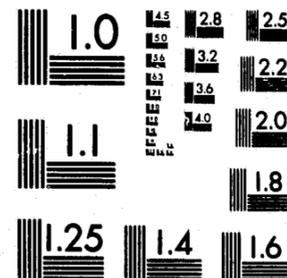


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Final Summary Report

THE APPLICATION OF SCIENTIFIC TECHNIQUES
TO LAW ENFORCEMENT
AND CRIMINAL JUSTICE PROBLEMS

April, 1967
1331-252

E. F. Fennesy
J. A. Russo, Jr.
R. H. Ellis

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THE TRAVELERS RESEARCH CENTER, INC.
250 CONSTITUTION PLAZA, HARTFORD, CONN. 06103



Final Summary Report

NCJRS

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ACQUISITIONS

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E. F. Fennessy
J. A. Russo, Jr.
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U.S. Department of Justice
National Institute of Justice

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1.0 INTRODUCTION

This study concerning the identification of problem areas and research projects associated with "The Application of Scientific Techniques to Law Enforcement and Criminal Justice Problems" was conducted by the Mathematical Sciences Department of The Travelers Research Center, Inc., (TRC) under contract 7331-03 as part of the Environment and Man Program supported by the Travelers Insurance Company. The study was performed during the period 1 October 1966 to 31 December 1966.

1.1 Objectives

The objectives of the study were:

(1) To review the crime problem in the United States and determine the general applicability of scientific and technological methods to problems of law enforcement and criminal justice.

(2) To identify specific problem areas in the realm of law enforcement and criminal justice which are amenable to solution by analytical and statistical techniques.

(3) To evaluate the problem areas and applicable techniques identified in (2) above, recommend specific projects for study by TRC, and develop possible approaches toward solving the selected problems through application of the appropriate techniques.

1.2 Background

Crime is a major social problem in the United States. The national crime rate is currently increasing at a rate substantially greater than that of the population increase. To combat this increasing crime rate, the law enforcement agencies, from the local to the national level, have become intertwined components of complex governmental systems with overlapping responsibilities and geographic boundaries. Further complicating the situation are the inherent political, administrative, legal, social and psychological factors and problems that, in many cases, have served as a deterrent to law enforcement activities. Because of present design, structure, and operational modes, law enforcement agencies appear ill-equipped to handle many of these complex problems. It appears, however, that analytical and statistical techniques developed in recent years through advances in science and technology are applicable to the study of law enforcement problems.

The Research Center, with competence in systems analysis, data analysis, mathematical statistics, and computer science, has developed and successfully applied analytical and statistical techniques to complex problems in other areas such as weapon systems, meteorological observation and forecasting, and biomedical systems. Attempts were made, as reported in the subsequent discussion, to determine where these powerful techniques might be applied to the problems associated with law enforcement and criminal justice.

1.3 Scope and Approach

The study scope includes a survey of problems associated with law enforcement and criminal justice in the United States, and an evaluation of analytical and statistical technique applicability to these problems. No detailed analysis of any specific problem area is attempted; however, specific problems amenable to solution by these techniques are identified. Also presented are discussions of possible approaches to those problems recommended for detailed study.

An initial survey was made of the U.S. law enforcement and criminal justice activities, problems and research as identified from the information collected from literature surveys, personal contacts and limited direct observation. The primary literature sources used are presented in Appendix A, and the people contacted during the course of the study are listed in Appendix B.

An extensive list of problem areas was developed from the survey. Several methods of categorizing the problems were evaluated: by association of the problem area with the sequence of activities in the law enforcement and criminal justice process; by program areas such as identification, manpower development, prevention, community relations, etc.; and by technique application such as simulation, broad scope systems analysis, cost/benefit analysis, mathematical modeling, multivariate analysis, etc. The amorphous nature of the set of problem areas, which included hierarchies of problem priorities and scopes, made categorization difficult. However, the objective was to place the problems into mutually exclusive categories to permit a more organized and detailed evaluation of each problem. It was determined that the problem categorization scheme which related problems to law enforcement and criminal justice missions or functions most satisfactorily accomplished the objective. Therefore, the problem areas were

grouped into functional study categories wherever possible. These categories are: police services projects, courts and adjudication projects, corrections and rehabilitation projects, criminal justice information projects, and crime prevention and control projects.

The identified problems within each of the primary study categories were screened against potential analytical and statistical techniques to provide a preliminary determination of those problems that might be amenable to solution by applying either a single technique or a combination of the techniques to provide a preliminary determination of those problems that might be amenable to solution by applying either a single technique or a combination of the techniques in which we are interested. Thus, within this problem categorization framework a number of law enforcement and criminal justice research projects, associating problem and technique, were identified and described. The projects were subjectively evaluated by the authors to select and recommend a set of further study. The selection was based on the importance of the problem and on problem interest as assessed by the evaluators, on capabilities and experience in the applicable techniques or methodology of interest, and the amount of past and current effort expended by other researchers in studying the problem through application of the recommended technique (i.e., the degree of duplication of effort). A number of projects were rejected either because they did not meet the selection criteria or because they required further detailed analysis prior to recommending them for research. A final set of twelve study projects was retained for further evaluation.

Finally, a recommended approach was developed for each of the twelve projects. Brief, general descriptions of these recommended approaches are provided to serve as guidance for those projects that may be selected for further work.

Section 2.0 of this report describes the U.S. crime problems and programs of technical assistance. Section 3.0 presents specific problems judged amenable to solution by scientific and technological methods. Section 4.0 gives an analysis of recommended projects and Section 5.0 presents the findings and conclusions of this study.

2.0 THE U.S. CRIME PROBLEM AND PROGRAMS OF TECHNICAL ASSISTANCE

Crime is a major social problem in the United States. The national crime rate is now increasing at five times the rate of population increase (see Fig. 2-1). Further, this crime rate is computed on the basis of reported crime, that is, crimes known to the police.¹ A great many crimes are never reported to the police and, a considerable number of crimes are probably unknown either to the victims or the offenders. For example, it would be difficult to estimate how often one is the victim of the felony of slander, or how often one commits this offense himself. For another example, an intoxicated driver is usually unable to analyze the extent of his drunkenness. The volume and value of goods illegally appropriated by employees is also impossible to determine. So-called "white collar" crimes (violation of trust, fraud, restraint of trade, misrepresentation in advertising, etc.) present another area that is generally not included in the statistics of lawlessness. An indication of the true extent of illegal behavior was presented in a study by Wallerstein and Wyle² in which a questionnaire detailing forty-nine common offenses was submitted to a sample of adult New York residents who had never been arrested. The responses to this questionnaire were startling. The Wallerstein-Wyle study revealed that:

Of the 1,020 men and 678 women answering the questions, 91 percent admitted committing felonies and misdemeanors that might have resulted in imprisonment.²

The deliberate suppression of crime statistics presents still another problem. Police departments and political administrations are frequently judged by the status of crime clearance rates (number of crimes solved compared to number of crimes reported) in areas under their jurisdiction. For example:

In 1949 the New York City Police Department reported that a total of 2,500 burglaries had been committed in the city and that 77.4% had been cleared by arrest. In 1952 the same police department, under a different commissioner, reported a total of 42,149 burglaries with only 12.9% cleared by arrest. Comparing these figures, the

¹Ronald H. Beattie, "Criminal Statistics in the United States—1960" in *The Journal of Criminal Law, Criminology and Police Science*. Vol. 51, No. 1, May-June 1960, pp. 49-65.

²James S. Wallerstein and Clement J. Wyle: "Our Law-Abiding Law-Breakers" in *Federal Probation*, 25:110, April 1947, p. 327.

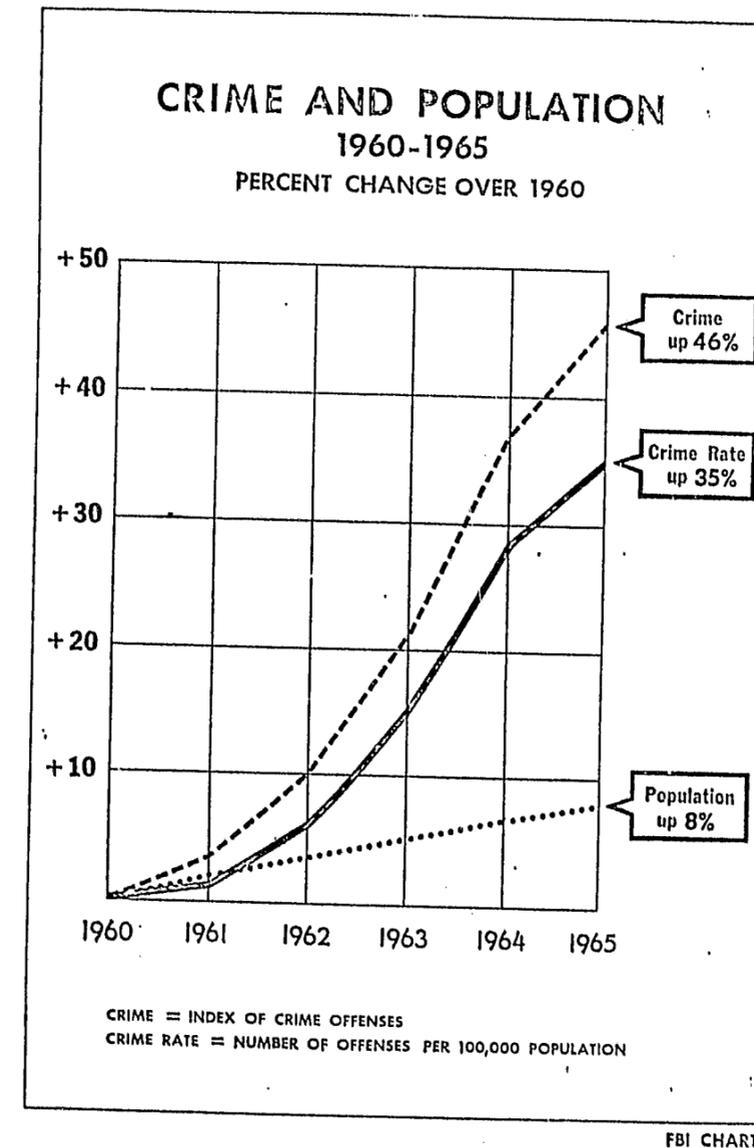


Fig. 2-1. National crime rate.

unsophisticated reader might have come to a variety of conclusions. He might have concluded that New York had been struck by a calamitous crime wave. While this disaster was developing, another had apparently overtaken the police: arrests had dropped from better than 3 out of 4 to little more than 1 out of 10.³

In fact, what had happened was that prior to 1952, the police crime reporting system had "canned" (failed to record) many complaints for unsolved cases. The 1949 figures included only a fraction of the burglaries actually committed. Hopefully, improvements have occurred in crime reporting methods since the above case. Also, the accuracy of crime data is also limited by the fact that police agencies, representing 8% of the population or approximately 15,000,000 people, do not participate in the voluntary crime reporting program. In 1965, the FBI presented their annual report of crime in the U.S.⁴ Exerpts from this report are presented below.

- more than 2,780,000 serious crimes reported during 1965; a 6% increase over 1964.
- 14 victims of serious crime per 1,000 inhabitants in 1965; an increase of 5% over 1964 and 35% over 1960.
- 118,900 robberies; 1,173,000 burglaries; 2,500,000 larcenies; and 486,600 auto thefts resulted in total property loss in excess of \$1 billion.
- arrests of persons under 18 for serious crimes increased 47% in 1965 over 1960. Increase in young age group population for same period was 17%.

The expanding population that police departments serve, along with a proportionally larger increase in crime rate, has led law enforcement agencies to realize that their traditional methods of operation are in serious need of modernization.

