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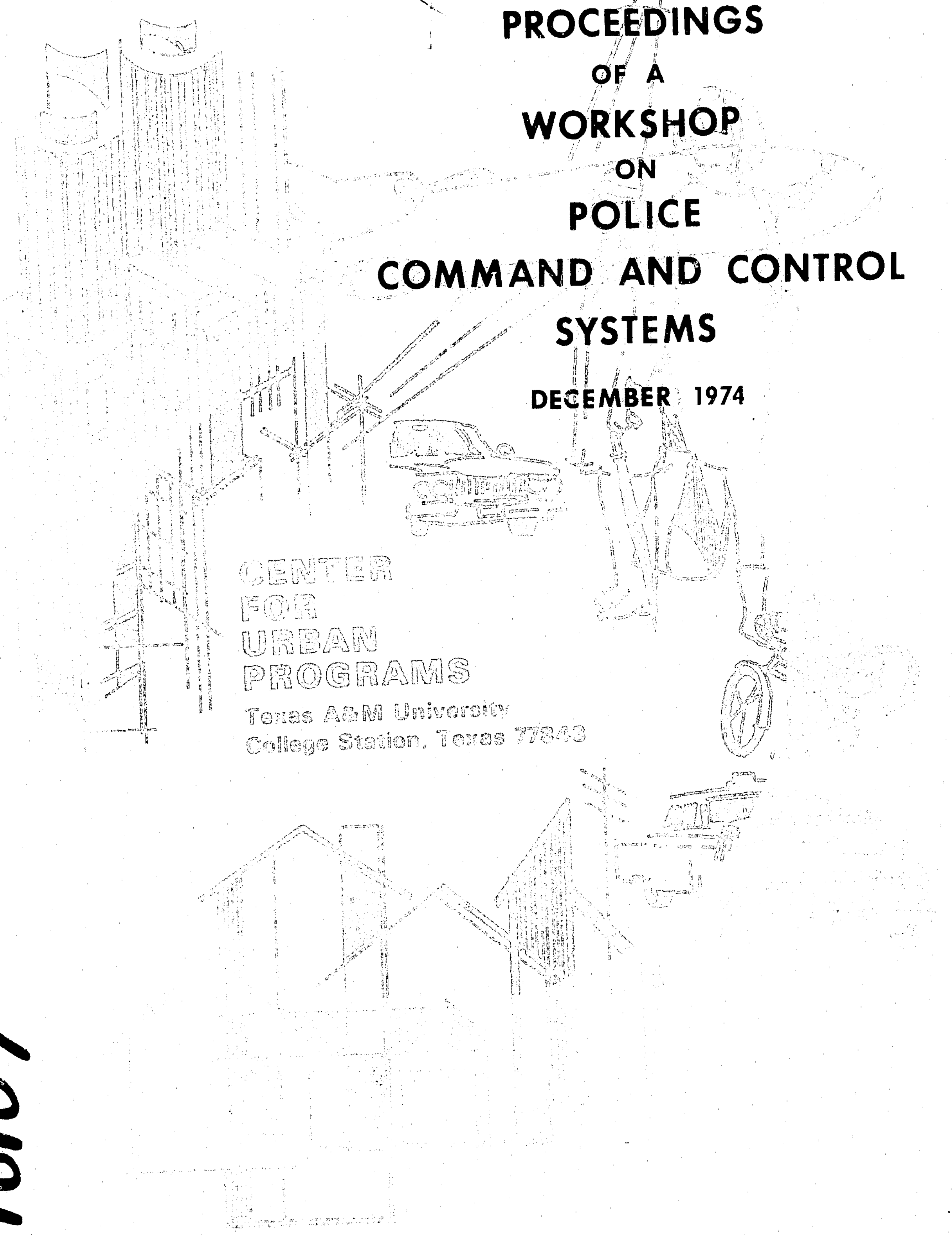

CENTER FOR URBAN PROGRAMS
Texas A&M University
College Station, Texas 77843

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PROCEEDINGS

of

A Workshop on

POLICE COMMAND AND CONTROL SYSTEMS*

Oct. 31, Nov. 1, 1974

Rudder Conference Center
Texas A&M University
College Station, Texas

Edited by:
Stephen Riter

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Criminal Justice Divison,
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Texas A&M University

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PREFACE

On October 31, November 1, 1974, the Center for Urban Programs, Tesas A&M University with the support of the Criminal Justice Division, Office of the Governor conducted a workshop on Police Command and Control Systems. The participants in the workshop were selected officials of medium size Texas police departments and of agencies responsible for criminal justice planning. The objective of the workshop was to present to these officials information on the costs and benefits of various police command and control systems, and to obtain from these officials an assessment of the relative value of the systems discussed.

This document contains the papers which were presented at the workshop, along with a summary of the assessment exercises and a discussion of goals for police command and control systems. We anticipate that this document will be useful to state and local planning officials in developing long range plans for specific departments and in weighing the relative value of different approaches to command and control.

Many people contributed directly and indirectly to the preparation of this document. Special thanks however are due to Mr. Saadi Ferris of the Criminal Justice Division who saw the need for the studies which lead to the workshop, enthusiastically supported our effort, and provided us with critical guidance and direction.

Although the Criminal Justice Division furnished financial support for this workshop, this support does not necessarily indicate the concurrence of the Criminal Justice Division in the statements or conclusion contained herein.

Stephen Riter
Center for Urban Programs
Texas A&M University
College Station, Texas
December 1974

INTRODUCTION

Police command and control systems have the potential for greatly increasing the effectiveness of police activities. To realize this potential, however, planners and administrators must clearly understand the technological options available to them. This information should be used to develop a long-term system design which in a cost-effective fashion yields a system which meets current needs and which will not be made obsolete by future technological advances. This paper presents an overview of police command and control systems, discusses the benefits of major system components, and offers recommendations on the sequence of implementation. Other papers in these proceedings contain more detailed information on costs and benefits. The recommendations presented concerning priorities were arrived at as the result of discussions of system elements with police officials throughout the state, the evaluation exercises, described in the paper beginning on page 26 of these proceedings and other studies and evaluations.

