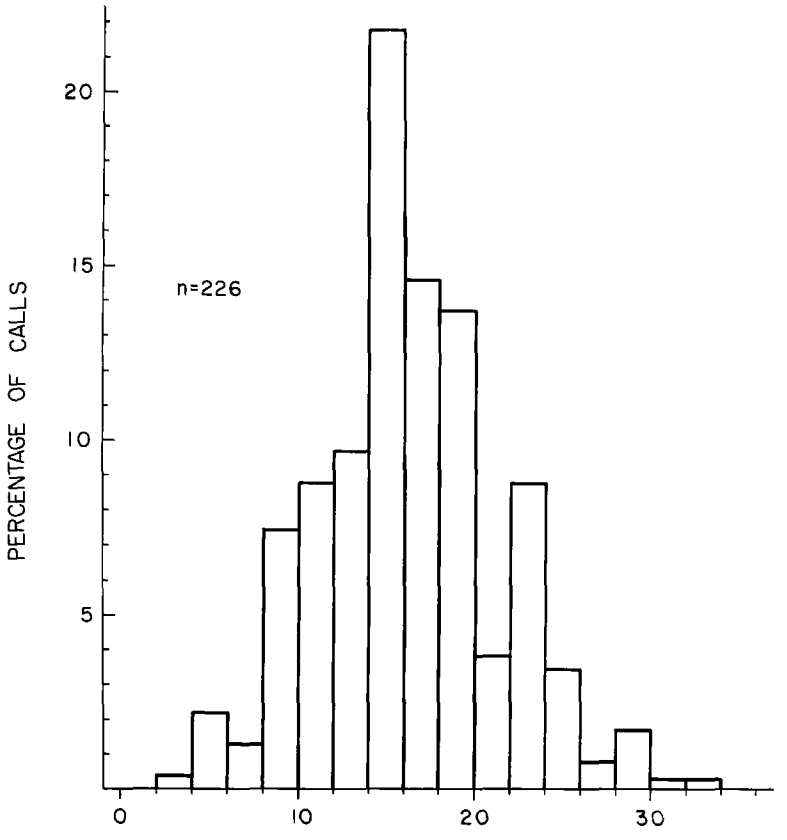

Fig. 8 Average travel speeds

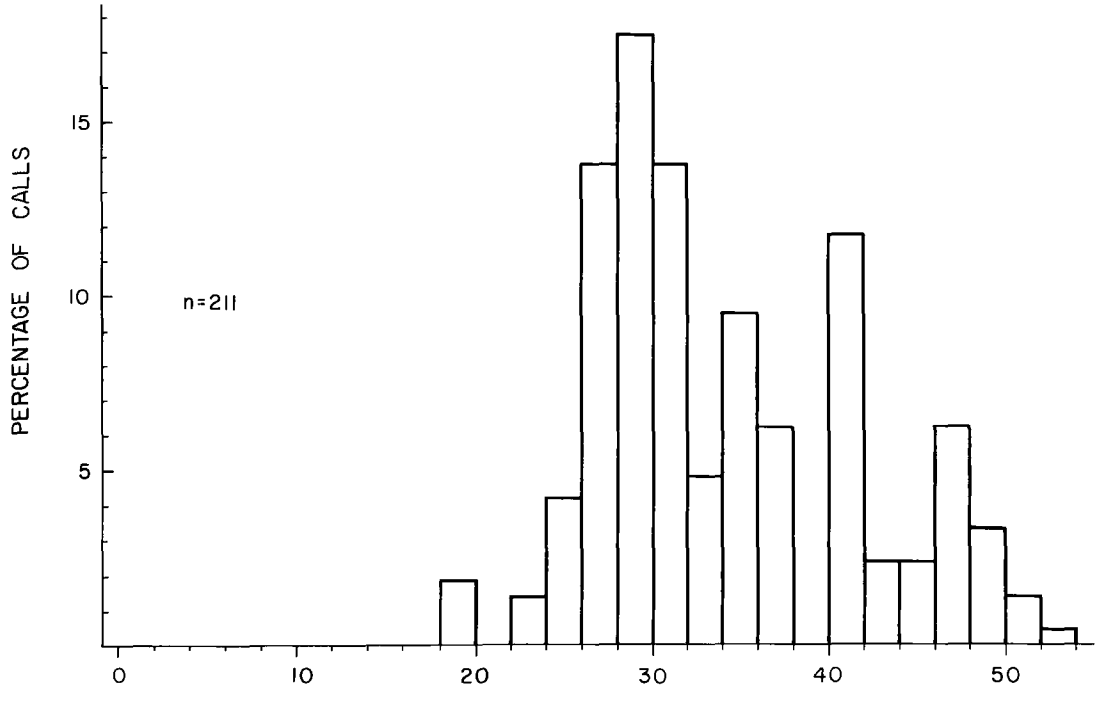

Fig. 9 Maximum travel speeds

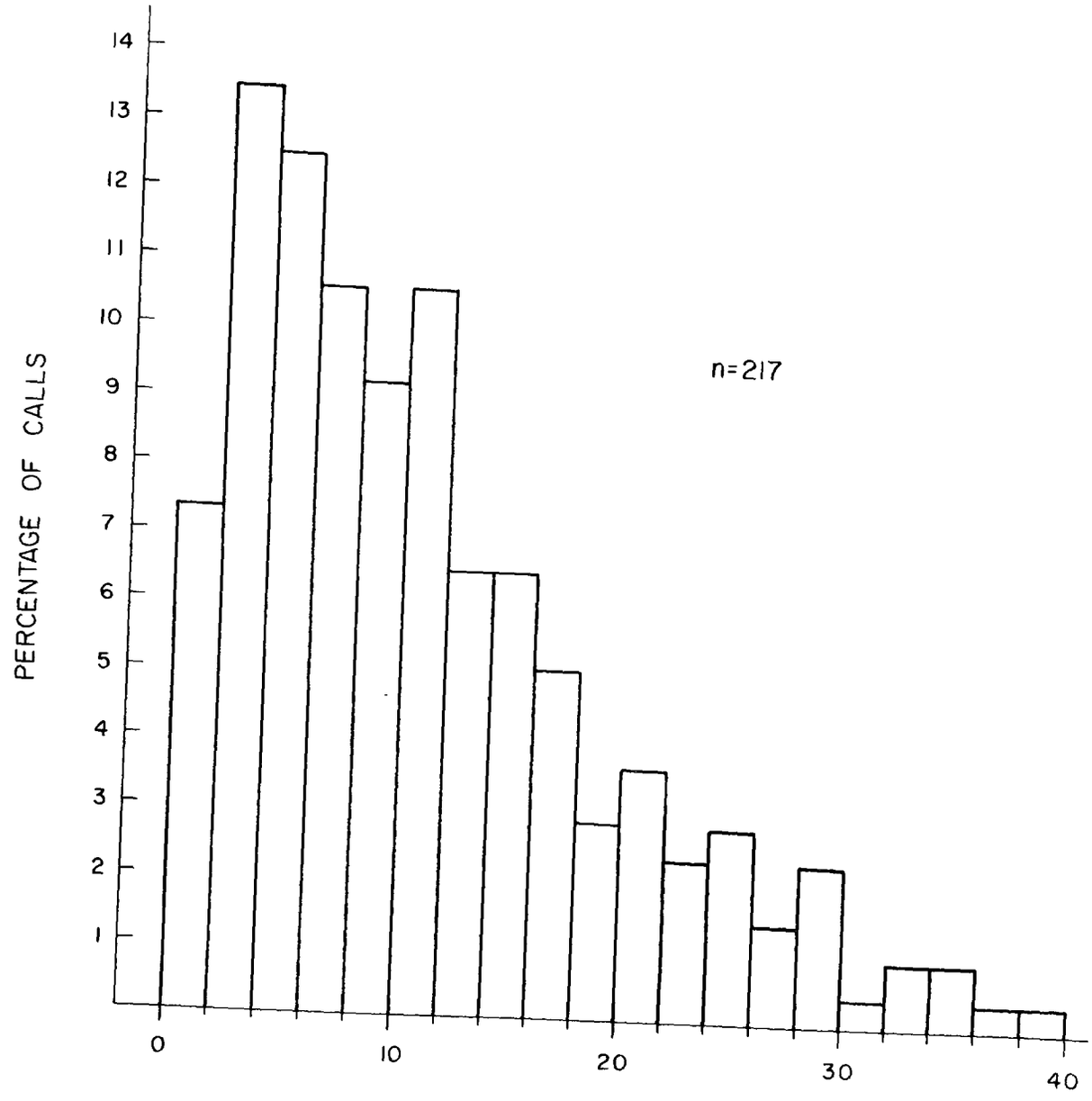

Fig. 10 Service time

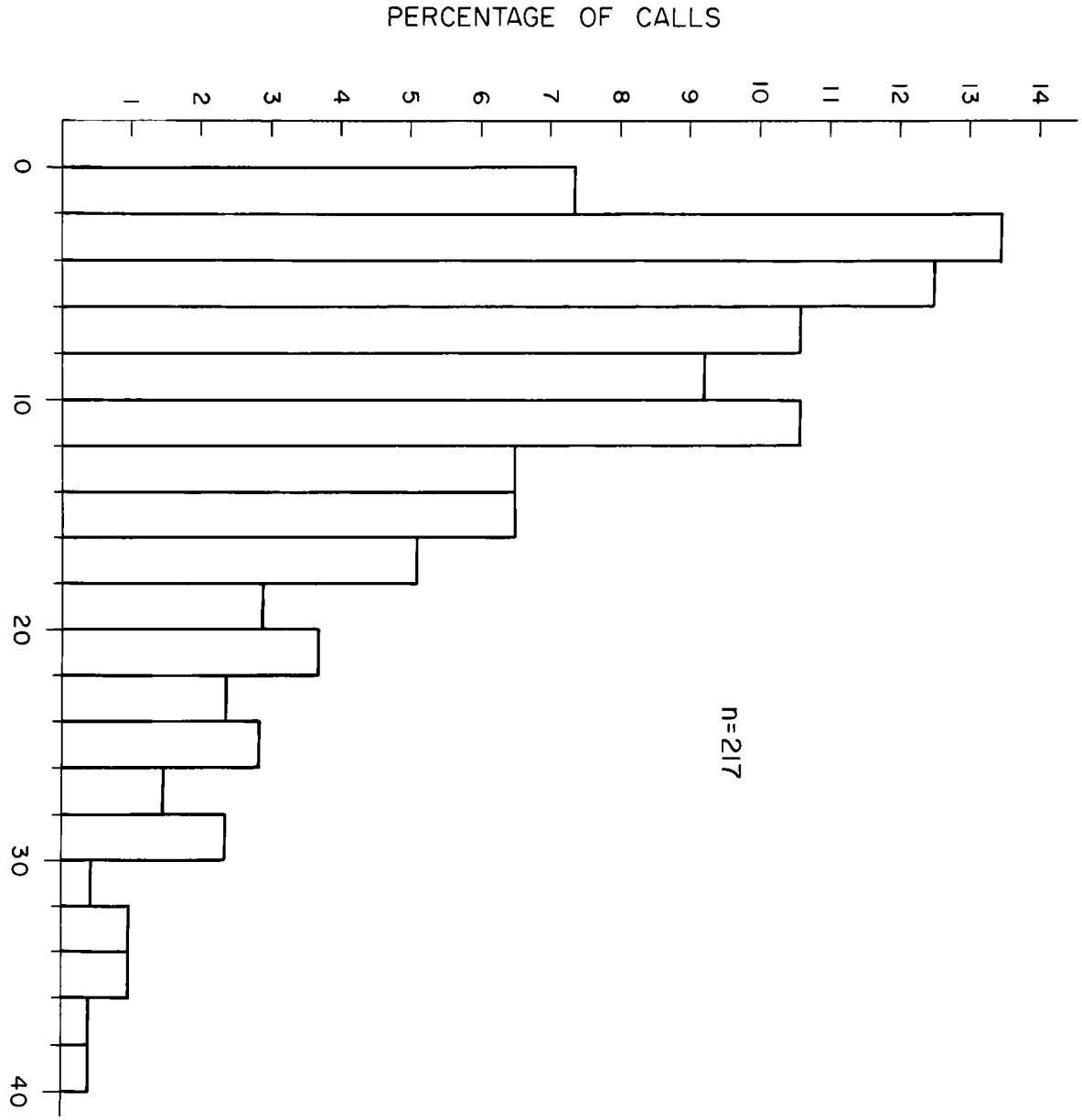

Fig. 10 Service time

The primary purpose of the research is to determine the effect that police system response times and patrol unit response speeds have on the disposition or outcome of calls for service. A cursory examination of the data as seen in the histogram of police system response times (Figure 11) reveals little or no difference between the means of outcome types A, B, and C for all occurrence types. Verification of empirical results was obtained using the analysis of variance (F ratio test) and the Scheffée post hoc test. The F ratio test (Table V) indicates that a significant difference exists between the means of the three groups; it does not, however, establish which mean or paired means are significantly different. This is done by using the Scheffée test. Calculations for the Scheffée test yielded the following confidence interval for the paired means (A, and B+C).

$$1.05 \pm 2.37 \text{ or } -1.32 \_\_\_\_\_ 3.42$$

Because the Scheffée test yields a confidence interval which spans zero, the hypothesis cannot be rejected. This suggests that there is a 95% probability that the means A, and B and C are from the same population, and therefore there are no significant differences between the means of outcome type A and outcome type B and C. Thus, when all occurrences are considered, it would appear that police system response time does not affect the outcome of calls for service.

In addition to discovering whether a reduction in police system response time affects the outcome of a call for service, an answer was sought as to whether police system response time was important for certain offense types. Based on a no action/action dichotomy for outcome types, the following table can be constructed based on the limited available data.