In addition to increasing crime rates, the police are confronted with another major problem. Recent Supreme Court decisions (Miranda, Mapp, and Escabedo, for example) aimed at protecting the innocent have forced police departments to alter their traditional methods of operation. These and other rulings, dealing with right to counsel, self-incrimination, pre-trial publication of information, the admissibility of certain types of

³Richard R. Korn, and Lloyd U. McCorkle: Crimnology and Penology, New York. 1963, p. 56.

⁴Federal Bureau of Investigation: Uniform Crime Reports—1965. Washington, D.C. 1966, p. 1.

evidence, and prearrest procedures, confront the police with major procedural problems in carrying out their responsibilities. They are currently in a process of reorienting their operations, and this is leading to a reduction in efficiency and serious morale problems among experienced policemen. Police response to these rulings has been vitriolic. At a recent symposium on crime, the Commissioner of Connecticut's State Police, Leo J. Mulcahy, commented:

Our basic authority to enforce the established laws, the power of arrest, which is the hallmark of police service, is being challenged by some who desire to determine for themselves who should and should not be subject to arrest.⁵

A far more serious problem, perhaps, is the quality of police personnel currently on duty. There is no adequate definition of what police responsibilities should be in contemporary society. Much of police effort is dissipated on tasks that are not related to their basic function of controlling crime. For example:

Some one hundred cities with populations in excess of 10,000 were surveyed to determine what services of a non-police nature were being performed by police departments. Although there were differences in what individual police chiefs considered to be a police or non-police function, the survey revealed that 75% of the departments spent 50-90 percent of their time on non criminal matters.⁶

Recent articles have been concerned with what they have termed poor police performance. For example:

Government officials are thinking now that bad police management rather than lack of manpower and advanced technology is the big drawback in fighting crime.⁷

Preliminary reports indicate that the National Crime Commission will also attack the quality of police performance in their report to the President in early 1967. One report states that a major theme of the Commission will be that:

⁵Brenda Vambaco: "Symposium on Crime Seeks Causes, Cures." The Catholic Transcript, September 30, 1966, p. 13.

⁶Benjamin Goldstein, "Non-Police Duties of Today's Policemen," in Connecticut Government, Vol. 19, No. 4, Institute of Public Service, University of Connecticut, June 1966, p. 2.

⁷Federal Urban Report, Washington, D.C. August 19, 1966, p. 3.

...what the policeman needs more than anything else is higher pay, more education, and training. The thought, of course, is that state and local police forces must, to do their job effectively, attract higher-caliber people into service. Which is a nice way of saying that today's policemen are less than totally satisfactory. A significant shortcoming in the Commissions' eyes is the relationship between many police forces and the community they patrol and protect...Results of the study are being kept under tight wraps, but conversation with someone who has seen the document disclosed that—unless changes are made in the Commission's final report—the performance of police will be cast in unflattering terms. "Its worse than we thought" declares the informant.

Richard A. Myren feels that these problems can be traced to three basic failings of police management:

- I. Police Management has failed to define a homogeneous police group.
- II. Police Management has failed to adapt basic police organizational structure to meet modern needs.
- III. Police Management has failed to create the challenge and satisfaction in police service necessary for effective utilization of the brain power now available.

Myren concludes that "until these failures are overcome, there can be no police 'profession'."¹⁰

These critical comments are not aimed at the individual policeman, but rather at the system under which he must operate. In general, the policeman on the street is doing an excellent job while working under some extremely adverse conditions. He is underpaid, often unappreciated and misunderstood by the community he serves, and his work varies from long periods of monotonous routine to periods of intense danger (53 policemen were killed in the performance of their duties in 1965 alone). His hours are irregular and he frequently must spend his days off waiting to testify in court. All in all, the policeman is one of society's most valuable resources if he is used effectively. The police cannot change the system in which they operate; forces for positive change must originate from outside of the criminal justice system. Research must be performed and findings relayed to the decision-makers who have the tools of power to exert these forces for change.

⁸Monroe W. Karmin, "Combatting Crime" in The Wall Street Journal, Vol. CLXVII, No. 125, December 28, 1965, Col. 1, p. 1.

⁹Richard A. Myren, "A Crisis in Police Management," in The Journal of Criminal Law, Criminology, and Police Science, Vol. 50, No. 6, March-April, 1960, p. 600.

¹⁰Myren, p. 600.

The emphasis in crime research has largely taken on the qualitative behavior science viewpoint aimed at the determination of the causal effects of crime. Criminologists along with a full panel of researchers from the behavioral sciences—sociologists, psychologists, and anthropologists—are probing the knotted causes of crime. Various Great Society programs, such as the War on Poverty, aid to housing and urban development, and assistance for elementary and secondary education, are aimed at correcting social and economic conditions that proponents believe encourage deviant behavior. But these efforts have for their target only one phase of the law enforcement problem—crime prevention through elimination of crime-producing social and economic conditions.

To be sure, much can be done now to assure a more crime-free future. But safer streets in the future offer small consolation to the victims of crime today. What is being done about the problems of crime control? The police are fighting Twentieth Century crime with Nineteenth Century methods. The patrolman on the beat carries a gun and a club; so did his predecessors in the last century. The policeman today, except in a few departments, has inadequate communication facilities and is often hamstrung by time-consuming paper work. The flow of criminal information relating to criminal activities in his area is slow and uncertain. The automobile, the radio, and fingerprinting are still "new" things in general police work.

The police have, to a great extent, been insulated from advances in other areas of our increasingly technology-oriented society. There have been tremendous advances in science and technology in support of the national space and defense programs. The transfer of these technological advances to other sectors of the economy has, however, been a slow process. In recent years we have seen some notable adaptations of this technology in such diverse areas as medicine, agriculture, meteorology, communications, and transportation. However, there has been a noticeable lack of technology transfer to the operations of state and local law enforcement agencies.

Application, it is generally agreed, can only grow out of comprehensive research endeavoring to relate the resources of science and technology to the current law enforcement situation.

This logical extension of science and technology to law enforcement problems has, in recent years, been recognized by the Federal Government, regional, state and local organizations, universities and private industry. Out of this awareness have evolved budget commitments at almost all governmental levels, the establishment of new agencies,

and significant research—all aimed at a more inclusive attack on crime than was possible in the behavioral-science approach of the past.

The Federal Bureau of the Budget has estimated that the total cost of the criminal justice system in the U.S. amounts to some \$4.3 billion annually. In line with President Johnson's "creative federalism" approach to public administration, he is now committed to applying the resources of the federal government to reduce the financial burdens of law enforcement to agencies of state and local governments.

In his message to Congress on March 8, 1965, President Johnson proposed a number of measures designed to increase federal participation in controlling and/or suppressing the rising incidence of crime in the nation.¹¹ Congress was asked to provide the Attorney General of the U. S. with authority to establish a program of grant and technical assistance that would enable state, local, and private groups to accelerate efforts in the application, development, and testing of scientific and technological methodologies for law enforcement problems. As a result of this request, Congress created a new agency in the Justice Department. The Office of Law Enforcement Assistance (OLEA) and enacted a Law Enforcement Assistance Act on September 22, 1965. Under this Act, research projects are encouraged which endeavor to:

- Develop new alternatives to generally accepted but often ineffective law enforcement management and operation practices,
- Provide new technical and scientific tools for agency functions, and
- Utilize advanced technological knowledge and concepts.

In fiscal year 1966, the first full year of the program's existence, approximately \$7.2 million were provided for research. This represents the principal external source of research funds in the law enforcement area.

The most significant study, with regard to comprehensiveness (\$498,000—9-month study) under OLEA sponsorship is being undertaken by the Institute of Defense Analysis (IDA). The aim of this research is:

- A comprehensive study of potential applications of science and technology to agencies, methods, and problems of crime control, law enforcement, corrections, and criminal justice administration.¹²

¹¹U.S. Department of Justice, Office of Law Enforcement Assistance; LEAA Grant Guide August, 1966. p. 1.

¹²U.S. Department of Justice, Office of Law Enforcement Assistance: List of Approved Projects: Fiscal Year 1966, July, 1966. p. 14 (This study represents Task 4 of the National Crime Commission project and the results will be published as part of the Commission's Final Report to the President.).

All indications point toward the increase, at a substantial rate, of federal involvement area. Planning studies are currently underway within OLEA to anticipate the major areas of research needed in expectation of this large commitment by the federal government. In any event, the OLEA budget for fiscal year 1967 will continue at \$7.2 million. In addition, Dr. R. L. Emrich, Director of Science and Technology at OLEA, stated in a personal interview (December 2, 1966) that he felt President Johnson will ask Congress to appropriate from one fourth to one half billion dollars for a major war on crime in his annual speech in March 1967. He felt that this program will be well received by Congress, but that the demands of the Viet Nam war may reduce the final amount appropriated.

The initial indications and outline of this national war on crime were provided in President Johnson's State of the Union message on January 10, 1967.¹³ The President stated:

I will recommend to the 90th Congress the Safe Streets and Crime Control Act of 1967. It will enable us to assist those States and cities that try to make their streets and homes safer, their police forces better, their correctional systems more effective and their courts more efficient.

Federal support to States and cities, according to the President, will take the following forms:

- (1) 90 percent of the cost of developing State and local plans to combat crime,
- (2) 60 percent of the cost of training new tactical units, developing instant communications and special alarm systems, and introducing the latest equipment and techniques to that they can become weapons in the war on crime, and
- (3) 50 percent of the cost of crime laboratories and Police Academy-type centers so that our citizens can be protected by the best-trained and best-equipped police.

¹³The New York Times: "Text of Johnson's State of Union Message", January 11, 1967, p. 16.

President Johnson has requested a Fiscal Year 1968 appropriation of \$50 million for this project. Fiscal Year 1969 appropriations are expected to total \$300 million.

In addition to the aforementioned sources of federal government research funds, another recent proposal on a giant scale comes from Congressman Scheuer, (Dem., N.Y.) who has introduced a bill in the House of Representatives to establish a National Institute for Crime Prevention and Detection. Scheuer compares it to the National Institute of Health and seeks an initial appropriation of \$100 million. This institute is to supply the National Crime Commission and OLEA with the basic research tools and brainpower to accelerate research and to implement findings. The institute would offer a central research facility to any law enforcement body needing it. There would be both empirical and behavioral scientists—anyone whose expertise or specialty touches on the administration of criminal justice. Sen. Edward Kennedy has introduced a similar bill in the Senate.

Another federal agency concerned with the problems of law enforcement is the Housing and Urban Development Department (HUD). This group is interested in new methods of crime control as part of their "Demonstration Cities" program. The newly formed Transportation Department will also be concerned with scientific applications of law enforcement as related to traffic problems.

While the Federal Government's response to the war on crime is rather promising, as indicated by the examples cited above, the area of maximum potential at the present time is at the state level. California, for example, in the next five years will devote approximately \$3.0 billion in support of its criminal justice system.¹⁴ In 1964, the State of California commissioned a "systems" study of the law enforcement problems of the state. This study was performed by the Space General Corporation and was entitled Prevention and Control of Crime and Delinquency. In general, this study recommends long-range, multi-disciplinary efforts to suppress the growth of criminal activity. The study further recommends state expenditures of \$122 million in research funds to aid in the suppression of crime.

While California has taken the lead in applying science and technology to their crime problems, the State of New York is not far behind. One indication of this fact is the recent design of the "New York State Intelligence and Information System (NYSIIS)," a revolutionary concept in the field of crime control.

¹⁴F. Kahn, et al.: Prevention and Control of Crime and Delinquency, Space General Corporation, El Monte, California, PCCK-7, July 1965.