GOALS

It is a generally accepted view that a police command and control system should:

(1) Provide information to the officer in the field immediately upon request
(2) Capture management information
(3) Reduce response time

A policeman's work is based on human judgement. He is continuously called upon to make decisions about people and events. As in any decision-making activity, the choices he makes are usually no better than the information available to him. For this reason, command and control systems must be able to provide him with accurate information about events, places, and people of interest as quickly as possible. In most Texas police departments, officers currently obtain information by requesting a manual file search through their dispatch center or by requesting a teletype check of the files of the Texas Crime Information Center (TCIC) or the National Crime Information Center (NCIC). While such information is usually valuable, these files are slow to access and as a result, in many departments, field officers are hesitant about requesting information checks. Furthermore, in many emergency situations the time required to make such checks is simply not available.

Police administrators, particularly those in rapidly growing cities, must continuously make decisions about the allocation of people, the location of beats, and the scheduling of shifts. Currently, these decisions are made based upon intuition and experience, but often with insufficient data. This is because most departments simply do not have the means to collect, and analyze operational data. A police command and control system should be able to collect this information. Furthermore, departments should develop the capability to analyze such data and use it to increase police effectiveness, more fully utilize resources, predict crime patterns, and provide vital management information to police department managers.

It is generally believed that the quicker the police respond to a call for service, the more likely it is that a criminal will be apprehended. Furthermore, savings of time on the order of a minute during the first few minutes after an incident is detected, will yield large incremental increases in the probability of apprehension. A high apprehension rate is important for a number of obvious reasons. Basically, it is one of the prime reasons for police department existence. Even if the criminal is not immediately apprehended, arriving quickly reduces the chance that evidence is inadvertently destroyed or information distorted. At the very least, it increases the confidence of the local citizenry and seems to deter future crimes since criminals are as aware of this correlation between response time and effectiveness as are the police. Consequently, a police command and control system should be designed so that, on the average, response time is made as small as possible.

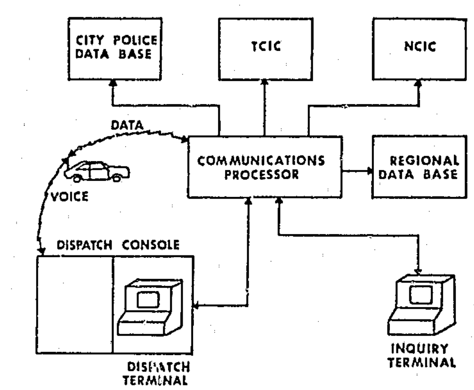


Fig. 1

AN IDEAL SYSTEM

Fig. 1 is a block diagram of a system which can meet all of the goals suggested. The heart of this system is a digital computer which may be either dedicated to police operations or shared with other city departments.

To understand how such a system might operate consider, for example, what happens when a citizen reports an incident. The call comes in over an emergency line and is received by a telephone operator. The operator gathers all the pertinent information along with the type of call. She is assisted in doing this by a cathode ray tube display which leads her through a computer-generated sequence of questions. The format of the questions depends upon the actual situation. She enters the response to each question into the computer via keyboard. If a police car needs to be dispatched the computer matches the location of the incident with a reporting area. The computer has a current list of the vehicles assigned to a particular reporting area and their current status and location. The computer then determines which vehicles are available to answer the call and either routes this information to a radio dispatcher or transmits a message dispatching the vehicle itself. Depending upon the urgency of the situation, this can all be done while the operator is still collecting information from the complainant. In addition to alerting the dispatcher to the need for sending a vehicle, the computer also initiates a sequence of data entries which are used to keep track of police department activities.

The officer in the field will have access to this central computer via a two-way data channel which can be used to retrieve information stored in various data banks. This includes information about stolen property, wanted persons, etc. The data will be available to him in hard copy form. He can also use the channel to input to the records section information that he collects during the day and which is now usually reported at the end of a shift or is lost. This includes the data that is usually entered on uniform crime reporting forms as well as general intelligence information.

The headquarters command receives continuous status data and information on each officer's location. This information would be formated and presented in a manner to allow them to make timely command decisions concerning the allocation of resources and reaction to unusual emergency situations.

Implied in this system but not specifically shown in the Figure are software routines which take the management data that is collected and use this information to evaluate the productivity of police operations, allocate personnel, and spot crime patterns.

IMPLEMENTATION PRIORITIES

The previous section describes a highly idealized police command and control system. Although such a system is technologically feasible there is at present no city in Texas with a system which incorporates all the features we have discussed. A number of particularly innovative departments have installed elements of this system. However, because of the price range of the equipment needed it is highly unlikely that any medium-sized Texas department would, in the near future, be able to afford all the innovations suggested.

This ideal system is technologically feasible but financially out-of-reach of most departments. What then should departments do first in the way of automated command and control? What are realistic short, medium, and long-term goals for such systems and in what order should the elements of such systems be acquired?

To answer the questions posed above each department must examine the total system suggested by Figure 1 and develop for itself a set of long-term priorities and a step-by-step implementation plan. This process should take into effect local priorities and problems and be designed so that as additional funds become available and as the cost of various innovations are reduced new elements can be integrated into the total system on a step-by-step basis.

While each city must set it's own priorities, for most departments the most cost effective innovation appears to be high-speed access to criminal information files. High-speed access implies the development of automated information systems on a local level and the replacement of teletype access to the TCIC and NCIC with high-speed access to these data banks.

Many Texas police departments are currently using microfilm with some type of automated retrieval to store and handle local records. It is not suggested that this trend is bad or that all local records should be stored in a local computer data bank. Instead, some combination of computer storage of critical information indexed to microfilm storage of routine information is proposed as an effective long term method for handling local information. A local system might for example have stored in the computer names, locations, and property of current interest with only a cursory explanation of its relevance and directions to a microfilm record which contains more complete information. In this case the computer would be used as an index to the microfilm files.

Improved access to state and regional files can only be provided by a phased replacement of the state teletype law enforcement system by a high-speed system. Sufficient capability exists to process the increased high-speed access to state and national files; however, such a transition will take careful planning and careful coordination with the Texas Department of Public Safety, operator of TCIC.