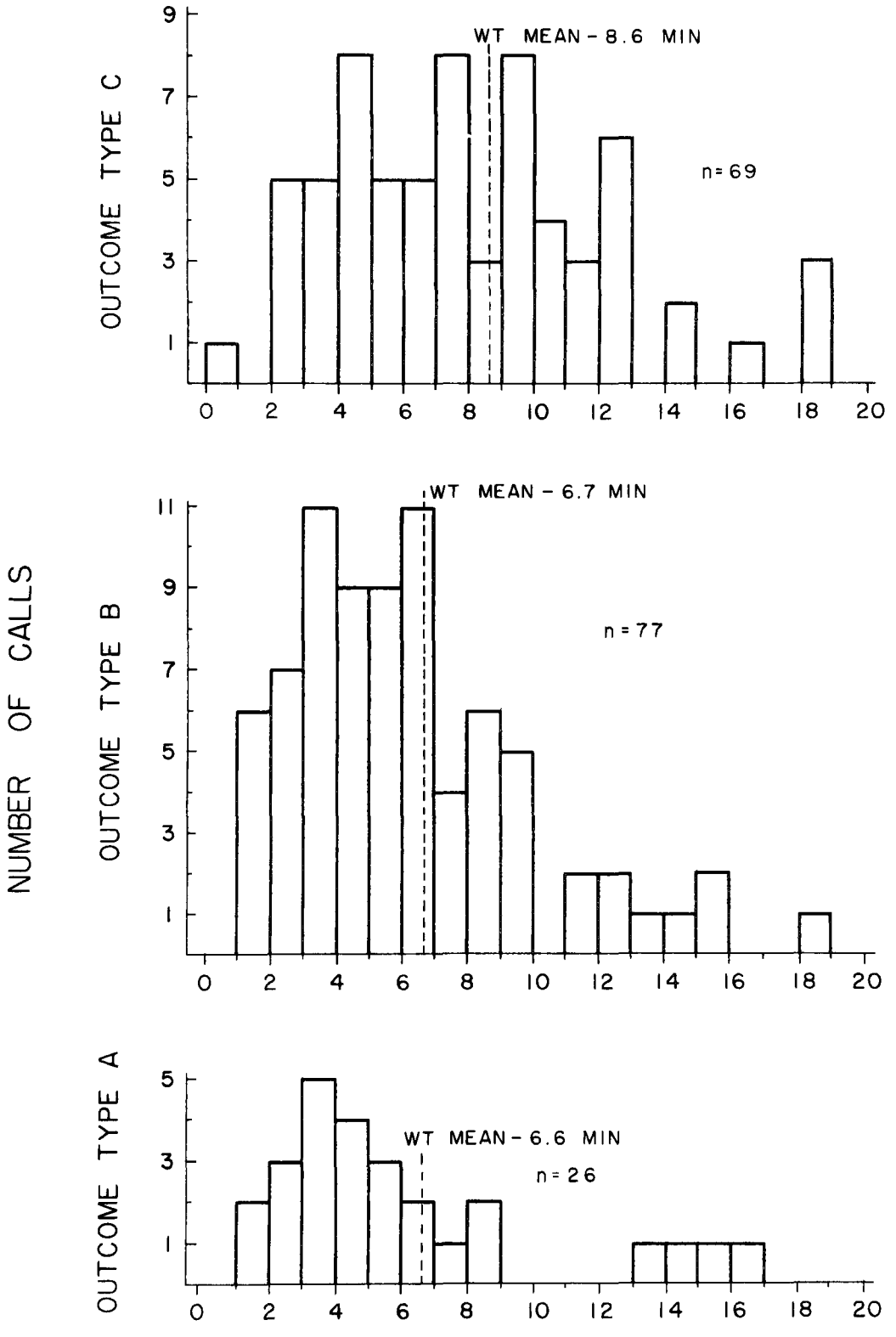

Fig. 11 Police System response times by occurrence and outcome type.