The basic purpose of NYSIIS is to develop a computer-based central information sharing facility to assist all agencies concerned with criminal justice to better perform their functions. NYSIIS is not only to be a repository of crime data, but is expected to become a leader in the development of new technology for improved crime control. First year appropriations (1965) for this agency totaled about \$1.5 million, primarily for planning purposes. As the system develops, it is expected that annual operating costs, which will include contractual research, will be in the \$5-7 million range. System Development Corporation, who in the past three years appears to have contributed the most toward tying science and technology to law enforcement problems, is working in conjunction with New York State officials in the design of this system. Many of the problems which are to be integrated into this system are formidable ones and still require a great deal of research. These problems include, for example, fingerprint classification, identification and retrieval, modus operandi files, personal appearance computerization, and criminal intelligence data storage and retrieval.

An even more ambitious concept, still in the planning stage, is the Federal Bureau of Investigation's National Crime Information Center. This facility is expected to be in limited operation by early 1967. The planners of the NCIC visualize a system that will eventually encompass the entire United States and which:

...will make available to each law enforcement agency, in a matter of seconds, the facilities of an informational file national in scope.¹⁵

However, before this system can be successful:

...metropolitan and statewide systems must develop to serve local needs which could not possibly be met by any national system.¹⁶

Therefore, there will exist a need, as the National Crime Information Center expands, to draw all of the states into the system. Plans are currently underway to have the Federal Government aid the states in developing their own systems. To develop a criminal information system for a state will take money that state legislatures may be unwilling to provide; so:

¹⁵ FBI Law Enforcement Bulletin, "A National Crime Information Center," The Federal Bureau of Investigation, p. 3.

¹⁶ Ibid, p. 3.

It is hoped \$25 million in matching funds will be provided to the States to complete the system over 5-10 years.¹⁷

California and New York State involvement are examples of the increased interest in scientific techniques in law enforcement. While they are ahead of all the other states in achievement thus far, almost all the states are at work in this area.

In addition to the federal and state involvement in the law enforcement research area, two other important sources of research funds should be mentioned.

First, a number of cities, primarily the larger ones, have initiated research programs through local police departments and, in many cases, in affiliation with industrial firms, universities or federal and state organizations.

The cities of Los Angeles and New York have been working with the Systems Development Corporation on the solution of a wide range of problems including the modernization and computerization of their record systems, rapid transmission and retrieval of stolen car information, and computerized modus operandi files. The Chicago Police Department, under the leadership of O. W. Wilson, has also made pioneering advances in police technology, notably in communications and data processing. St. Louis, Missouri has been working with the Systems Science Corporation on the solution of a wide range of problems, notably, deployment of personnel. The Oakland, California Police Department allocated \$188 thousand of its own 1965 funds for research and development. At this time, it appears that local-level support of this type, because of limited resources, will be in areas in which a small research effort promises a quick return. This is certainly true for the smaller cities, at least.

It should also be mentioned that while the U.S. program in scientific crime control and prevention is still, essentially, in a planning stage, the British have at least three years of solid experience with their program in this field. In 1963 the British Government established an Operations Research unit on the national level to investigate police problems. The first two, formative, years of this unit were largely unproductive, but in 1966 their research program was beginning to provide significant feed-back and important results. Their major efforts to date have been in problem definition. In this regard, one study was concerned with an investigation of the wide variation between U.K.

¹⁷ Fairchild News Service "Nationwide EDP System to Spur Crime Detection" in Electronic News, December 5, 1966, p. 11

cities in the incidence of indictable offenses per thousand population. Their approach to this problem was as follows:

An explanation was sought for this in terms of differences in demographic and police factors between the various cities and a mathematical analysis was made to see if this rather wide scatter could be tidied up. A multi-regression analysis was also made. The results of the analysis...suggested that the differences in the police strength, the capital expenditure per head of policeman, and the way in which men were tactically deployed were not dominant factors in the variation in incidence of crime between cities. On the other hand population density appeared to matter a great deal as also did distribution of wealth within the community.¹⁸

There has also been a great deal of stress in the U.K. program on the development of mathematical models, such as "A Police Conflict Model" by Fry, a "Dynamic Model of the Conflict between Criminals and Society" by Wilmer,¹⁹ and "A Simulation Model of a Police Unit" by Pasque. Another interesting approach to a common problem of law enforcement has been attempted by Wilmer. Wilmer has made a significant breakthrough in his development of a method for measuring the value of information in the police context.¹⁹ He has shown that:

...where two sets of phenomena are associated in some way with a given set of probabilities, that is to say the population and the crimes that are committed within it, then the problem can be reduced to assessing the choice which exists and this enables the concept of entropy to be used to advantage...Further development of this line of thought has led to the proposition that one measure of effectiveness of a police officer depends upon the probability that he will, or will not, miss a piece of high value information.²⁰

The United Kingdom program, then, has definitely established that scientific techniques, such as traditional operations research methods, have an important place in the understanding, prevention, and control of criminal activity. To our knowledge, research of this type has not yet been produced by U.S. scientists, although all indications now point to the high probability that U.S. efforts in this area are on the increase.

¹⁸A.G. McDonald: Operations Research on Police Problems in the United Kingdom, Home Office Scientific Advisor's Branch, Police Report SA/POL 14, London, England, 1966, p.1.

¹⁹M.A.P. Wilmer: "On the Measurement of Information In the Field of Criminal Detection" in Operational Research Quarterly, Vol. 17, No. 4, December 1966, pp. 335-346.

²⁰Ibid., McDonald, p. 6.

In summary then, out of the awareness of the logical extension of science and technology to the law enforcement areas have evolved budgetary commitments at all governmental agencies as well as significant research aimed at an all-inclusive attack on crime. However, it has to be made clear that this scientific and technological emphasis is in the infant stage, with less than two years of substantial effort. Further,

Granting all its benefits, technology can only apply knowledge that exists. The creation of new knowledge for effective crime prevention is attainable through scientific research. Together, science and technology provide the tools which can be used by enlightened police agencies to fulfill their ultimate responsibilities to the communities and society they serve.²¹

Much work remains to be done and the field is wide open.

²¹J.K. Parker, "New Challenges and Potentials in Law Enforcement" in New Horizons for Modern Government, Vol. XIV, No. II, Nov. 1966, pp. 12.

3.0 PROBLEMS AMENABLE TO SOLUTION BY APPLIED SCIENCE AND TECHNOLOGY

Governmental authorities, as discussed in the preceding section, are becoming increasingly aware of the need for progressive scientific techniques to combat the mounting problem of crime in the United States. This section identifies and evaluates study projects which appear to be most susceptible to scientific solution. The major aim of the first phase of our study was to identify the major problems of law enforcement without regard to the applicability of scientific and technological techniques to their solution. These problems have been subjectively chosen through intensive literature search, interviews with knowledgeable law enforcement officials and researchers, and by our observation of law enforcement operations.

Based on our knowledge and experience of analytical and statistical techniques (e.g., mathematical modeling, multivariate analysis, cost/effectiveness analysis, resource allocation methods, information storage and retrieval, game theory, Monte Carlo methods, matrix analysis, linear and non-linear programming techniques, design of experiments, survey sampling, computer programming, data systems design, etc.), we were able to identify 44 potential study projects which matched techniques with problems. These 44 projects were further assessed and a large number of "hardware" type projects were eliminated for further consideration (i.e., design of police patrol vehicles, laboratory research and production of a "true" non-lethal chemical agent, etc.). Other projects were eliminated because technique application was questionable (e.g., prevention of housebreaks, treatment of alcoholics, etc.).

In this investigation our primary goal was first to identify a problem of law enforcement and then to match this problem with an approach or technique that can be applied in its solution. Therefore, the problem to be attacked will be inherent in the proposed project; for example, a problem faced by the majority of police departments is in efficient deployment of their uniformed patrol force to control or prevent crime. From this problem, we have developed a number of potential projects such as "An evaluation of alternative approaches to preventative patrol in a variety of situations," and "The development of improved police deployment procedures." Hopefully, the root problem will be clear to the reader from the nature of the potential project.

The projects we selected for further evaluation are categorized according to the functional area of law enforcement to which they relate. Section 3.1 briefly describes

each of the broad functional categories, to which analytical or statistical techniques might be applied. Section 3.3 deals with the evaluation of these projects with regard to the interest of the authors, level of previous research, urgency of the problem, and TRC capabilities and experience. According to these criteria, a smaller sub-set of projects were selected for detailed analysis. These projects are listed in Section 3.4. The contents of Section 3.0 are synopsized in Table 3-1 which is at the end of the section.

3.1 Problem Categorization

A number of specific study projects, judged to be amenable to scientific analysis, have been identified. These projects have been categorized on the basis of the functional area of criminal justice in which the problem exists. There are four such categories, plus a general category entitled "Crime prevention and control projects." These categories, listed below, are briefly described in the following sections:

Police services projects

Courts and adjudication projects

Corrections and rehabilitation projects

Criminal justice information projects

Crime prevention and control projects

Police Services Projects

These projects are specifically aimed at the improvement or modernization of traditional police department functions. The objective of these projects is to utilize analytical and statistical methods in attacking police problems.

Courts and Adjudication Projects

These projects relate directly to the administrative process of criminal justice. They are aimed at the modernization of court and legal management procedures and techniques.

Corrections and Rehabilitation Projects

Study projects in this category are primarily focused on attempting to improve correctional treatment and control procedures as they relate to probation, incarceration, and parole.

Criminal Justice Information Projects

Projects in this category are aimed at the automation and improvement of criminal information processing and retrieval capabilities either of specific agencies or of the criminal justice system as a whole.

Crime Prevention and Control Projects

Projects in this category are those which do not specifically apply to any functional area of criminal justice, nor fit into any of the previously defined categories, but whose solution would be of general value or benefit to the total criminal justice system and to society.

3.2 Projects Amenable to Solution by Analytical and Statistical Techniques

The projects considered most susceptible to the applicability of scientific and technological methodologies are listed and briefly described below within the broad categories defined in Section 3.1. In certain cases, projects could be considered in more than one category. In these cases, the project was placed in the category considered most appropriate. An arbitrary numbering scheme is used to facilitate reference. Each category has a letter identifier; the projects are numbered sequentially from 1 to 44.

A. Police Services Projects

A-1) Systems Analysis of a Municipal Police Department

The structure, functions, needs, system demands, and relationships of the individual divisions of a municipal police department will be analyzed. The objective will be to design an optimum police system, better able to cope with increasing urban crime problems.

A-2) Development of a Prototype Police Records System

A prototype police records system will be developed which is capable of meeting the increasing needs for police information in the most efficient manner. Information needs of all divisions, units and offices will be specified and integrated into a centralized records system capable of meeting both internal and external demands.

A-3) Functional Analysis of Police Activities to Define Proper Police Responsibilities

This proposed study is aimed at determining the proper role of the policeman in a contemporary society. Some major questions are: What proportion of the policeman's time should be spent in crime prevention activities (Police Athletic League, Drum Corps, etc.) in contrast to crime control? Could many of the duties he performs today (caring for and transporting sick, issuing licences, directing traffic, etc.) be better performed by other agencies in order to release manpower for crime related activities?

A-4) Application of Advanced Statistical Techniques to Selection of Law Enforcement Officers

This project requires the collection of a data sample containing pertinent information (educational background, experience, training, etc.) about police officers. From this data, meaningful indicators might be developed relating to the degree of success or failure of individuals. These indicators would be used with an appropriate statistical prediction technique to obtain a forecast procedure aimed at predicting the likelihood of success for new police applicants.

A-5) Development of Improved Criminal Investigation Techniques

The purpose of this project is to apply analytical and mathematical techniques (game theory, REEP, probability concepts, etc.) to the criminal investigative process. The role of information in this process will be analyzed with the objective of isolating those units of data which play a crucial part in crime solution.

A-6) Analysis of Alternative Approaches to Preventative Patrol in a Variety of Situations

The purpose of this study project is to attempt to establish optimum patrol routes in high crime rate areas in order to test the premise that police "visibility" plays a major role in suppressing crime. This project will involve comparisons of different modes of patrol structure such as foot patrolmen vs. vehicles, or motorbikes, mixed teams, etc., with regard to area and time coverage.