At the present time, only one major area in the state, the Dallas-Fort Worth area, has high-speed access to TCIC and NCIC. Examination of departments within this area indicates that this access has had a significant effect on operating procedure, apprehension rates, and TCIC/NCIC usage. Cities within this area are continually the major users of these services, and the number of requests for information from this area are continually way out of proportion to the population of the area when compared with requests from the State as a whole.

A number of problems must be resolved however, before such high-speed access can become statewide. The first of these is the problem of regional cooperation. Agencies within a region must work together and must all agree to obtain this capability if it is to be at all provided within the region. While the cost for this service to major agencies within a region would in general be a small part of the agency's budget, the cost to smaller agencies might be prohibitive. This situation would necessitate special cost sharing arrangements, cooperation, or other incentives to make this capability attractive to small departments.

Computer usage has a history of increasing out of proportion to expectations. Consequently it is possible that increased usage might well saturate the system, although it appears to us that proper planning would make it possible to adequately predict future demand, and provide additional capacity.

A department with high-speed access to local, state, and regional files has two attractive alternatives available:

(1) It can try to capture in a machine compatible form operational information and develop the capability to analyze this information.

or

(2) It might acquire a special purpose computer to automate the dispatching operation.

To acquire information in machine compatible form does not necessarily imply that the department have on line a real time computer system. It is possible to collect information as is presently done by hand and then punch it on cards for off-line batch processing and evaluation. However, this data can only be worthwhile if the department develops the ability to analyze, interpret, and use the information it collects. This implies the addition to the department of trained operations analysis personnel. These personnel might be sworn officers or civilians with a background in operations research. They could make use of computer software packages designed to design beats, schedule shifts, evaluate effectiveness and spot crime patterns. Such packages are currently under development in a number of different localities and by numerous organizations. While still largely experimental they seem to have the potential for improving the management of police operations.

A police dispatch computer has the potential for capturing the information previously noted and for assisting the dispatcher in allocating field vehicles and controlling the vehicles under his command. Such systems are becoming cost effective and they warrant consideration by Texas police departments.

There are numerous other innovations suggested in Fig. 1 which should be deferred until prices come down or until the three previous recommendations are adopted. These include automatic vehicle location systems, in-car terminals, scramblers, integrated police information systems, etc. In general these innovations are currently unproven and may be of little positive benefit in the near future. In fact, to fully utilize such systems, departments need to have experience with high-speed access to information and the analysis of current operations.

CONCLUSIONS

A review of currently proven technologies and an orderly evolution of police department facilities leads to the conclusion that the highest priority in the near term should be placed on providing to as many departments as possible rapid access to local, regional, state, and national crime information systems. Departments which have such a capability should be encouraged to develop a management analysis potential and/or automated dispatching. Other more sophisticated approaches to crime control and police operations should be deferred until experience with these innovations has been obtained.

TEXAS POLICE DATA INQUIRY SYSTEMS

by

Roger W. Elliott
Industrial Engineering Department
Texas A&M University
College Station, Texas 77'43

INTRODUCTION

Police departments have, historically, been quick to make use of available technology. And, although literally thousands of technological changes have been adopted, relatively few have any significant impact on Police department operations.

The criminal justice community is now on the threshold of wide-spread use of high-speed on-line computerized information systems, and there is every indication that this development will indeed make significant changes in departmental operations.

This paper summarizes the state of the art of police information system technology in Texas. It describes the kinds of information that are available and useful, the hardware that is required to access it and its cost, and the political and legal constraints on its use. It attempts to place automated inquiry systems in perspective as a subsystem in a larger system for the prevention of crime.

This paper does not describe anything which is really a technological innovation. Computerized inquiry systems are used in few police departments, but they are widely used in the commercial sector in banks, manufacturing plants, transportation systems, etc. This technology is available in much the same sense that helicopters, mace, and portable radios are available.

REQUIREMENTS FOR INFORMATION IN A POLICE ENVIRONMENT

There are essentially three reasons which justify data inquiry systems in a police environment.

The first justification is the requirement for safeguarding the officer in the field. On a routine car stop or in any other situation requiring citizen contact, the officer needs to know as much information concerning the citizen as possible. When stopping a car, the officer should know if the vehicle is stolen, who the owner is, and whether the owner is wanted by law enforcement authorities anywhere. When the citizen has a record or a history of violence, the officer needs to know. When dispatched to an address that has a history of violent incidents, the officer needs to know about it for his own safety.

Secondly, information is required to enhance the effectiveness of the officer in the field. There are numerous cases of officers stopping wanted criminals for routine traffic violations and releasing them, only to discover at a later time that they were wanted. It is extremely difficult to interrogate a criminal effectively unless the officer has some knowledge of his previous activities. Also, officers waste large quantities of their own time and greatly increase citizen tension by requesting time-consuming manual record checks. Most officers simply do not use inquiry systems that involve delays over five minutes.

Finally, management information is needed to enhance the effectiveness of the organization as a whole. The police manager needs to be able to gage his workload and his effectiveness in meeting this workload. There is a great need for data to support management planning activities, and much of it must be provided on an "as-needed" basis.

INFORMATION AVAILABLE

Information is available to Texas Police Departments from three sources.

1. The FBI provides crime information through the National Crime Information Center (NCIC).

2. The State of Texas provides information from three sources.
   (a) The Texas Highway Department Motor Vehicle Division makes available motor vehicle registration information.
   (b) The Department of Public Safety provides a drivers license file.
   (c) The Department of Public Safety also supports the Texas Crime Information Center (TCIC).

3. Finally, information is available from local police department files and the files of other city departments.

The NCIC is a computerized index and communication network linking a broad spectrum of law enforcement agencies with the FBI. It maintains information on wanted felons plus ID numbers for stolen weapons and a variety of serial numbered properties including vehicles, boats, securities, and so forth.