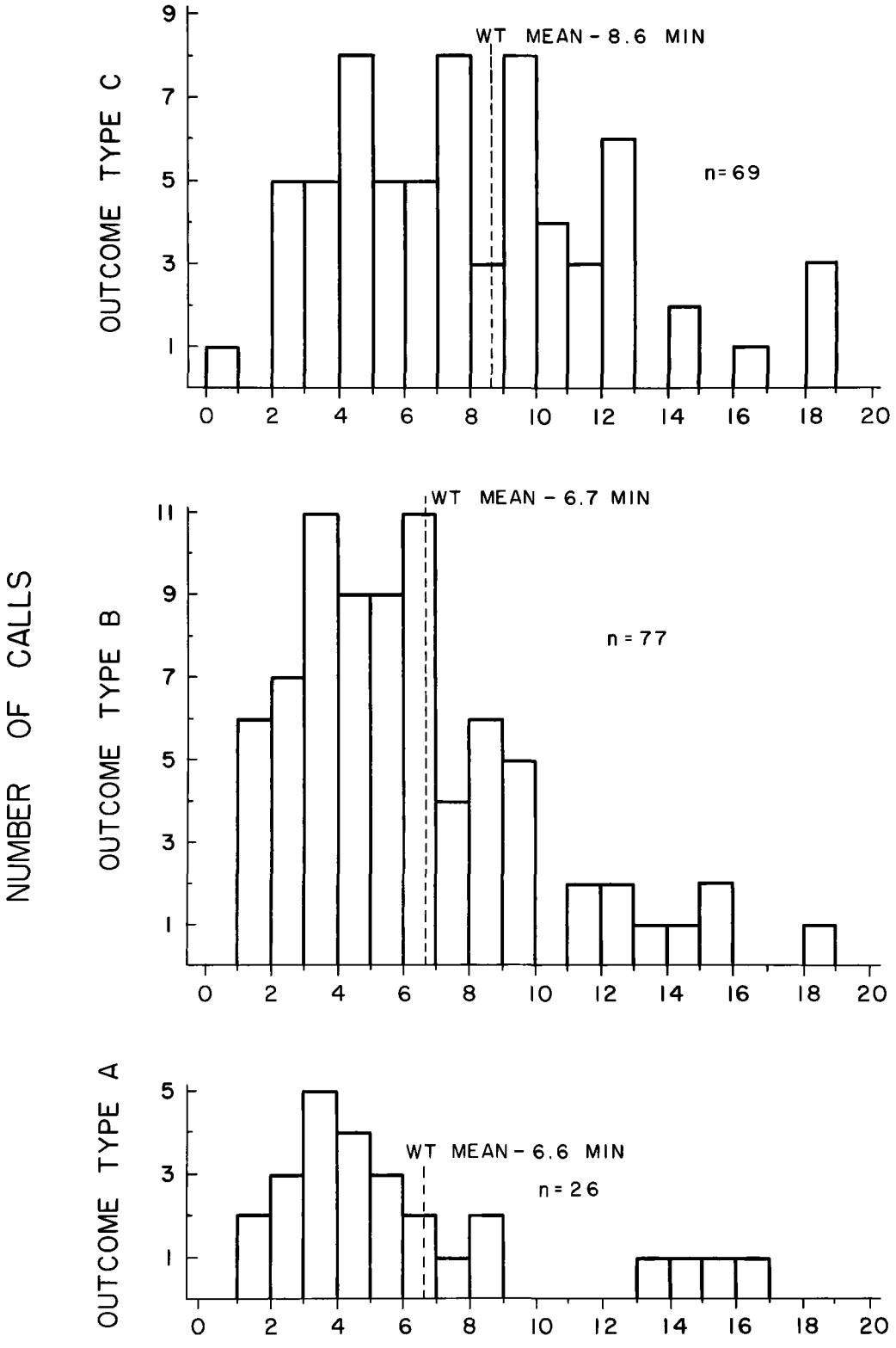

Fig. 11 Police System response times by occurrence and outcome type.

Table V POLICE SYSTEM MEAN TIMES AND STANDARD DEVIATIONS BY OCCURRENCE AND OUTCOME TYPE

Occurrence Type	Outcome Types 1-2			3-4-5			6		
	$\bar{X}$	σ	n	$\bar{X}$	σ	n	$\bar{X}$	σ	n
601 -Disorderly/ Assault	4.4	1.4	5	6.5	3.1	15	9.8	2.8	3
609 -Domestic Dispute	3.0	0.0	1	4.6	2.2	9	7.1	0.6	2
613 -Drunkeness	8.6	5.9	5	6.0	4.3	9	-	-	-
614 -Damage to Property	-	-	-	-	-	-	10.7	7.6	3
616 -Barking Dog	-	-	-	-	-	-	8.0	0.0	1
621 -Suspicious Character	4.8	1.9	6	7.8	1.1	2	-	-	-
626 -Fire Alarm	4.5	0.0	1	5.5	0.0	1	6.0	0.0	1
628 -See Complainant	8.3	0.0	1	6.4	4.2	8	8.3	4.2	6
630 -Streaker	-	-	-	-	-	-	2.5	0.0	1
633 -Weapons	-	-	-	6.5	0.0	1	-	-	-
637 -General Medical Emergency	-	-	-	3.5	1.0	5	5.7	4.3	7
643 -Traffic Accident	17.0	0.0	1	9.1	5.1	9	10.4	6.2	6
644 -Hit and Run	-	-	-	-	-	-	11.5	0.0	1
645 -Obstruct Lane Private Parking	15.0	0.0	1	8.2	3.4	8	10.5	0.0	1
648 -Dominion Signal	2.3	0.4	2	4.4	3.4	5	5.0	5.7	2
651 -Theft (Misc.)	7.5	2.1	2	8.0	0.0	1	8.7	3.1	13
656 -Auto Theft	-	-	-	8.4	1.9	2	8.4	2.6	7
660 -Break and Enter	4.7	0.0	1	5.0	0.0	1	8.2	5.0	13