A-7) Application of the Planning, Programming, Budgeting System (PPBS) to Municipal Police Administration

This is a feasibility study project concerning the application of PPBS to municipal police department budgeting. It is directed toward the development of techniques for treating uncertainty in police planning.

A-8) Determination of the Environmental Effects on Police Operations

This study project deals with the determination of the major geophysical phenomena which effect police operations. Operations considered sensitive to environmental conditions will be analyzed with emphasis on the possibility if improved, more effective alternatives.

A-9) Development of Improved Police Deployment Procedures

The purpose of this study project is to develop computerized procedures to distribute the patrol forces to areas with high probabilities of crime. This study project will draw upon both crime prediction studies, which attempt to relate socio-economic conditions to crime rates, and studies aimed at optimum resource allocation.

A-10) Cost/Effectiveness Study of Police Utility

This study project involves the use of cost/effectiveness analysis to develop measures of the value both of the individual policeman and of his department to a community in terms of services rendered based on certain dollar expenditures.

A-11) Determination of Feasibility of a Regional Police Force

This study project is aimed at determining the feasibility of eliminating redundant functions of local agencies and designing a more efficient regional agency to serve a group of communities more efficiently, for less cost. The first stage of this project would be devoted to an evaluation of the structure and relationships of autonomous police departments within a bounded region (e.g., the Capital Region Planning District). The second phase of the investigation would be to devise an appropriate organizational structure for a regional police force.

A-12) Simulation of Police Operations for Police Management Training

This study project is aimed at the creation of police training games or simulations. The primary goal is to simulate critical events which tend to overload and break down the efficiency of police services. A Watts, Harlem, or Chicago type disorder might be simulated, as well as a disaster such as a plane crash in an urban area.

A-13) Evaluation of Municipal Police Crime Prevention Methods

This study project represents a quantitative analysis aimed at the determination of the benefits of various police functions such as the Police Athletic League (PAL), drum and bugle corp, etc., with special consideration to the cost and time involved in the projects.

A-14) The Technical and Psychopolitical Implications of the Use of Incapacitating Chemical Agents in Law Enforcement

The purposes of this study project would be (1) to investigate the status and probable developments of non-lethal chemical agents, and the characteristics of agents that offer the greatest potential for use in law enforcement; (2) to analyze police utility of non-lethal chemical weapons in a variety of situations and concepts for their effective exploitation; and (3) to investigate the implications of the use of incaps as expressed by leadership elements together with indications of probable informed public opinion.

A-15) Development of Methods for Assessing Law Enforcement Operational Devices

The purpose of this study project is the development of a generalized assessment framework which could be used to determine the usefulness of new or existing operational police "devices" on a cost/benefit basis. Examples of the type of hardware or devices that would be considered in this project are:

- Chemical identification systems for criminal identification,
- Trace analysis,
- Acoustic surveillance systems,
- Image-intensification devices for night vision,
- Computer systems,
- Chemoluminescent compounds for area illumination.

A-16) Planning Projects for the Determination of the Police Department Role in Community Protection During Disasters

This study project is aimed at the evaluation of the role of the police in a variety of "crisis" situations; i.e., post nuclear attack, major fires, outbreaks of contagious disease, violent civil disorder, airplane crashes, etc. The ultimate aim is to provide guidelines for police planners in developing strategies for dealing with disasters.

B. Courts and Adjudication Projects

B-17) Application of Advanced Statistical Techniques to the Consequences of Alternative Sentences

In this study project an appropriate statistical prediction technique is used to find the probable most beneficial sentences for criminals from the viewpoints both of society and of the offender.

B-18) Statistical Analysis of Sentence Variability for Similar Crimes

This study project involves the determination, on a statistical basis, of the sentence variability for the same or similar crimes, on a national basis. The purpose of the study is to provide factual guidance for judicial personnel.

B-19) Design and Development of Improved Techniques for Court Scheduling

This study project involves the analytical examination of legal case types and issues involved in order to determine quantitatively the time and costs required to handle various case types. This information could represent an important means of guidance for court management. Hopefully, application of operations research techniques could eventually lead to a partially or fully automated processing program for court scheduling.

C. Corrections and Rehabilitation Projects

C-20) Development of Improved Methods to Aid Management of Correctional Institutions

The purposes of this study project would be to implement or devise appropriate scientific techniques and methods to aid management personnel in the operations of prisons and correctional institutions. Objectives of this project would be to develop improved projections of trends in institution populations and caseloads of rehabilitation personnel; develop improved methods for the allocation of men and resources within an institution or agency; and develop increased information processing capabilities of an institution to meet both internal and external reporting requirements.

C-21) Develop Guidelines to Evaluate Alternative Rehabilitation Programs

This project consists of a data gathering and analysis study of persons dismissed from correctional institutions to provide feedback to persons engaged in correctional programming. It is aimed at the development of necessary guidelines for evaluating the effectiveness of various alternative rehabilitation programs.

C-22) Design of Experiments for Evaluation of Various Correctional Strategies

The purpose of this project is to design and conduct statistical experiments that are aimed at determining the cost/benefit ratios of various alternative rehabilitation programs.

C-23) Application of Advanced Statistical Techniques to the Prediction of Recidivism

This study project involves the collection of a large sample of criminal offender history, development of a number of meaningful indicators (predictors) such as the number of prior offenses, types of offenses, etc., and the application of an appropriate statistical technique to estimate the probability of recidivism (repeat offenses) on the part of individuals.

C-24) Application of Advanced Statistical Procedures to Prediction of the Most Beneficial Correctional Program for Individuals

This study project involves the development of pertinent indicators and their use in the appropriate statistical technique aimed at the prediction of the most beneficial correctional and rehabilitation program for individual inmates, given pertinent information regarding their background.

C-25) Development of Improved Approaches to Perimeter Control at Maximum Security Institutions

The purpose of this proposed study project is to analyze developments in military technology, including the use of non-lethal incapacitating weapons, in order to develop new or improved techniques for preventing escapes from correctional institutions.

C-26) Development of Improved Techniques for Quelling Prison Riots

This is an analytical study project of past prison riots aimed at the establishment and definition of relevant aspects both of riot characteristics and of methods to control and prevent riots. Consideration will be given to the use of new or improved incapacitating agents for riot control.

D. Criminal Justice Information Projects

D-27) Development of Centralized Criminal Justice Information System on a State or Regional Basis

This study project involves a comprehensive systems analysis effort aimed at the design and development of a joint operational data bank in which all criminal justice agencies in an area may share. This project would draw heavily upon the results of studies performed in support of the New York State Intelligence and Identification System and The National Crime Information Center.

D-28) Development of a Personal Appearance and Name Searching Identification System

This study project involves the development of an automated data storage and retrieval system to replace the present manual system used to obtain prior information on suspects or known offenders when only sketchy information (such as height, weight, hair color, etc. or name, address, date of birth, etc.) is available.

D-29) Development of a Modus Operandi Data Storage and Retrieval System

This study project requires the design and development of a system of classifying and storing the operating characteristics of known criminals in such a manner that this information could be retrieved and matched rapidly and expediently when a crime is committed.

D-30) Design and Development of a Forgery Information Data Storage, Retrieval and Communication System

This study project involves the design and development of a computerized system which would result in rapid dissemination of pertinent information regarding forged checks, money, etc.

D-31) Design and Development of a Computerized License Plate Identification, Storage and Retrieval System

This study project is aimed at the rapid identification of stolen vehicles, drivers without licenses or under suspension, etc., and will draw heavily on the systems being successfully employed in New York City, Wash. D.C., and Los Angeles.

D-32) Development of a Computerized Fingerprint Classification, Identification and Retrieval System

In this study project a comprehensive survey and evaluation of the numerous approaches aimed at automating the fingerprint classification and identification problem is to be made. Utilizing the findings of this survey and integrating those which appear appropriate into the pattern recognition programs developed at TRC, the objective of this study would be to develop a completely automated inked-fingerprint system and at least a semi-automated latent print system.

D-33) Design and Development of an Organized-Crime Information System

The purpose of this study project is to design an organized-crime intelligence information system which will take into account user requirements, information requirements, information availability, and transmission modes, and will ultimately result in

a centralized automated-information repository. This system would be concerned exclusively with organized interstate crime.

D-34) Design and Development of a Semi-Automated System for the Reduction of Police Clerical Tasks

The purpose of this study project is to analyze an individual municipal police department's daily reporting procedures with the aim of automating many of the presently burdensome tasks.

D-35) Design and Development of a Computerized Handwriting Analysis Technique

This project will apply mathematical analysis and pattern recognition to the problem of handwriting analysis and will assess the feasibility of automatic handwriting analysis routines.

E. Crime Prevention and Control Projects

E-36) Statistical Prediction of Crime in Urban Areas

This study project involves the extraction and analysis of past crime data in an attempt to identify useful indicators of the most probable times, areas, and situations for various types of crimes. Such indicators might be the time of day, day of year, closing time of bars, unemployment rates and trends, payroll dates, etc. If useful indicators are found, statistical procedures may be employed to forecast the probability of specific types of crimes for given areas.

E-37) Evaluation of the Science and Technology Program Supported by the Office of Law Enforcement Assistance (OLEA)

It appears that a need exists to evaluate the quality and usefulness of scientific research being performed for OLEA. A project is proposed whereby OLEA projects are evaluated with regard to their technical soundness, general rather than specific applicability, and resulting benefits to law enforcement agencies and the community.

E-38) Systems Analysis of the Law Enforcement Establishment in a Specific Area

This potential study project represents a comprehensive systems analysis of the functions, structure, and interfaces of the numerous agencies of criminal justice for a given region (e.g., New England, Connecticut, Capital Region Planning District) and is aimed at the optimization of available resources.

E-39) Application of Advanced Statistical Techniques to the Determination of Criminal and Non-Criminal Tendencies

In this study project a large sample of personal history records, both of known criminals and of non-criminals, would be collected, pertinent indicators of individual tendencies toward or away from crime would be searched for, and an appropriate statistical technique would be applied. If statistically meaningful indicators can be identified, these would be used to help social welfare agencies direct correctional treatment of young people who exhibit a significant potential for criminal activity.

E-40) Design and Development of a Traffic-accident Routing System

The purpose of this study project is to design and develop methods of traffic control, police force deployment, and communications, aimed at the alleviation of traffic congestion and attendant accidents when accidents do occur.

E-41) Analysis of the Use of Motor Vehicles in the Commission of Crimes

This study project involves the examination of the magnitude and implications of the roles that vehicles play in the commission of crime to develop strategies for the prevention of such use.

E-42) Statistical Determination of Significant Socio-Economic Differences between High- and Low-crime-rate Urban Areas

This study project involves the integration of available socio-economic data (e.g., census, industrial employment data) into a framework suitable for analytical analysis of the major differences between high- and low-crime-rate areas.

E-43) An Economic Assessment of U.S. Crime

The purpose of this study project, through use of all available crime information and accompanying economic data (insurance company, hospital claims, burglary reports, police reports, etc.), is to assess the impact of crime on the economy of the United States.

E-44) Study of Urban Disorders in the United States

This study project includes a detailed examination of urban disorders in major U.S. cities in an attempt to determine the dynamics of riot situations and present law enforcement capabilities in coping with this type of disorder. Included in this study will be investigation of Department of Defense counterinsurgency studies in an effort to determine the applicability and relevance of techniques developed for military operations to urban law enforcement,

3.3 Project Evaluation

In the previous section, a number of specific projects believed to be amenable to the application of analytical and statistical methods were listed and briefly described. These projects were subjectively evaluated according to four major criteria and supplementary background information, in order to select projects for study by scientists at TRC. The evaluation procedure is described in Section 3.3.1. The specific projects selected for further study are discussed in detail in Section 4.0.

3.3.1 Project Evaluation Procedure

The third objective of this study is to select specific projects for study at TRC and to recommend approaches. To accomplish this goal, the extensive list of potential study projects listed in Section 3.2 was evaluated according to four major criteria.