The TCIC provides a real-time information system serving all law enforcement agencies in Texas on an around-the-clock basis. Vital data concerning stolen properties and wanted and missing persons are stored and maintained for immediate access. Inquiry and distribution of this data is accomplished by use of the Texas Law Enforcement Teletype Network which encompasses all agencies of law enforcement including city police departments, county sheriff offices, U.S. Customs Bureaus, U.S. Provost Marshalls Offices, FBI Offices, and the like. The system has computer links to several Texas regional systems and to the National Crime Information Center in Washington.

Although a few large cities in Texas are connected directly to NCIC, most Texas cities access

NCIC through the Department of Public Safety switcher in Austin. Inquiries to TCIC are subsequently forwarded to NCIC. Similarly, information placed in the TCIC is also placed in the NCIC when it is appropriate.

The TCIC/NCIC Data Base contains the following types of records:

(a) Vehicle

This includes stolen vehicles, vehicles of persons associated with felonies or serious misdemeanors, and vehicles of wanted persons. Also in this category are stolen vehicle identification number (VIN) plates, engines, and transmissions, if they are serially identified. Unique to TCIC are impounded vehicles and vehicles associated with misdemeanors/missing persons.

(b) Boat

Stolen or missing vessels are entered, provided the registration and permanent identification numbers are available.

(c) License Plate

Entry of plates is permissible if they are reported as stolen or removed from vehicle.

(d) Person

Individuals are entered, provided a warrant, either Federal or local, has been obtained and the agency will extradite. Missing persons and those wanted for misdemeanors (these are unique to TCIC) are also entered.

(e) Gun

Both stolen/missing guns and recovered guns not reported as stolen/missing may be entered if uniquely identified by serial numbers.

(f) Article

Any stolen article that is serially numbered may be entered into the system. The reporting agency uses the value of the article and their own discretion in determining whether to enter the item.

Note:

At the discretion of the reporting agency, securities that are stolen, embezzled, counterfeited, or missing can be entered. (These records will be maintained only in the NCIC System).

There are more than ninety transaction codes that may be used depending on what type of message and action is involved.

The specific data elements in each record are shown in Tables 1 and 2.

The Texas Highway Department Motor Vehicle Division (MVD) also maintains files which are available through the law enforcement teletype terminals. The MVD Data Base actually includes three data files: the master title-registration data file, the registration index data file, and the vehicle identification number index file. The two index files are merely utilized to access the master data file which is in index number sequence and contains the data elements shown in Table 3.

The information contained in the MVD Data Base is essentially public information available to anyone. Information necessary for a peace officer performing duties of protecting the public or keeping the peace is provided by the Texas Highway Department without charge through the Teleprocessing Network. Information for this purpose is available 24 hours a day, 7 days a week.

The Department of Public Safety also maintains a drivers license record system which consists of four files. A basic (or master) file, a name index file, history file, and an alarm file. The name index file is used to access the basic or master record which in turn accesses the history file. The alarm file may be accessed to provide suspension information and departmental action. The basic file consists of 8 million drivers license records organized by sequential numbers. This file consists of the data items shown in Table 4.

The name file is used to access a basic (or master) file that contains the driver's name in soundex format, date of birth, and drivers license number.

The history file contains a complete description of the driving record of each individual. This data set is accessed directly using the drivers license number as a key to an index containing the position of a particular record or file.

The most recent effort at the State and Federal level to expand their crime data bases is the Computerized Criminal History (CCH) program. The basic source document for this program is the fingerprint card taken at the time of arrest. While the criminal history file in the NCIC system is open to all law enforcement terminals for inquiry, only a state agency can enter and update a record. Rules regarding the classes of data which can be included are strictly enforced, and only serious and/or significant violations are entered. With a few exceptions, juvenile offenses, charges of drunkenness and/or vagrancy, public order offenses, traffic offenses, and non-specific charges are not included.

The Texas Department of Public Safety is entering all new records into their data base and is entering old records as quickly as possible. At the present time, they have about 450,000 records on-line and have an additional 2,000,000 records in a manual file.

There is a good deal of information which is required for local police operations, but which is not appropriate for inclusion in State or Federal data bases. A list which contains some of these items, but which is far from complete, is shown in Table 5.

In summary, local police departments have a requirement for a broad spectrum of different kinds of information for operational purposes. Much of this information has little utility outside the local municipality, and it is Federal and State policy that these data should be retained at the local level. Some data, on the other hand, have broader utility, and State and Federal information centers have been established for their retention and dissemination.

The responsibility for entering data, purging it, and retrieving it still rests with the local law enforcement agency, and compliance is essentially voluntary. In general, local law enforcement agencies have shown a willingness to use these systems, although there are significant variations in

ELEMENT ...OCCURS IN...	FILES(S)
Message Key	License Plate, Vehicle, Article, Boat, Gun, Securities
Originating Agency	License Plate, Vehicle, Article, Boat, Gun, Securities
License Plate Number	License Plate, Vehicle
License Plate State	License Plate, Vehicle
License Plate Yr. Expire	License Plate, Vehicle
License Plate Type	License Plate, Vehicle
Date of Theft	License Plate, Vehicle, Article, Boat, Gun, Securities
Original Case Number	License Plate, Vehicle, Article, Boat, Gun, Securities
Miscellaneous	License Plate, Vehicle, Article, Boat, Gun, Securities
NCIC Numbers	License Plate, Vehicle, Article, Boat, Gun, Securities
Vehicle ID Number	Vehicle
Vehicle Year	Vehicle
Vehicle Make	Vehicle
Vehicle Model	Vehicle
Vehicle Style	Vehicle
Vehicle Color	Vehicle
Type	Article, Gun, Securities, Boat
Serial Number	Article, Gun, Securities
Brand Name	Article
Model	Article
Reg. Document Number	Boat
Reg. Document State	Boat
Reg. Doc. Year Expire	Boat
Hull Outer Mat.	Boat
Hull Serial Number	Boat
Propulsion	Boat
Make	Boat, Gun
Length	Boat
Color	Boat
Caliber	Gun
Denomination	Securities
Issuer	Securities
Owner	Securities
Social Security Number	Securities
Security Date	Securities