ANALYSIS OF VARIANCE (F RATIO TEST) - POLICE SYSTEM RESPONSE TIME

Variance	SS	d.f	MS	F Ratio
between	128.97	2	64.485	$\frac{64.485}{15.186} = 4.246^*$ $F(2,165)_{.95} = 2.30$
within	2505.69	165	15.186	

Occurrence Type	Outcome Type: No Action $\bar{X}$	No Action σ	Action $\bar{X}$	Action σ	t-test Score	Level of Significance: 95%	99%	
601 -Assault/ Fight	4.4	1.4	7.1	3.3	1.72	2.1	2.9	N.S.
613 -Drunkeness	8.6	5.9	6.0	4.3	0.85	2.2	3.0	N.S.

These results indicate that a significant difference does not exist between the means for outcome types Action and No Action by occurrence types 601 (assaults/fight) and 613 (drunkeness). This suggests that police system response time is not critical for the above listed occurrence types. An analysis of other occurrence types is not possible because of limited data for this purpose.

The second part of the study was to relate patrol unit response time to the availability of police personnel and hardware if it was found that the final outcome of a call for service is dependent upon patrol response time. Because the results of the experiment suggest that patrol unit response time does not affect the final outcome of a call for service, the second phase of the experiment was not necessary and therefore was not carried out.

CHAPTER IV

DISCUSSION - CONCLUSIONS

Much of the current literature (1,2) suggests that the ratio of criminal to non-criminal occurrences is usually 20:80. The findings of this study refute this; the present results reveal a ratio of 56:44 for criminal and non-criminal events. This apparent disparity invites investigation - was the city under study different in criminal activities from those of earlier studies? This is difficult to ascertain without a detailed comparative analysis which is not within the parameters of this research. There are, however, possible contributing factors which may be briefly outlined. For instance, these data are based on an analysis of calls for service for a relatively short period (336 hours) which may not be representative of the annual workload and occurrence type for a downtown patrol car. A second reason for the disparity may lie in the terms of reference between the present study and others. For example, Brown and Lipsett (3) conducted a survey of Canadian police forces to determine current patrol deployment strategies - in the opinion of 78% of the respondents, responsibility for crime prevention, deterrence and apprehension of offenders is made more difficult because of the requirement to provide non-criminal services. These responses were based on an analysis of total requests for police service by the respective forces. The ratio of criminal to non-criminal calls as determined by other studies is based on the total annual calls to a department, whereas the test results in this study are responses to dispatched calls for service by one downtown patrol car. It is conceivable that calls of a non-criminal nature have been screened by experienced dispatchers to a large extent. Thus, the calls for service to which a patrol unit is dispatched tend to be of a more serious nature and are reflected in the study results. It is conceivable that

a complete analysis of calls for the city under study would yield a ratio of criminal to non-criminal events similar to other studies, and that the apparent disparity lies only in the short-term one-car research design.

As previously outlined, the tachograph proved to be completely adequate for measuring response times and speeds. It is felt that many of the limitations found in earlier studies have been eliminated, or considerably reduced. Because of this accuracy, it is possible to complete the conceptual model previously outlined on Page 30 by use of modal times. This is illustrated in the following diagram.

			Modal Times (Min
CITIZEN REACTION TIME		Time of Incident minus Time of Call to Police	unknown
POLICE SYSTEM RESPONSE TIME	Communications Centre Time	Time of Receipt of Call minus Time of Dispatch of Call	0-1
	Patrol Unit Travel Time	Time of Receipt of Call by Patrol Unit minus Time of Arrival at Scene	2-3
	Service Time	Time of Arrival minus Time Returns to Accept Another Call or Preventive Patrol	1-2
			3.0 minutes

The modal police system response time for a downtown patrol car for the city under study is 3.0 minutes, which resulted in police action of one form or another in 86% of the calls for service.

The F ratio and Scheffée test indicate that, when the means of all occurrences with outcome type A are compared with the means of outcome types B and C, there are no significant differences between these means. This suggests that response time has no effect on the disposition or outcome of a call for service. It must be remembered that the statistical analysis was done on the total of all occurrences within the respective outcome subsets. The 336-hour test period did not include occurrences of a serious criminal nature such as murder, rape, armed robbery, to be certain that the same conclusions can be drawn. Another qualification rests with the experimental design. If it had been possible to greatly decrease average police system response times through zone saturation patrols ($\overline{X}$<6.6 minutes), the outcome results may have been significantly different.