- (1) Applicable TRC skills, methods, and techniques,
- (2) Importance or urgency of the problem,
- (3) Evaluators interest,
- (4) Level of previous research effort.

With reference to (1) above, a distinction must be made between a skill area and a scientific technique or methodology. The term skill area, as used in this report, refers to the discipline or competence area needed for a project. A scientific technique or method, however, refers to the primary approach that will be used in the solution of a problem. For example, mathematical statistics would be the major skill area involved in performing a statistical prediction study while multiple discriminant analysis might be the specific method employed. Columns 3 and 4 of Table 3-1 represent the TRC skills and techniques or methods, respectively, thought to be applicable to the potential projects listed in Section 3.2. In this table, these skills and techniques or methods are matched against each of the potential projects.

Of interest also, with regard to the project capability, comparison, is the supplementary external skill needed for each study project. These are also presented in Table 3-1.

It is evident that certain projects, as a reflection of problem areas, are more important or urgent than others. While this aspect is virtually impossible to assess quantitatively, certain background information is helpful in obtaining a meaningful estimate. Useful in this regard are considerations of the sources of problem indication

and the scope of interest. The source of problem indication refers to four specific considerations:

- (1) work area has been previously sponsored,
- (2) emphasis in law enforcement literature,
- (3) guidance from governmental agencies,
- (4) observation of law enforcement activities

By scope of interest, in this context, is meant the most suitable source or sources of prime interests or potential support for a given project. Included in this category are:

- (1) local
- (2) state
- (3) regional
- (4) national
- (5) private (foundational)
- (6) TRC proprietary
- (7) commercial

Using the above considerations, as well as others, resulted in a subjective judgment of the relative importance of each potential study project. Each project was rated as to having (1) high, (2) average, or (3) low importance as reported in Table 3-1.

Since the sources of problem indication and scope of interest were inherent in the rating discussed above and present useful background, they are included in Table 3-1.

The interjection of the areas of interest on the part of the authors is unavoidable in this evaluation. It is quite possible that other scientists, even at TRC, could conceivably arrive at a different set of recommended projects, based primarily on their preferences for different types of studies. For this reason, it was thought appropriate to rate each potential study project, again on a (1) high, (2) average, and (3) low basis, with regard to the level of interest on the part of the evaluators. The matching of each potential study project on this basis is presented in Table 3-1.

The fourth criterion for selecting recommended study projects for TRC scientists consisted of an appraisal of the amount of past and current effort expended by other researchers in studying a specific problem through application of the recommended skills or methodologies. This consideration is made in an attempt to avoid duplication of effort, and as a check to eliminate areas that have already been over researched or

study projects that have been satisfactorily solved. On this basis, an estimate of the past and current research expended on each study project is given in Table 3-1. Columns 3 and 4 of Table 3-1 represent the TRC skills and techniques or methods, respectively, thought to be applicable to the potential projects listed in Section 3.2. In this table, these skills and techniques or methods are matched against each of the potential projects.

Each of the potential projects listed and described in Section 3.2 was evaluated according to the four criteria and supplementary background information described in this section. The project evaluation, according to these criteria are summarized in Table 3-1. From this evolved a priority rating for each of the potential study projects, as shown in the last column of Table 3-1. The priority ratings range from 1 to 3 where:

- (1) Represents projects which are of immediate interest to TRC and for which a more detailed analysis is given in Section 4.0,
- (2) Represents projects capable of being solved by scientific methods but either require additional pre-study research or are of secondary interest to TRC scientists, and
- (3) Represents projects which have been rejected for further consideration due to their overall low rating from the standpoint of the criteria considered.

It is shown in the Ranking Column of Table 3-1 that 12 study projects were classified as appropriate for study by TRC. There are 27 other projects that appear to be amenable to scientific solution, but are not recommended for immediate investigation by TRC. The remaining 5 projects were rejected for further study. In Section 4.0, the projects selected for study at TRC are analyzed in further detail.

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4.0 ANALYSIS OF RECOMMENDED PROJECTS

This section presents a more detailed evaluation of each of the projects selected for further study at TRC. For each of the recommended projects, a statement of the problem is given, the purpose of the study is outlined, a suggested approach is briefly outlined and a review of the scope of interest (e.g. local, state, regional, national) is given. The projects are presented under the same categories developed in Section 3.0, with the exception of those projects that require the use of advanced statistical techniques. There are three projects in this category and they are prefaced with a short explanation of the technique to be utilized and are presented in Section 4.3 entitled Statistical Technique Projects.

4.1 Police Services Projects

A-1) Systems Analysis of a Municipal Police Department

The purpose of this study is to utilize the techniques of systems analysis in the design of a more efficient municipal police department. The police department of most medium sized (under 250,000) U.S. cities has grown and developed primarily in response to the demands that society has placed upon it. This study will be concerned with reevaluating the proper responsibilities of a department, evaluating in-depth the functional relationships within the department and within the society that the department serves, and also with delineating informational needs and requirements both externally and internally. Further objectives of this project will be to evaluate and recommend new technology that is appropriate for police department use and to examine in detail the whole area of police cost/effectiveness. This latter area may present complex problems in evaluating the qualitative benefits of police services.

A study of this type must be conducted in close cooperation with an interested police department. This should be an approximately equal effort on the part of the research organization and the police department. Police activity areas in the study will provide input on police concepts and theories, police requirements, factual material, organization, and relationships with the community. The research organization should provide strong systems analysis capabilities, management, and knowledge of modern technology.

An overriding consideration that should guide this study from beginning to end should be the need to develop a creative definition of police problems. Emphasis in

this activity should be directed at proceeding beyond the outward symptoms of problems toward identification of root problem causes.

There has been a limited amount of work done in this area in the past. The great majority of work performed in the past has been aimed at producing greater organizational efficiency. The Field Survey Division of the International Association of Chiefs of Police (IACP), for example, has been providing management consultation in the improvement of police departments for a number of years. However, the IACP approach operates under a serious constraint from a systems analysis point of view. The IACP has developed an outline of what the ideal police department should look like, based on generally accepted police principles. Based on this model, they perform a survey of the police organization they are studying to compare its organization with the model department and then they make recommendations for change in the existing organization so that it will conform to the model. This approach makes the assumption, of course, that their model is correct. The systems approach to this problem would be more concerned with developing a new model to optimize police efficiency. As far as can be determined there have been no projects performed that are directly concerned with performing a systems analysis of a municipal police department.

A-5) Development of Improved Criminal Investigation Techniques

The investigative responsibilities of the police are usually associated with the commission or prevention of crimes. The police are, however, essentially a reaction force. They are usually not aware of a crime until after its commission and subsequent reporting. There are exceptions to this pattern, however, as in the case where a general condition exists, such as organized gambling or a continuing trend of crime in certain neighborhoods.

In the case of a known commission of crime, the police investigator has a dual responsibility. He must first solve the case and identify the perpetrator and, second, he must then present evidence to prove beyond reasonable doubt to a court of law that the person arrested is, in fact, guilty. The investigator's objective in dealing with a general pattern of crime is to obtain sufficient information to prove a crime has occurred or to prevent the commission of a crime.

The criminal investigator's approach to a case is similar to that of the academic researcher, in that he must collect relevant data, evaluate and analyze this material, develop logical conclusions from it, and present his results in court in a form that leaves little doubt of his conclusion. However, the criminal investigator operates under far more serious constraints than does his researcher counterpart. For one thing, his conclusions will come under skillful attack by a defense attorney, whose primary responsibility is to prove the investigator wrong in order to exonerate his client. Other constraints include lack of data, uncooperative witnesses, public pressure for rapid crime solution, conscious attempts to destroy or withhold evidence on the part of the criminal, and legal restrictions designed to protect an individual's rights (e.g., specified interrogation and prearrest procedures, no wiretap evidence).

There has been virtually no attempt made to relate the capabilities of the analytical tools of science (other than laboratory techniques) to the needs of the criminal investigation process. The fact that criminal investigation is a process that proceeds in a logical stepwise basis indicates that there are potential applications of scientific techniques. M. J. Fitzgerald, author of a standard text in this field, states that:

Many crimes are the exception rather than the rule, but the same general procedures will be followed on all cases. Naturally, more time and effort will be expended on important cases, but the procedures followed will be an extension of those used in minor cases.²²

In general, then, it would seem that the investigation of a crime is a systematic process dealing with repetitive events that vary (hopefully) only in detail and can thus be placed in a logical framework and sequence of activities.

The criminal investigation procedure in the case of a known crime generally will follow a two-stage process. A uniformed patrolman will be dispatched to the scene to investigate the reported crime. His functions, when he arrives at the scene, are roughly as follows:

- (1) Determine if a crime has been committed.
- (2) Arrest the perpetrator, if present.

²² Col. M. J. Fitzgerald, Handbook of Crime Investigation, New York, 1952, p. 48

- (3) Prevent persons who witnessed the crime, discovered the crime, or who are found at the scene from leaving until identified and questioned.
- (4) Isolate the scene, prevent unauthorized persons from entering the area, and prevent those present from destroying evidence.
- (5) Secure all available information.
- (6) Search for and preserve evidence.
- (7) Record all facts.

If the criminal is not identified during this phase of the investigation, and if the crime is serious enough to warrant further investigation, a detective will be assigned to the case. Frequently, in the case of minor crimes, the detective will not pursue the investigation actively because there is not enough evidence present to warrant the expenditure of his effort (i.e., the detective determines that his efforts will be futile). In the case of a serious crime (e.g., murder), however, most police departments will assign a detective team to full-time coverage of the case for as long as three or four months or until the crime is solved. Unfortunately, during these periods of intensive concentration on particular cases, other, less serious, crimes will not even be investigated due to the lack of manpower.

The detective's mission in crime investigation can be divided into a series of activities:

- (1) Ascertain and record the facts concerning the commission of the crime,
- (2) Identify the criminal and his accomplices, if any,
- (3) Arrest and apprehend the criminal(s),
- (4) Secure, preserve, and evaluate evidence,
- (5) Present evidence.

During the crime investigation, some clues are generally available, e.g., latent fingerprints, a description of the perpetrator(s), a chemical stain, physical evidence, an overheard snatch of conversation, a handwriting sample. The crime scene is the focal point for the investigator to develop his initial leads to pursue. The primary objective of the investigator is to relate these leads to the name of a suspect (or a list of possible suspects). This is the crucial part of the investigation. A recent study by the New York

State Identification and Intelligence System²³ indicates that:

There is no way to predict in general terms the facts that may "make" or "break" the logic of a case. The circumstances surrounding crimes vary, and so does the evidence available the investigator. Necessary leads often result from the piecing together, and analysis, of seemingly isolated items of information; there is room for arguing that virtually anything that can be learned about the suspect may be helpful to the total investigation.

Proceeding from this assumption, they conducted a survey of New York State Police departments that produced a listing of types of information that the experienced investigator will turn to early in a case concerning a suspect. These information types are:

- (1) Prior criminal record,
- (2) Current criminal justice status,
- (3) Personal description,
- (4) Previous addresses,
- (5) Information concerning associates,
- (6) Motor vehicle and operator license data,
- (7) Social and other non-criminal history.

The Police Operations Research Staff of the United Kingdom, however, disagrees with the concept that it is not possible to predict the type of facts that "make" or "break" a case. A recent study by Wilmer²⁴, for example, has provided an indication of the potential of operations research techniques in the improvement of criminal investigation methods. In a technical sense, Wilmer:

showed that where two sets of phenomena are associated in some way with a given set of probabilities, that is the population and the crimes that are committed within it, then the problem can be reduced to assessing the "choice" which exists and this enables the concept of entropy to be used to advantage.²⁵

²³R.S. Gallati, et al. NYSIIS: System Development Plan, New York State Identification and Intelligence System, Albany, New York, 1966, p. 29.