Data Elements for Stolens - TCIC/NCIC

Table 1

Message Key
Originating Agency

Name
Sex
Race

Place of Birth
Date of Birth

Height
Weight

Eye Color
Hair Color
FBI Number
Complexion
Scars, Marks and Tattoos
Fingerprint classification
Miscellaneous Numbers
Social Security Number
Operator's License Number

Operator's License State
Operator's License Year Expire
Offense
Date of Warrant
Originating Agency Case Number
Miscellaneous
1. Date apprehended/cancelled
2. Apprehension agency
3. Apprehension agency case number

License Plate Number
License Plate State
License Plate Year Expire
License Plate Type
Vehicle I.D. Number
Vehicle Make

Vehicle Model
Vehicle Style
Vehicle Color

NCIC Number

Data Elements for Wanted Persons - TCIC/NCIC

Table 2

Index Number
Current License Number
Previous License Number
Title Number
Title Date
Year of Registration
Registration Classification
Manufacturers Rated Carrying Capacity in Tons-Commercial Vehicles
County of Registration
License Fee
Empty Weight
Gross Weight (Commercial Vehicles)
Miscellaneous Codes (such as stolen, safety responsibility suspension, vehicle junked, duplicate title issued, etc.)
Year Model
Make
Body Style
Vehicle Identification Number (VIN)
Previous Owner
Owner's Name
Owner's Address
Owner's City
Owner's State
Owner's Zip Code
Lienholder's Name
Lienholder's Address
Lienholder's City
Lienholder's State
Lienholder's Zip Code
2nd Lien Date
2nd Lien Information
Miscellaneous Remarks

Data Elements - MVD Data Base

Table 3

Drivers License Number
Name (last, first, middle, suffixes)
Date of Birth
Street Address
City
Zip Code
Race/Sex
Eye Color
Hair Color
Height
Weight
History (relates to driver education, etc. not driving)
Original Issue Date
Alarm
Restrictions (maximum of three)
Operator issue date, expiration date, station number
Commercial issue date, expiration date, station number
Chauffer issue date, expiration date, station number
Batch number

Data Elements - Drivers License File

Table 4

Complete criminal history files including juveniles, traffic offenses, drunks, etc. These must normally be cross-indexed by person, type of offense, etc.

Criminal justice files for tracking offenses through the court system

Jail records

Files on outstanding traffic warrants

Records on traffic flows, accidents, etc.

Complete files on stolen and missing articles, vehicles, etc.

Geocoding information

Dispatching data including calls for service, response time, etc.

Manpower allocation data for patrol purposes

Data for scheduling officers for court appearances and overtime

Officer efficiency data

Crime analysis data for determining trends in types of crime, locations, hours, etc.

Vehicle performance/maintenance information

Data Required for Local Operations

Table 5

Query, Stolen/Wanted Vehicle
Query, Wanted Persons
Motor Vehicle Registration
License Information - Driver Record
Query, Stolen/Recovered Gun
Query, Stolen Article
Query, Stolen Boat
Query, Stolen/Embezzled Securities
Query, History
Query, Retrieval (RAP Sheet)
Query, Region Wanted Person
Regional Computer Identification System
County Name Index
County Name Index
Entry, Stolen/Wanted Vehicle
Entry, Stolen/Wanted License Plate
Entry, Wanted/Persons
Entry, Stolen/Recovered Gun
Entry, Stolen Article
Entry, Stolen Boat
Entry, Stolen/Embezzled Securities
Entry, Region (only) Wanted Person
Update, Stolen/Wanted Vehicle or License Plate
Update, Wanted Person File
Update, Stolen/Recovered Gun File
Update, Stolen Article File
Update, Stolen Boat File
Update, Stolen/Embezzled Securities File
Update, Regional Wanted Person File
Region CIS
Region CIS File
Region CIS File (enter Loss Record)
County Name Index
County Book-in
County Book-in
Inter-Terminal Message

NCTCOG Information System Terminal Functions

Table 6

the amount of this use. But, the value of the systems have been impaired by a reluctance on the part of local law enforcement agencies to establish programs to enter and maintain the input data.

In addition, the question of replication of files has essentially not been addressed by local police departments. All police departments currently maintain, in their own files, duplicates of records that are forwarded to TCIC and NCIC, sometimes both in hardcopy and machinable form. A similar situation exists at the State level. The situation persists, apparently out of a desire to maintain complete files, even though it is currently faster to access TCIC than almost any local data base.

INQUIRY SYSTEMS TECHNOLOGY

For the present, most inquiry systems are used by dispatchers as opposed to the officer in the field. In most existing systems, the dispatcher serves as an interface between the officer in the field and any data base he may need. The officer requests a particular piece of information; the dispatcher in turn queries the data bases and relays the response to the officer.

This arrangement offers the advantage of requiring the officer to deal with only one piece of relatively simple and reliable hardware -- his radio. Also, since terminals are expensive, a single inquiry station would appear to be the most economic alternative, although it may not be the most cost-effective alternative.

The technology exists, or will exist in the near future, to enable an officer in the field to inquire directly into any available data base. Mobile computer terminals are currently being marketed by KUSTOM Electronics and IBM among others, which have keyboards so that officers can key inquiries indirectly. The KUSTOM terminal has a video screen for response and may be equipped with an optional printer.

Although systems of this type are yet in the experimental stage, they would appear to offer several advantages over conventional systems. They make much better use of the radio channel because the messages are transmitted much faster. They offer better security than voice communication. They offer better security for officers, but mostly, they offer speed by bypassing the dispatcher completely.

There are essentially two technologies upon which most current automated inquiry systems are based -- microfilm technology and computer technology.

Microfilm is produced in three basic forms: roll film, microfiche, and ultrafiche. Roll film, as its name implies, is a roll of 16 mm or 35 mm film (usually 16 mm) containing photographic images of documents and sometimes marks used for coding these images. Typical reduction ratios range from 20:1 to 40:1 with approximately 3000 images stored on a 100 foot roll of film. Microfiche is a 6 x 4 film card, typically containing from 60 to 100 microimages per card. Ultrafiche is similar to microfiche except that much higher reduction ratios are used, often as high as 400:1, and cards contain over 2000 images. Ultrafiche is not commonly used.