Because the hypothesis that there are significant differences between the means of outcome type A, and B anc C is rejected, it would seem that police system response time is not the sole factor in the final disposition or outcome of a call for police assistance. Other factors such as citizen reaction time, or as yet undiscovered contaminants may be responsible. One of these may have been included in the experimental procedures. For example, psychological considerations turned out to be of prime importance in implementing the research and may have biased the results. At the outset, the officers expressed distrust with the intent of the research and how the results were to be used. For example, several officers assigned to the downtown patrol car likened the tachograph to "Big Brother" and expressed fear that the data was going to be used as a time study of each officer's shift activities. As a result, a considerable amount of time was spent at the beginning of each shift during the changing of the tachograph cards to explain the purpose of the experiment and to assure all officers that the results were confidential.

Several errors were made in the implementation of the research. The instrument was installed in the downtown patrol car without advance warning or prior discussion with patrol officers as to its purpose and function. As a result, strong negative feelings were readily apparent when the experiment began one week later, and the officers were asked for their cooperation. For future experiments, an outline as to the purpose of the research which has been disseminated and discussed, prior to the installation of the experiment, would be desirable. A second error was an initial plan to have the tachograph charts changed by garage personnel. Again, there were strong feelings on the part of officers that this data was being observed and judged by the police administration. This was readily apparent at the second card-changing during heated discussions with patrol officers; subsequently, the author changed the tachograph cards for the duration of the experiment.

During the initial stages of the experiment, the police association expressed considerable interest in the purpose and results of the experiment. This presents an ethical dilemma - should the research be made available to the participants in an experiment, as well as to the agency which authorizes the study? Or do the results become the exclusive property of that agency? The author suggests that the former is preferable. In a subsequent study, the results of this research were used to illustrate the type of data and results which could be obtained using this experimental procedure. It is suggested that the availability of results from this study contributed much to breaking down negative beliefs and attitudes so prevalent initially.

Lastly, it is suggested that research in the area of citizen reaction time to contact the police might be of benefit in explaining why police system response time has little apparent effect on the final disposition or outcome of a call for service. Such a study may show that

it is the time between the occurrence of an event and contact of the police by an observer of the event that significantly affects the outcome of a call for police service.

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APPENDIX A

RESPONSE TIME EXPERIMENT 1973

WHY

1. To discover patrol car average response times and speeds to be used in a concurrent NRC Research Project.
2. To discover the influence of patrol car response speeds and times on the final disposition of a case. (An attempt to answer the question "Does a faster response to a call increase the likelihood of apprehending a suspect?" and "Are there certain types of occurrences or offenses where a fast response speed makes no difference to apprehending a suspect or the final disposition of a call?")

HOW

1. In several cars an instrument (the Argo Tachograph) which will measure average response speeds and times will be installed.
2. The tachograph is the property of National Research Council and will remain in the car during the experimental period.
3. All charts and data collected become the property of National Research Council and will be evaluated in their labs.
4. The results of the data collected will be available to members of the Ottawa Police Force upon completion.

REMARKS

This is NOT a time-study of the Police Officer's Shift. Rather, it is an experiment initiated and arranged by the National Research Council to measure patrol car response times and speeds and to discover whether this effects the rate of apprehensions. While the instrument in itself will measure average response speeds and times, your cooperation in this experiment will serve as a means to double-check the recordings on the graph.

Initially, it is our intention to begin a pilot study with one car in the downtown area a dn then expand to several cars in the city. The duration of the experiment has not yet been determined.

Several experiments of this type have been conducted in the United States under grants from the Law Enforcement Assistance Agency of the U.S. Department of Justice. Projects of this type have been completed in cities such as Los Angeles, Edina, Missouri, Boston and New York. There have been no similar studies in Canada which take into consideration Canadian police operations or conditions. We ask for your assistance in this project.

Thank you,

Bill Brown

APPENDIX B

Instructions to Officers

(1) When answering dispatched calls for service
- turn on record trip switch at the instant you begin to drive to the call

- upon arrival at the scene of the call, turn off the record trip switch

(2) When writing up your patrol log sheets after the call for service has been completed, write in one of the following types to indicate how the call was dealt with.

IF GONE ON ARRIVAL	write type 1
IF ALL IN ORDER	type 2
IF SETTLED ON ARRIVAL/ADVISED	type 3
IF SETTLED BY WARNING/TICKET	type 4
IF CLEARED BY CHARGE/ARREST/SUMMONS TO APPEAR	type 5
IF INVESTIGATION INITIATED (REPORT/OCCURRENCE NUMBER)	type 6

The dispatcher has been given a block of occurrence numbers for the use of Car 101 - ALL SHIFTS
Request and a number will be supplied for your occurrence report. Please state number on log sheet.