²⁴M.A.P. Wilmer: "On The Measurement of Information In The Field of Criminal Detection," in Operations Research Quarterly, Vol. 17, No. 4, Dec. 1966, p. 335-346.

²⁵Wilmer, p. 335.

Wilmer has attempted to develop a measure of the value of information to the police investigator in a general sense. He applied his technique to the investigation of a case of simple larceny. This particular case, Wilmer found, illustrated several points, the most important of which was that some pieces of information, although they are very important to the police, only change the level of uncertainty in a case very slightly. In these cases, the piece of information generally demands that the police perform an action which may either provide useful information or lead to further action. He then defined a potential entropy (entropy measures the lack of information about the actual structure of the system in question) change which takes this factor into account. Wilmer's primary objective was to develop a fuller understanding of how information flows into the police system and to determine how efficiently this information was being used.

Another project that the British are conducting concerns the application of game theory to the criminal investigation process. As an example, the approach has been applied to the case of the theft of a camera from an unattended motor vehicle. This crime was analyzed on the basis of nine possible strategies open to the criminal. For example, there are combinations of vehicle used by the criminal (his own car, borrowed vehicle, stolen vehicle) and the way the camera is disposed of (pawn shop, personal sale). The British analysis showed that the police would have the greatest probability of solving the crime if the thief had used his own car and tried to dispose of the camera through a respectable dealer in town.

It appears then, that the best way to approach the problems of crime investigation would be to think of the entire process in terms of an information problem. The investigator receives and must act on a large mass of data collected in the course of his investigation. In this sense, he is a gatekeeper who regulates the flow of the amount and type of information that will be used in the solution or non-solution of a crime. His decision on the value of any particular bit of information may well determine the outcome of the investigation and the arrest and correction of the criminal.

There is only one measure of effectiveness that has any real meaning in an attempt to improve criminal investigation procedures. This measure is the crime clearance rate: the number of crimes solved compared to the number of crimes reported. The status of current (1965) crime investigation techniques are reflected in the presentation that follows.

In examining the statistics of crime in the U.S.²⁶, it is obvious that the police have been least successful in solving crimes against property and most successful in solving crimes against the person (see Table 4-1 below).

TABLE 4-1
CRIMES CLEARED BY ARREST—U.S., 1965

Crime	% cleared	% not cleared
Against person		
Murder	91	9
Negligent manslaughter	85	15
Forcible rape	64	36
Aggravated assault	73	27
Against property		
Robbery	38	62
Burglary	25	75
Larceny	20	80
Auto theft	25	75

Looking at the 1965 statistics (Table 4-2) for the City of Hartford²⁷, we see that they roughly approximate the national averages:

TABLE 4-2
CRIMES CLEARED BY ARREST—HARTFORD 1965

Crime	% cleared	% not cleared
Against person		
Murder	90	10
Negligent manslaughter*	100	0
Forcible rape	80	20
Aggravated assault	85	15
Against property		
Robbery	45	54
Burglary	34	66
Larceny	22	78
Auto theft	28	72

* Only 3 cases

²⁶Federal Bureau of Investigation: Crime In The United States: Uniform Crime Reports 1965, Washington, D.C., 1965, p. 19.

²⁷Hartford Police Department. Annual Report 1965, City of Hartford, Conn., 1966, p. 4.

While Hartford seems to have a higher clearance rate for property crimes than the national average, it should be noted that the statistical sample is considerably smaller. However, the gross pattern that the police are more successful against crimes against persons than they are against crimes against property still exists.

No specific approach to this problem can be suggested until discussions have been held with experienced operational personnel. However, presented below are some possible objectives which should be considered:

1. Utilize operations research techniques in the development of new or improved concepts of criminal investigation.
2. Analyze the information requirements of criminal investigation with the objective of developing an improved understanding of the role that specific units of information play in crime solution.
3. Continue study of employing probability concepts and game theory in the investigative process.
4. Investigate the use of computers to rapidly collate and evaluate (using multiple discriminant analysis procedures) evidence collected in the course of an investigation.
5. Develop guidelines to assist police management in their evaluation of the probability of successfully solving a crime, and thus prevent or limit unnecessary assignment of personnel to cases where the probability of solution is low.

A-12) Simulation of Police Operations for Training Police Management Personnel

The police department is usually the first organization of government to be called on for assistance when a natural or man-made disaster strikes a community. Overall direction of the control effort usually winds up as a police responsibility because of its communications equipment and available trained man power. How well the police department fulfills this responsibility in the early stages of a disaster may determine in great measure its outcome.

Contingency planning for major disasters is done in most police departments to provide guidelines for departmental response; but, generally, experience is the only effective weapon in mitigating the consequences of these events.

How prevalent are disaster situations in the United States that call for police reaction? In the six years since 1960, there have been over 100 major disasters in this country. At a recent symposium on emergency operations, the following facts were presented:

Forty-one states and four territories have received more than \$300 million in federally allocated disaster funds during this period (since 1960). Twenty-five major disasters occurred in 1964 and again in 1965, the worst two years in the history of the Federal Disaster Acts.²⁸

Fires, epidemics, civil disorders, natural and perhaps nuclear disasters are the type of events that require the organization of emergency operations. Since most police departments do not face these events very frequently, they are ill-prepared to do so. It is not uncommon for individuals and organizations who function well during normal operations to perform poorly during periods of crisis. Day-to-day operations provide poor training for dealing with uncommon events that place major stress upon the organizations.

The military long ago recognized the need to gain experience in fighting wars through the medium of "wargaming." While gaming is, at this stage, more an art than a science and is beset by numerous technical problems, it is widely recognized that gaming is a valuable tool in training command personnel. The same concept of gaming the unusual can be applied to police operations. The purpose of this study project is to develop a manual or semi-automated game for the training of police command and operational personnel in the management of emergency situations.

Before going into detail on this project, it is necessary to review the type of work currently being done in simulating organizational response situations.

In mid-1964, Systems Development Corporation established an Emergency Operations Research Center designed to meet a wide variety of experimental situations in a laboratory environment. This is the only major facility of its type operated by a private organization in the country. Several universities, notably Ohio State, operate Disaster Research Centers. Simulation is the basic tool used most frequently at these centers. The stated purpose of the SDC Center, for example, is as follows:

²⁸Robert C. Brutson, "Crisis by Appointment" SDC Magazine, Vol. 9, No. 6, System Development Corporation, Santa Monica, California, June 1966, p. 7.

Therefore, System Development Corporation has developed training methods and procedures specifically directed toward providing responsible persons and agencies with concrete experience in emergency operations. The basic tool for this training is simulation-- if they are to achieve a high degree of proficiency in countering emergencies, individuals and organizations must be confronted with, and trained in reacting to typical disaster situations.²⁹

The simulation of disaster events has not been ignored by social scientists either. The majority of research in this field, however, is not done primarily for training purposes but rather to gain an understanding of individual and organizational dynamics and to analyze stress situations. In this regard, a recent study by Drabeck³⁰ examined the use of simulation in a police environment to "analyze organizational stress and to explore the utility of realistic simulation as a technique for the analysis of complex organizations." Guetzkow³¹ has also utilized simulation as a tool for examining periods of stress in international relations. Massachusetts Institute of Technology has also pioneered in the use of simulation in the social sciences with the "Simulmatics Project."³²

A project of relevance to this proposal is being conducted by Polytechnic Institute of Brooklyn. The PIB study is funded by OLEA and is aimed at the:

Development of a computer model of police operations...to explore selected agency problems and test effects of changes in operations and organizations by mathematical simulation techniques.³¹

As far as can be determined, however, there is only one "game" that has been developed in support of police operations. This game, "The Urban Insurgency Patrolling Game" is not, however, directed at normal U.S. police activities³³. Rather this game is aimed at simulating the battle between security police and terrorists in an insurgent or revolutionary environment.

²⁹Ibid., p. 11.

³⁰T.E. Drabeck., Laboratory Simulation of A Police Communications Systems Under Stress, Doctoral Dissertation, Ohio State University, Ohio, 1965.

³¹H. Guetzkow, et al. Simulation In International Relations, New Jersey, Prentice Hall, Inc., 1963.

³²Ithiel DeSola Pool and Robert Abelson, "The Simulmatics Project" in Simulation in Social Science: Readings, ed. H. Guetzkow, New Jersey, Prentice Hall, Inc. 1962, pp. 70-81.

³³J.D. Yates and M. Westlake, "Urban Insurgency Patrolling Game" in Report on Urban Insurgency Studies, Vol. 1, Simulmatics Corp, Cambridge, Mass. 1966, pp. VI-1-29.

Activity in the field of simulation or gaming, in the past, appears not to have been directed specifically at the training of police personnel. The SDC Emergency Operations Center, for example, has been more a laboratory simulation aimed at specific situations and geared toward evaluating total community reaction to disaster situations. Furthermore, while the SDC effort in this area is commendable, it is insufficient to meet the needs of the entire country. Therefore, a definite need exists to produce a game specifically oriented toward the training of police personnel and directed at the simulation of "crisis" type events that U.S. police forces must cope with in a domestic environment. It is recommended that TRC approach this problem with the aim of developing a single game simulation model that can be generalized to the extent that various types of emergency situations can be played, according to the type of input.

A-14) The Technical and Psychopolitical Implications of The Use of Incapacitating Agents in Law Enforcement

A major police function is the control of large-scale domestic disorder. In recent years these disturbances have increased in scope and intensity. They have been confined primarily to heavily urbanized areas. Since 1960, the police have been called upon to quell major riots in the following cities: Los Angeles (Watts); New York City (Harlem and Bedford-Stuyvesant); Rochester; Cleveland (Hough); Chicago; San Francisco; Birmingham; Selma; Jackson; and Oxford. The rioting in Watts area of Los Angeles, for example, resulted in 37 deaths, hundreds of injuries, and arrests and property damage in the millions. In all of these outbreaks, the police (and, in most cases, the National Guard) had to resort to the use of firearms to control the disorder.

In the general course of a civil disorder the police use violence in an ascending scale in order to control the situation and restore order. The first stage generally consists of the implied use of force; i.e., loudspeakers will be used to threaten a mob and order it to disperse. If this has no effect, the next stage may be the use of trained riot-control squads armed with clubs, batons, yawara sticks, etc., against the mob. It is during this phase that tear gas grenades or dispersers will be used against the mob. If these tactics are successful, and the danger to law enforcement personnel becomes extreme, the police will use conventional weapons against particularly dangerous members of the mob.

In the Watts riot, these tactics proved virtually useless because the character of urban mass violence had undergone a change. The rioters in Watts did not gather in a central location; small groups (ranging from 2-4 individuals up to 2-3 thousand individuals) were dispersed over a wide area. Chief Parker of the Los Angeles Police Department summed up his frustrations when he said, "This is not a riot, its guerrilla warfare!"

Numerous studies of these riots have shown that the precipitating factor in most cases has been overly harsh police response to illegal activity. The Harlem riot, for example, began when an off-duty policeman was forced to shoot a 16 year old Negro youth. The basic police problem then is how to control violence without resorting to the use of conventional weapons with their attendant lethality. How, for example, can an outbreak such as Watts be suppressed without resorting to the very force which may lead to intensification of the conflict. The use of more sophisticated chemical incapacitators than tear gas (CN) may provide part of the answer.

Tear gas (CN) is the standard riot-control weapon in most major police departments. A very small number of departments also maintain stocks of the so-called "super tear gas" (CS) and nausea gas (DM). However, there is only one recorded instance of the use of either of the latter two agents. CS was used to disperse a mob at Oxford, Miss., when CN proved completely ineffective.