The primary advantage of microfilm systems as compared to computer systems is their relatively low cost and their ease of use. They do not require expensive terminals or persons with a high level of expertise, either as users or operators. In addition, some types of data, for example photos, are not amenable to digital storage. Finally, they are a popular replacement for inactive paper files because they take far less space and are more permanent. In the right situation, microfilm is appropriate and effective. There are numerous examples of companies which have replaced computer-based applications with more cost-effective microfilm systems.

On the other hand, microfilm systems have some serious drawbacks. Data in microfilm form is not amenable to electronic transmission. Unless quality control is outstanding, the image quality is often marginal. Finally, the retrieval itself may be slow.

Several roll film systems exist which retrieve particular images depending upon code marks placed on the film. The most popular of these is the Eastman-Kodak Miracode system which is found in many police departments. This system allows for retrieval based on relatively complex logical conditions, but it still requires a time-consuming linear search through the entire data base.

Some microfiche systems exist which, when given a fiche number and an image number, will locate and display that particular image. These terminals are relatively fast (approximately 3-15 seconds), but they provide for absolutely no indexing.

Computers can be effectively used in conjunction with these systems by storing the indexing information in the computer, using the computer to determine the proper image to be displayed, and then using the microfilm terminal to retrieve that image.

Although microfilm systems are seeing some use for storing inactive files, mug shots, fingerprints, etc., there is currently far more interest in computerized systems.

In Texas, dispatchers use one of three different terminals to communicate with TCIC. The Texas Law Enforcement Communications Network is shown in Figure 1. For the most part, it consists of a number of "loops" connected to a store and forward switcher in the DPS offices in Austin, although there are also switchers in Dallas and Houston that serve users in those areas. There are currently nearly 400 terminals in this network.

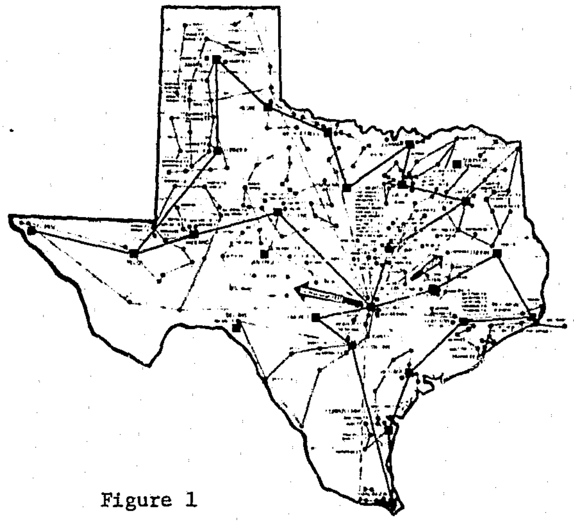


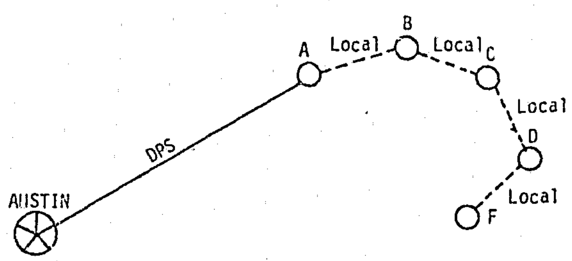
Figure 1

Most of these terminals are Teletype Model 28 ASR or Model 35 ASR terminals. Because Model 28 ASR terminals and Model 35 ASR terminals use different codes, all terminals within a given loop must be identical. The basic difference between the Model 28 and Model 35 teletypes is that the Model 28 is an older, slower, and cheaper machine than the Model 35. Both are extremely dependable and widely used machines.

The cost for these two terminals will vary somewhat depending on the options that are selected and the distance from the telephone company's central office, but the following costs are approximate.

Machine	Installation Costs	Monthly Rental
Model 28 ASR	$125	$135
Model 28 (Receive Only)	$ 15	$ 35
Model 35 ASR	$170	$230
Model 35 (Receive Only)	$ 35	$ 55

These costs include the costs of all equipment located at the police department. In addition, there are two line charges which apply. The line charges for connecting the terminals within each loop are borne by the station in the loop. These charges are at the rate of $1.80 per mile per month. The line charges from the closest point on the loop to Austin are normally borne by the Department of Public Safety. For example, if the drawing below represents a loop consisting of five cities, the cities must provide the dashed part of the circuit and DPS would normally provide the link from Austin to City A.



DISTRIBUTION OF LINE CHARGES

Figure 2

It must be emphasized that DPS requires both justification and lead time before it can make changes to the network, e.g., it would not normally provide high speed lines to one or two distant and isolated stations, and even where requests are justified, upgrading circuits usually requires considerable extra funding which must be budgeted.

In the Dallas area, the North Texas Council of Governments (NTCOG) has developed a regional information system that is in turn tied into TCIC and thus to NCIC. This system makes use of INCOTERM CRT terminals with a separate line printer. These terminals are much faster and easier to use than the teletype terminals. They are connected to a computer operated by Dallas County. A data base is maintained on this computer and users in cities and that network update or inquire into the regional, state, or NCIC data base using the same terminal. A list of the terminal functions is shown in Table 6.

The INCOTERM terminals were purchased in 1972 at a per station cost of about $10,000. Line costs within the loop are at the rate of $3.00 per mile per month and average about $50 per station per month. Terminal maintenance currently averages $143/month.

The primary advantages of this network are the speed and convenience with which transmission is accomplished. The data rate is 1200 baud, over 10 times as fast as the teletype terminal. In addition, the messages may be formatted much more conveniently. The popularity of this terminal is evidenced by the fact that each month, over half of the top 20 users of TCIC come from the NTCOG network.

There are numerous CRT terminals on the market which are essentially equivalent to the INCOTERM terminals used by NTCOG, and there is no fundamental reason why they could not be used in other regional networks. DPS has, however, indicated a natural reluctance to incorporate other types of terminals into the network, because a lack of standardization will generally degrade the switching system.