ABSTRACT

Evaluation of Police Patrol Operations

Several attempts have been made in recent years to evaluate police patrol operations by measuring police system response times and, in one case, to study the effects of these times on the outcome of calls for police service. For instance, Larson sought to measure patrol unit travel times with the City of New York Police Department; Isaacs arranged an experimental design which sought to demonstrate that the probability of arrest is directly proportional to the immediacy of response. However, no study to date has illustrated a cause and effect relationship between response and final disposition or outcome of a call for service. The present state of knowledge does not explain the effect of change in police personnel and hardware on police system response time nor what effect change in police system response time has on the final outcome or disposition of a call for service. This study seeks to answer some of these questions.

The literature on the police patrol system indicates that traditionally police efficiency and effectiveness have been measured by two sets of criteria, system input and system output. System input criteria are the number of policemen on duty, the number of cars in service, the hazard/workload formula and the like, whereas system output criteria are represented by crime rates, arrest rates, clearance rates and so on. The use of either depends on a series of assumptions which link the criterion utilized with the objectives of police work. While attempts have been made to study the effect of each of these, no studies have been

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conducted to relate input to output through the intervening variables. The present state of knowledge does not tell us what changes in police personnel and hardware result in what changes in police response time, and what effect changes in police response time has on the final outcome or disposition of a call for service. This study is designed to provide answers to some of these questions. What it specifically seeks to do is first to relate the final outcome or disposition of a call for service to patrol response time and then to relate patrol response time to the availability of police personnel and hardware if it is found that the final outcome of a call for service is dependent on patrol response time. The purpose of this study is to provide empirically derived information which will permit the police to more effectively organize the deployment of their personnel and hardware. The first part of the study consists essentially of monitoring patrol cars over a period of time for the collection of data which will permit the comparison of response times with the action taken and the second part the comparison of response times with the deployment procedures utilized during the period of study.

The design of this study necessitates the collection of three types of information which could be, for convenience, identified as input, intervening and output variables. Input criteria used for the evaluation of a police force, such as the number of patrol cars available for dispatch, the number of men to staff the cars and perform beat duties, the area of zones to be patrolled, and the locations, frequencies and types of calls for service are

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readily available. The measurement of intervening variables such as police system response times and patrol unit response speeds is, however, more problematic. A method in which the human factor was reduced to a minimum appeared desirable. Such a method comprised the use of the tachograph which is an electronic recorder used by highway fleet operators to monitor the movements of vehicles. The instrument automatically records the following data:

a) elapsed time between two points or locations,

b) speed of vehicle in miles per hour

c) distance travelled between two points or locations

d) maximum speed reached.

Output criteria depend upon what the police seek to do. Crime rates, arrest rates and clearance rates become output criteria only when it is assumed that people can be deterred from committing crime, that the effectiveness of deterrence is dependent on the certainty of punishment and that the certainty of solution of the case is dependent on the rapidity of police response. These criteria are, however, too far removed from the event for meaningful analysis. A more immediate output criterion is the type of police action of which there are apparently six:

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1. Suspect/vehicle gone on arrival: no police action possible. 2. All in order: no police action possible.	OUTCOME TYPE A
3. Settled on arrival: police action - advise. 4. Settled by warning: police action - ticket or warning issued. 5. Settled by charge: police action - arrest or summons to appear.	OUTCOME TYPE B
6. Further investigation necessary: police action: investigation initiated, report.	OUTCOME TYPE C

The experiment consisted of monitoring the movements of a downtown patrol car over a period of 336 hours during which the necessary data was collected. A downtown patrol car was selected because it was felt that the core area presented the greatest challenge in terms of the number of calls and the shorter times and distances to both the officer operating the vehicle and the instrument recording his activities. A period of one week was selected for the experiment as it coincided with the individual officer's tour of duty as well as monitoring the fluctuations in the types and number of calls for service; the remaining 168 hours of the test period were used as a check on the original week and as a source of additional data. Several approaches were used to analyze this data. These included frequency distributions and histograms for the graphic presentation of the data. In order to test for significant

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differences between two or more groups, an analysis of variance computation was used followed by a Scheffée post hoc test.

The primary purpose of the research was to determine the effect that police system response times and patrol unit response speeds have on the disposition or outcome of calls for service. A cursory examination of the data reveals little or no difference between the means of outcome types A, B, and C for all occurrence types. The F ratio and Scheffée test indicate that, when the means of all occurrences with outcome type A are compared with the means of outcome types B and C, there are no significant differences between these means. This suggests that response time has no effect on the disposition or outcome of a call for service.

Because the hypothesis that there are significant differences between the means of outcome type A, and B and C is rejected, it would seem that police system response time is not the sole factor in the final disposition or outcome of a call for police assistance. Other factors such as citizer reaction time, or as yet undiscovered contaminants may be responsible. Therefore, it is suggested that research in the area of citizen reaction time to contact the police might be of benefit in explaining why police system response time has little apparent effect on the final disposition or outcome of a call for service. Such a study may show that it is the time between the occurrence of an event and contact of the police by an observer of the event that significantly affects the outcome of a call for police service.