We have not been able to identify any major study of the implications of the use of incapacitating agents by law enforcement agencies in the United States. A study of this type represents a definite need for decision-makers who must consider the use of these weapons. Serious studies of the operational and psychopolitical consequences and implications of incapacitant use have been confined primarily to the context of military operations; little attention has been devoted to police use except in counterinsurgency operations. The primary goal of this study, then, will be to determine the technical, operational and political feasibility of the use of incapacitants in certain law enforcement operations, as an alternative to the more lethal weaponry currently in use.

The objectives of this proposed study would be to assess the following:

- (1) The status of non-lethal chemical weapons; probable developments in the field; and the characteristics of agents appearing to offer the greatest potential for use in law enforcement,
- (2) The police utility of non-lethal chemical weapons in riot control operations and concepts for their effective exploitation,
- (3) The political, sociological, and psychopolitical implications of the use of incapacitating weapons based on attitudinal studies of leadership elements in selected communities together with an indication of probable public opinion.

TRC currently has the capability to undertake Tasks 1 and 2 of the proposed study, but to perform the political analysis phase of the project, it will be necessary to secure the services of selected social and behavioral scientists. It will also be necessary to obtain the cooperation of police personnel in the analysis of those police operations where incapacitants could be utilized.

4.2 Criminal Justice Information Projects

D-27) Development of a Centralized Criminal Justice Information System on a State or Regional Basis

During the investigation of the now notorious "Apalachin Meeting" conducted by the New York State Commission of Investigation in 1958, the Commission was plagued by the serious lack of available information on the criminals present at the meeting. One of the individuals being investigated, for example, was the subject of almost 200 separate official police files within an area of several hundred miles around the Apalachin site. The mechanical task of finding and collecting this information was enormous and extremely frustrating. The files that were examined often were barren of relevant material; generally the files contained meaningless collection of loose notes, newspaper clippings and copies of other files.

This investigation and its problems provided the impetus for development of a centralized criminal information sharing facility that would be available to all agencies within the New York State Criminal Justice System (e.g., police, district attorneys, courts, probation authorities, penal institutions and parole authorities). Rather than maintaining their own files, as in the past, these agencies will share a joint data bank since they all have a need for similar information. This concept has now come to be nationally recognized as essential to the efficient operation of all criminal justice systems. However, at this date only one state—New York—has brought this concept to fruition. With the advent of the National Crime Information Center being developed by the FBI, there will be an increasing need for all states or regions to develop a system similar to the New York State Identification and Intelligence System (NYSIIS) in order to function effectively.

The study proposed here is essentially an extension and application of the research that has gone into the development of NYSIIS^{35, 36}. In this study, the New York System would be thoroughly analyzed and relevant aspects of the system would be integrated into a system for other states or regions. This would not be a straight duplication of the New York State System, since the crime problems of the rest of the nation are much different from those of New York, as are the structures of their criminal justice systems.

The general approach to this problem would consist of, first, a system analysis of the information needs and demands of the various agencies within the area under question and, second, the design of the joint operational data bank to which these agencies could contribute and share.

The primary informational demands that this system would meet are generally as follows:

- Criminal history records,
- Fingerprints,
- Name searches and personal appearance,

³⁵Ezra W. Geddes, et al: Feasibility Report and Recommendations For a New York State Identification System, System Development Corp. Santa Monica, Calif. 1963.

³⁶R.J. Gallati, et al: NYSIIS: System Development Plan, New York State Identification and Intelligence System, Albany, N.Y. 1966.

Modus operandi,
Stolen motor vehicles,
Fraudulent checks,
Organized crime,
Warrant and wanted notifications,
Stolen property,
Social history.

The ultimate system would be designed in such a manner as to integrate each of the above types of information into the operational system in the most efficient and economical manner. Much work remains to be done, however, on the development of the individual components of the system. For the purposes of this study, these are considered to be separate projects, in addition to the comprehensive system described above. Several of these component studies are recommended as being of interest to TRC and are described below.

D-28) Development of a Personal Appearance and Name Searching Identification System

In a visit to the New York State Identification and Intelligence System headquarters, it was established that approximately 500,000 requests are made annually for the identification and description of persons from a name or other personal descriptors against name cards already on file. The requestors are generally requesting prior offense type information. The system used was a manual retrieval scheme with the aid of a sorter. Although the computer application can easily be seen, there are a number of problems such as aliases, wrong ages, etc. The first step in the development of a computerized name searching system would be to separate and measure the extent of the problem areas. The final system might be divided into two parts with the problem areas being searched and retrieved in the present manner.

Early in the course of the investigative process, all available witnesses to a crime are interrogated. An important piece of information which the investigator will attempt to obtain is the description of the perpetrator of the crime. The present method of identification is manual, through "mug" files or facial composite constructions.

The objective of this proposed study is to develop an automated data storage and retrieval system to replace the present manual system used to obtain prior record information of suspects when only sketchy personal appearance information is available (e.g. height, weight, race, hair color, eye color).

D-29) Development of a Computerized Modus Operandi Retrieval System

Modus Operandi (M.O.) is Latin for "method of operation" and, in police terminology, refers to the fact that criminals seem to follow the same pattern of activity in committing their offenses. Most municipal police departments maintain M.O. files on criminals who operate within their jurisdictions. When, for instance, an armed robbery is committed, it may be known that a short, heavy-set man used a revolver covered by a newspaper and told his victim to "give me all your money or I'll kill you." With this information, the police investigator will query his files to see if this pattern has been used by known offenders in the past. Searching the files is generally a manual operation in which the records are broken down by type of crime. The Hartford Police Department conducts a slightly more sophisticated operation in which they use punch cards and an IBM sorter. Unfortunately, with this system they can only retrieve the physical appearance of the criminal and various data about the type of crime; when it was committed, time, of day, etc. When they have located a personal description in which physical characteristics seem to match those of the bandit, they must then locate the individual's record in the standard filing system. This method is not intended to be a positive means of identification, but rather to serve as an investigative aid in locating possible suspects. However, as the rate of crime continues to increase and the volume of data increases in the M.O. file, it is becoming apparent that this system needs to be automated. It is therefore proposed that TRC develop a method for constructing an automated M.O. information and retrieval system.

To develop this system it will be necessary to define the needs of police users. The programming of this system, however, is the key to its successful use. The system must be designed with no particular computer in mind, but so that it can be adapted without major program revisions to the computer in use. Some potentially difficult data conversion problems must be overcome.

Systems Development Corporations has been working with the Los Angeles Police Department in developing an M.O. system³⁷. Unique to their program is an attempt to develop a natural language capability, in which the non-programmer can query this automated filing system in plain language and receive his answer in plain language. This system has been developed to be used on a time-sharing basis with remote terminals located in the different police districts. It is important that our efforts in this area incorporate either the SDC natural language method or one of our own development.

To simply convert the existing manual and semi-manual systems (such as Hartford Police Department's) into an automated system would be a fairly easy task for an experienced programmer. However, to develop an automated system with a natural language capability may call for a more sophisticated effort. If we proceed with the simple conversion it is estimated that a program could be developed in 3-6 months. If the more sophisticated model is desired, a far longer period of development time will be needed.

D-32) Development of a Computerized Fingerprint Classification, Identification and Retrieval System

The fingerprint problem, although similar in nature to the previous two study areas, requires a more extensive developmental program. The use of fingerprints as an identifying mechanism dates back to the 1800's. However, even at the present time, although the idea has been rather heavily researched, no automated or semi-automated system is in existence. Proof of the importance of a rapid classification, storage, and retrieval system is the fact that both the FBI and New York State have recently issued requests for proposals (RFP's) amounting to about \$350,000 work of research effort.

Preliminary analysis of the problem and discussions with fingerprint experts tend to indicate that the pattern-recognition computer programs developed for radar echoes³⁸ may be directly applicable to the fingerprint problem.

³⁷W.W. Herrmann, et al., Natural Language Computer Processing of Los Angeles Police Department Crime Information, Systems Development Corp. TM-1793/000/00; April, 1964.

³⁸E. Kessler, III, and J.A. Russo, Jr., Statistical Properties of Weather Radar Echoes, Proceedings of the 10th Weather Radar Conf., Wash. D.C., 1963.

These computer programs might be modified to give statistical characterizations of digitized fingerprints. The statistical properties to be considered are the pattern bandedness, orientation of bands, the characteristic length and width of fingerprint pattern elements. Studies involving the use of these properties with radar echoes showed that, although statistical parameters differed considerably from storm to storm, they varied only slowly over many consecutive hours during a storm. It is hoped that similar parameters, individually or in combination, will be able to classify and discriminate between pattern features of different fingerprints.

At this point it appears that approximately six months of effort and about \$15,000-\$20,000 is involved in determining preliminary feasibility.

4.3 Crime Prevention and Control Projects

E-38) Systems Analysis Study of the Law Enforcement Establishment in a Region or Area

Earlier in this report evidence was presented to indicate the growth and magnitude of the problems of crime in the U.S. The first line of defense against crime is the law enforcement establishment.

It is patently clear that an ineffective system of law enforcement will promote the acceleration of the crime rate. This study project is to perform a "systems" study of the law-enforcement establishment. An analytical study of the structure of the law enforcement establishment will provide a basis for identifying and evaluating weaknesses and designing more efficient and effective systems.

In approaching this problem area, however, it is essential to keep in mind that the problems of the law enforcement community are not confined to the officially authorized components of the system. In this regard, T.F. Van Natta delineates the environment of the criminal justice system:

The framework of laws obviously is not the responsibility of the police: but of society, similarly, the general nature and effectiveness of a police force are not a function and responsibility of the police alone, but are equally a function and responsibility of society. This sharing of responsibility demands coordination and understanding between the two systems, and particularly demands that the minor system adjust to the trends of growth and development of the major, encompassing system. No social system is static, but tends to grow

and develop in many ways and directions, not all of which are beneficial. This can pose a serious problem to an efficient police system, for as a part of the larger system, the police system shares the total responsibility of molding and guiding the whole social system.³⁹

While Van Natta's remarks were directed toward the police alone, it is clear that they are equally applicable to the total system of law enforcement. Therefore, any study in this area must be prepared to take into account the demands of society, and cannot be directed only at performing the usual "systems design" analysis of organizational efficiency.

The law enforcement system in a given region usually consists of the following interrelated components: police, probation, parole, courts, and corrections. These are the integral parts of the system; their purpose is to deal justly with illegal behavior within society. Over the years, these agencies have grown and developed independently of each other due to the different demands that society has placed on them, although they all deal with or process the same client—the offender. Major problems of coordination exist between these diverse agencies because of their autonomy. For example, each agency maintains independent record systems which often result in duplication of effort and overall inefficiency within the total system. Efforts are currently underway in California and New York to eliminate this particular problem by creating centralized information-sharing facilities. However, these are the only two states who are beyond the planning stage on this problem.

In 1964, the State of California contracted with the Space-General Corporation to perform a systems analysis study of the California system of criminal justice.⁴⁰ This study marked the first application of systems analysis techniques to the problems of law enforcement. The study was not particularly well received by the technical community because of theoretical deficiencies, nor by the sponsors for numerous reasons, not the least of which was the recommendation that the state spend \$122.0 million dollars in R&D funds. However, it did contribute to opening the minds of the law enforcement

³⁹T.F. Van Natta: Applying Systems Analysis to the Municipal Police System, General Electric Co. (TEMPO) Santa Barbara, California, 1965, p. A-1.

⁴⁰Space-General Corp.: Prevention and Control of Crime and Delinquency, Final Report PCCD-7, El Monte, Calif., 1965.

community to the potential benefits of the "systems" approach to their problems.

A major task of this study was creative problem definition:

Of primary importance for a systematic evaluation of crime and delinquency, its prevention and control, is a thorough understanding of the scope of the problem. The problem, to be amenable to analysis, must be defined in a manner which clearly indicates its extent, and does so in a manner which whenever possible extracts what is relevant from the total.⁴¹

This approach is clearly the correct one, but what must be stressed is that the results of the study are relevant only to the State of California's criminal justice problem. The problem will vary from area to area. Therefore, each regional area of the nation will have to perform a similar study in order to understand its own problems.