ALTERNATIVES FOR IMPROVING COMPUTERIZED INQUIRY CAPABILITY

Let us discuss what can be done now to improve a city's access to crime information. There are essentially four approaches to this problem.

First, a city can upgrade its terminal to TCIC/NCIC by replacing teletype terminals with INCOTERM terminals. All cities in a given "loop" must do this at the same time, and DPS must agree to the replacement. It would normally involve a capital expenditure of about $7,000 per station, plus an approximate doubling of the line charges borne by the cities in the loop, plus an increase in the line costs to the loop that DPS would have to agree to absorb. This alternative improves upward communication, but it does nothing to facilitate access to local data.

The NCTCOG network provides a basic model for the kind of system which must be built in cities all over the State. As discussed earlier, cities have pressing needs for data which is not appropriate for inclusion in a State or Federal data base while at the same time they require access to Federal and State data bases for other purposes. Thus, it is required that they develop some data bases of their own and then provide a capability for inquiry into these data bases as well as other non-local data bases. There are some basic disagreements concerning how these systems can best be realized.

Most cities large enough to consider an automated police data inquiry system already have a computer which is used for other functions such as accounting, bills, tax work, and so forth. Most city administrations will press for adding the police inquiry capability onto the existing computer. From a purely economic point of view, this usually makes sense. For a given amount of money, one can expect to receive much more compute power from a large machine than from two small machines. In addition, much of the data of interest to the police department has utilization in other city departments also, and it makes sense to share it.

The basic question is: Is it better for a law enforcement agency to share a large computer with the city or to operate a smaller computer wholly within the agency? The city administration usually argues for sharing for economic reasons. The police department on the other hand usually argues for a dedicated computer for two reasons: (1) The priorities on a shared computer and its operational procedures are not usually consistent with the police department's requirement for highly reliable 24-hour service. (2) The police department has an ethical and legal responsibility to keep some of its data secure and it cannot do this in a shared machine.

The federal government has stepped into this controversy. In a policy statement approved by the NCIC advisory policy board in 1972, the board stated:

(1) The hardware including processor, communications control, and storage devices to be utilized with the handling of criminal history data, must be dedicated to the criminal justice function.

(2) The criminal justice agency must exercise management control with regard to the operating of the aforementioned equipment by (a) having a written agreement with the non-criminal justice agency operating the data center providing the criminal justice agency authority to select and supervise personnel, (b) having authority to set an enforced policy concerning computer operations, and (c) having budgetary control with regard to personnel and equipment in the criminal justice agency.

While this statement is still the subject of a great deal of discussion, it is official policy and it is is unlikely to be altered significantly.

These arguments strongly suggest the second alternative, a dedicated police department computer with a capability for manipulating data bases and also providing communications capabilities. A minimum configuration would cost in the neighborhood of $225,000 and involve a substantial operating cost. Most city administrators in the 100,000 population range would be loathe to spend this much money on a dedicated police computer system.

The third alternative is a compromise which shows promise of being acceptable to both NCIC and city administrations and which makes use of minicomputer technology. This compromise involves placing all local files on a large shared (city) computer. A minicomputer located in the police department and completely controlled by the police department is then used as a front end switcher (see Figure 3).

Queries to NCIC are routed to NCIC, but queries to local data bases are routed to the shared computer. Other terminals on the shared computer are, however, inhibited from originating inquiries to NCIC. This does not, of course, solve the security problem for local data or the priority problem, but these are both problems which could be resolved by proper management of the computer facility.

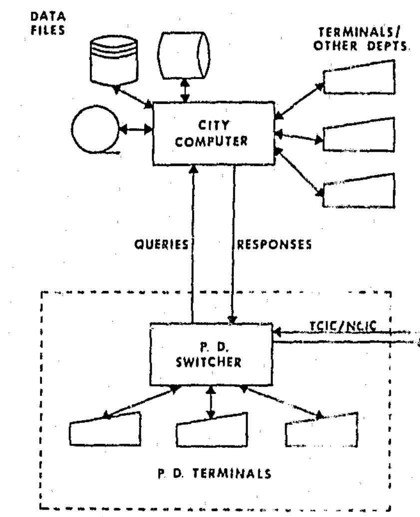


Figure 3

The switcher for an arrangement of this type can be very simple. It does not require any data management facilities, and the software is also relatively simple. Such a system should be obtainable for approximately $50,000, and while there would be some operation costs, they would be marginal.

Finally, a city can opt to operate two parallel systems -- one making use of the TLETN terminals and a second making use of terminals to a local city computer. From the user's point of view, this is certainly the least desirable alternative because it requires two separate inquiries. On the other hand, it is relatively devoid of political problems; it is relatively inexpensive; it does make all the data available to the police; and it does permit sharing of data among city departments.

A chart comparing these alternatives is shown in Table 7.

<u>SUMMARY</u>

It is necessary to provide the police officers with more information than they currently have for a number of reasons. Additional information enhances safety; it makes the officer more efficient; and it makes his manager more effective.

Information is available from a number of sources. The NCIC and TCIC provide inquiry facilities for information on wanted persons and a variety of numbered articles. It is still, however, necessary to develop local inquiry systems <u>for those items not appropriately stored elsewhere</u>.

In developing local inquiry systems, there are economical benefits to be derived from sharing local computer systems. However, NCIC policy requires that computers which inquire into the CCH data base be dedicated to criminal justice applications and be controlled by criminal justice agencies.

Mobile terminal technology is developing rapidly and will soon allow officers to inquiry into data bases directly.