The New England area, for example faces different problems than the State of California in that it has a more homogeneous population and pattern of living. It is felt that the systems approach offers great potential benefits to the improvement of the criminal justice system in this area. Therefore, it is proposed that large-scale systems evaluation studies be conducted either for the individual states of the New England area or for the area as a whole. An even more inviting possibility, perhaps, would be a study for individual planning regions within the states, as they appear to be the most likely forerunners of regional cooperation. The Capitol Region Planning District within Connecticut, for example, would benefit from a study of this type.

The Space-General study could be used as a base from which to approach this problem. Many of its techniques could be applied to problems of this area. The basic objectives of the suggested study should be similar to those of the Space General project:

Analyze the system of criminal justice utilizing the techniques of systems engineering and operations analysis and thereby explore the feasibility of applying these techniques to social problems.

Recommend a program directed toward more effective prevention and control of crime and delinquency.

To perform a systems analysis in this region we would have to face the same, or similar, problem areas that confronted Space-General.

⁴¹Ibid., p. 6.

The major tasks of the Space General Study were as follows:⁴²

1. A systematic study of persons involved in criminal activity and identification of crime susceptible groups.
2. The development of an information system linking together the various agencies of criminal justice (police, parole, courts, corrections and probation) and being capable of evaluating program and system effectiveness through collection, storage and processing of appropriate data.
3. Carefully selected prevention programs directed toward susceptible offender groups.
4. Technical assistance in the apprehension and processing of offenders.
5. Continuing systems engineering analysis of the management and effectiveness of the system of criminal justice.
6. Development of more effective methods in the management and treatment of offenders with attendant studies of subsequent behavior and costs.
7. The development of public support and understanding through information and community education programs.
8. A comprehensive master plan which projects over a five year period the scheduling and costs of the program.

A study of this type is clearly a major effort that requires not only augmenting the present TRC skill specialties, but initiating intensive marketing effort to locate support for the study. This is not the type of project that can draw entirely upon studies in the past; it is a major developmental effort that will need highly original research efforts if it is to be performed successfully. However, this type of study must be performed by someone, and within the near future a major decision must be made in developing the correct approach to this problem area.

4.4 Statistical Technique Projects

Three study projects, described in this section, have been chosen for more detailed evaluation because of the direct applicability of a statistical prediction procedure developed at TRC. The procedure, Regression Estimation of Event Probabilities (REEP) defined by Miller⁴³, is discussed briefly below. Its attributes and applications are

⁴²Space-General, pp. 4-5.

⁴³R.G. Miller, Regression Estimation of Event Probabilities, Tech. Rpt. 7441-121, The Travelers Research Center, Inc., 1964.

further described in numerous TRC publications.^{44, 45, 46}

REEP provides estimates of the probability that a designated event (the predictand) will occur under specified circumstances. It is a practical method for extracting the combined predictive content of many statistical predictors bearing on the same predictand. It is applicable not only to the estimation of probability that a single designated event will occur, but also to the broader problems of estimating the respective probabilities that each of several mutually exclusive probable events will occur.

The REEP procedure utilizes the binary arithmetic of the computer to develop forecast systems. Because of this, the procedure is more rapid, computationally, than other statistical procedures. Also, it does not require variables to be numerical, ordered, or continuous in any manner.

The REEP technique employs a screening procedure which objectively selects a small subset of effective predictors from a large set of possible predictors. It first selects the predictor having the highest predictive ability. Then it selects, as the next best predictor, that one which adds the most predictive information to the first predictor selected. This continues; at each step a predictor is selected which adds most to the previously selected predictors, until the predictors selected contain most of the predictive ability of the possible set so that one more predictor would not significantly improve the predictive skill. Regression equations are then computed between each category of the predictand and the selected predictors.

As there is one equation for each category of the predictand, solutions of the equations provide an estimation of the probability of occurrence of each category.

The three problem areas in which the REEP procedures appear to be applicable are described below.

⁴⁴I. Enger, J.A. Russo, and E. L. Sorenson, A Statistical Approach to the Short-Period Prediction of Ceiling and Visibility, Tech. Rpt. 7045-91, The Travelers Research Center, Inc., 1964.

⁴⁵J.A. Russo, I. Enger, and G. Merriman, A Statistical Approach to the 12-48 Prediction of Precipitation Probability, Tech. Rpt. 7671-217, The Travelers Research Center, Inc., 1966.

⁴⁶J.G. Bryan and A. Singer, Prediction of Reenlistment Using Regression Estimation of Event Probabilities (REEP), Center for Naval Analysis, Washington, D.C., 1966.

A-4) Application of REEP Procedures to the Selection of Law Enforcement Officers

The effectiveness of a law enforcement agency is partly contingent on its ability to select its personnel adequately. Personnel selection is expensive, difficult, and time-consuming, but vital to the success of the agency. A recent study of police personnel selection by Colarelli and Seigal effectively states the substance of the selection problem as follows:

During this period the authors had been impressed with the fact that the officers within this organization (The Kansas Highway Patrol) have had an excellent well conceived picture of the attributes and performance that made for an effective patrolman. However, the problem appeared to be one of applying this knowledge and information to the rather large number of individuals applying for the few positions available.⁴⁷

At present, selection of law enforcement officers, although based on a number of indicators, is somewhat subjective. The applicant passes through stages of examination; at each stage, selected criteria are used to determine his fitness for employment. These criteria generally require both quantifiable data (e.g., test results, educational achievement) and subjective data (e.g., background investigation, interviewer impressions of a candidate).

The efficiency and reliability of this process might be improved by providing the selection board with objective criteria in the form of a success probability scheme based on REEP. This is not to say, however, that human judgment can or should be removed from the selection process.

This study project will attempt to correlate the information available to a selection board at the time of an individual's application with his subsequent performance over a specified time period. The objective of the study will be to devise a prediction scheme, using REEP, to estimate the probability of a candidate's success or failure as a law enforcement officer.

⁴⁷ Nick J. Colarelli and S. Siegal "A Method of Police Personnel Selection," in The Journal of Criminal Law, Criminology and Police Science, Vol. 55, No. 2, June 1964, pp. 287-298.

A recent TRC study, for example, was concerned with the probability of reenlistment for U.S. Navy electronics personnel. In this case, the specified circumstances were combinations of available records on individual men—predictors such as age, education, scores on various tests, place of birth, and recruiting area. The separate indications of reenlistment potential, from the different records on each man, were weighed and balanced by means of mathematical formula called a regression function. The calculated resultant indication then provided the estimated probability of reenlistment for that man.

This project will involve the collection of data on personnel currently on duty and will cover a specified time period (e.g., 5-10 years). All available information recorded for these personnel at the time of their employment application will be collected along with data concerning their performance record during the specified time period (e.g., promotional exam results, performance reports, further education, evaluation by fellow officers, citations). To provide meaningful results, the sample size for this study will require the complete personnel files of at least 1,000 individuals. A punched card input procedure will be developed to handle both qualitative and quantitative variables. However, experienced law enforcement officials must provide the measures of effectiveness against which an individual will be assessed. Performance profiles will then be developed for all individuals utilizing a high-speed computer and REEP techniques.

Most of the statistical techniques used in various employee selection procedures in the past have had to rely upon quantitative information, and this was their major deficiency. REEP, however, with its capability to generate dummy variables, is able to process important qualitative, non-ordered variables.

Appropriate measures will, of course, be used to safeguard any personal information on law enforcement candidates.

C-23) Application of REEP to the Prediction of Recidivism

A major problem confronting a number of law enforcement agencies is the disposition of judicial cases after conviction; an important consideration in sentencing is the probability that the offender will repeat the offense.

A number of studies have attempted to estimate or predict recidivism (^{48, 49, 50,} and ⁵¹, for example) and a number of meaningful indicators have been established. However, because many of the variables used were qualitative, non-ordered, etc., the work previously accomplished has been essentially on an univariate basis, with little effort to combine or exploit the pertinent variables in the most useful manner.

This study involves the use of REEP in extending the previous research efforts to obtain the maximum amount of information (non-linear as well as linear) from a number of variables and to combine this information into a usable probability framework. It has become apparent that data samples are available from past researchers ⁵², and a number of meaningful indicators, such as the number of prior arrests, type of offense, family background, religion, have evolved as useful indicators and may be directly applied in the REEP framework.

E-39) Application of REEP to Differing Characteristics of Criminals and Non-Criminals

Through a study of pertinent personal history characteristics of individuals during an early stage in their life cycle, the object of this study is an attempt at the determination of indicators which might aid in the classification or prediction of crime prone individuals before they have committed any crimes. Hopefully, this could lead to controlled modification of the important indicators and thus to crime prevention.

⁴⁸Walter C. Bailey: Correctional Outcome: An Evaluation of 100 Reports in The Journal of Criminal Law, Criminology and Police Science, Vol. 57, No. 2, June, 1966, pp. 153-60.

⁴⁹Ralph Metzner and Gunther Weil, "Predicting Recidivism: Base Rates for Massachusetts Correctional Institution Concord," in the Journal of Criminal Law, Criminology, and Police Science, Vol. 54, No. 3, Sept., 1963, pp. 307-316.

⁵⁰Sheldon and Eleanor Glueck, Predicting Delinquency and Crime, Mass. 1959.

⁵¹Jerome Laulecht, "Problems of Statistical Research: Recidivism and Its Correlates" in Journal of Criminal Law, Criminology and Police Science, Vol. 54, No.3, June, 1963, pp. 163-180.

⁵²Letter Communication from Dr. A. Blumstein, December 21, 1966.

This study involves the collection of personal histories of a large number of people, at a given point in time. Half sample histories will be of people who later became criminals. The largest and most difficult problem will be the selection of a representative data sample. However, the necessary data may be available at universities or correctional institutions where behavioral science approaches to this problem have been attempted.

Literature sources, sociologists, psychologists, and operational law enforcement personnel will lend their support in depicting the types of variables which may serve as input. Employment records, type of employment, family background, social environment, etc. are typical of the types of variables to be considered by the REEP procedure.

5.0 FINDINGS AND CONCLUSIONS

Crime is a major problem in the U.S. and will continue to increase in scope and magnitude unless an effort is made to check this pattern of growth.

The analytical and statistical techniques developed through advances in science and technology have definite applications in the war against crime.

There is an increasing awareness at all levels of government as to the applicability of science and technology to traditional "police problems." Growing out of this awareness, government officials are recognizing the need for research and are making substantial amounts of money available for this purpose.

Our evaluation revealed an initial list of 44 specific problems amenable to solution by application of one, or a combination of techniques.

The following projects are judged to be of immediate interest to TRC based on our evaluation of the applicability of techniques for which TRC possesses competence and experience, the importance of the problem, level of previous research on a problem, and Evaluator Interest:

Systems Analysis of a Municipal Police Department (A-1)*

Development of Improved Criminal Investigation Techniques (A-6)

Simulation of Police Operations for Training Police Management Personnel (A-12)

The Technical and Psychopolitical Implications of the Use of Incapacitating Agents in Law Enforcement (A-14)

Development of a Centralized Criminal Justice Information System on a State or Regional Basis (D-27)

Development of a Personal Appearance and Name Searching Identification System (D-28)

Development of a Computerized Modus Operandi Retrieval System (D-29)

Development of a Computerized Fingerprint Classification, Identification and Retrieval System (D-32)

Systems Analysis Study of the Law Enforcement Establishment in a Region or Area. (E-38)

Application of REEP (Regression Estimation of Event Probabilities) to Differing Characteristics of Criminals and Non-Criminals. (E-39)

Application of REEP to the Selection of the Ideal Law Enforcement Officer. (A-4)

Application of REEP to the Prediction of Recidivism, (C-23)

* Note: these numbers refer to the project identification numbers used in the text to facilitate easy reference.

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APPENDIX B
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