Alternative	Cost	Advantages	Disadvantages
Replace Teletype by CRT	$10,000 per station plus increased line charges	Easier Utilization of State and Federal Data bases Low cost	Requires regional cooperation
Stand-alone PD computer that accesses TCIC and local data	$225,000 plus operating cost	Provide access to local data PD control	High cost Other city depts can't share data
PD Switcher	$70,000 plus operating costs	Moderate cost Access to local, state, and Federal data Other city departments can share data	PD doesn't control local data or local computer operations
Parallel system - Terminals to TCIC - Terminals to City computer	Variable	Low cost Access to local data & state data Share local data	Requires two inquiries PD doesn't control local data or local computer operations

Alternatives for Upgrading Inquiry Capabilities

Table 7

AUTOMATED COMMAND AND CONTROL SYSTEMS

by

Stephen Riter
Electrical Engineering Department
Texas A&M University
College Station, Texas 77843

INTRODUCTION

In this paper, we examine how automated command and control systems can be used to reduce response time, improve the quality of information given to the officer responding to a call, and capture management information concerning calls for service. In some cases, the approaches suggested will be relatively simple from a technological point of view, while in others they will be complex and expensive, however, we feel that police planners should be aware of all the options available to them now and in the future even if costs currently preclude their use.

THE DISPATCH PROCESS

The dispatch process can be thought of as comprising four distinct elements. They are:

(1) citizen calls police
(2) information collected
(3) vehicle dispatched
(4) vehicle travels to scene

In the sections that follow, we will look carefully at each of these elements with the goal of reducing the time required to perform them while at the same time improving the effectiveness and efficiency with which they are performed.

EMERGENCY TELEPHONE NUMBER

Approximately 50% of all incidents reported to the police are reported via the telephone. The remaining sources include other local agencies, alarm systems, and the police themselves. It is the telephone connection between the citizen and the police which is the most vulnerable link in the chain of events which must take place between the call for assistance and the arrival of the officer on the scene. In most Texas cities, to call the police a citizen must look up the police emergency number and then dial this 6-digit number. A recent Houston phone directory lists 42 emergency numbers on one page. The Dallas directory lists nearly as many.

An examination of this problem lead the U.S. Department of Justice to recommend that all U.S. telephone companies adopt a universal emergency number. Although this service has been available for a number of years, relatively few communities have adopted it. The reasons for this include:

(1) local telephone company complacency,
(2) rivalry between local agencies,
(3) hesitation on the part of local police officials to press for initiation of these services.

This service should be as much a part of an integrated command and control system as any of the more sophisticated technologies we will discuss. To have an ultra-sophisticated command and control system but one in which the caller must spend precious seconds looking up a police number, figuring out what number to dial or dialing operator and waiting, simply does not make sense. The link between the citizen and the department via the telephone is one of the most important steps in the dispatch process. In many cases, it is the weakest link but one where a relatively low expenditure of funds can yield significant improvements.

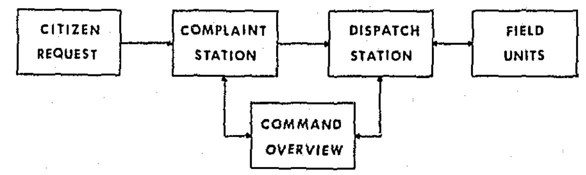
We feel that the impetus for installation of 911 must come from the police themselves. Few citizens or citizen groups are aware enough of this problem to yield the proper pressure to get their community to adopt this service.

The cost of the service depends on the type of central office switching equipment in a particular locality. In some new Bell central offices, 911 can be installed by single technician in a matter of days. In other offices, 911 requires new hardware. However, the costs are generally not high.

There are a number of options which can be installed with 911. Some represent realistic near-term requirements. Others will unnecessarily delay installation of this service. Options which can be realized in the near term include dial tone first on pay phones, exchange identification, and called party hold/forced disconnect. An option which is desirable but which cannot always be easily installed is automatic number identification.

It goes without saying that after a department obtains a universal emergency number, it takes steps to make the existence of the number known to as many citizens as possible.

THE DISPATCH CENTER



Typical Response Sequence
Figure 1

In Figure 1, we show the flow of information in a typical dispatch center. The primary interface between the citizen and the police is the complaint clerk. It is here that the first image of the police is established and from here that the subsequent servicing of citizen requests is initiated. To accomplish this, the complaint clerk must collect from the caller information relative to the call and then make a decision as to whether or not police action is called for. In most departments, the information is collected on some type of radio call sheet.

The recorded complaint information is then transferred to the dispatcher. If the complaint requires, in the dispatcher's opinion, a commitment of police resources, it is here that the commitment is made. Note that the dispatcher must make key decisions as to the allocation of people and physical resources.

In Tables I and II, we delineate the type of tasks each of these individuals must perform.

(1) Respond to Public Complaints
(2) Identify Nature and Collect Facts
(3) Determine if Police Action Necessary
(4) Determine Urgency and Seriousness
(5) Accurately Record Situation and forward to Dispatcher

Table I
Complaint Clerk

(1) Assimilate Complaint Information
(2) Determine Appropriate Vehicle
(3) Dispatch Unit
(4) Maintain Status of Units
(5) Monitor Radio
(6) Respond to Field Inquiries
(7) Maintain History of All Responses

Table II
Dispatcher

It should be clear from the list of tasks that a dispatch facility is a place where people carry out critical demanding work, requiring intense concentration and where a human error can have disastrous consequences.

If careful consideration is not given to the human asp cts of the physical layout of the center, then all the technology in the world cannot make it operate efficiently. This means that the operation of the center should be carefully examined to determine what it is each of the participants in the dispatch operation do and to establish the best possible environment for them to carry out their required tasks.

COMPUTER AIDED DISPATCH

Up to this point, we have discussed approaches which require little in the way of new technology. We now look at how technology can be incorporated into this system, what it will cost, and what it will do.

The heart of any advanced system should be an automated dispatch console. By this we mean a computer controlled system of interactive terminals and information storage devices. To understand how these are used, let us trace through the sequence of events that takes place when a call is received and how this sequence might differ from that in current systems.

```
INC LOC:                                            INC NO:

COMPLAINT:
COMPLAINANT:
                                    PHONE:
SUSPECT:                   SEX:     RACE:     HT:     WT:
                           EYES:    HAIR:     BUILD:
                           COMPLEXION:

BEAT                            UNIT ASSIGN:
TIME RECVD:
TIME DISP:                        DATE:       REC ID:
TIME AT SCENE:                    DISP ID:
TIME CLEARED:
```

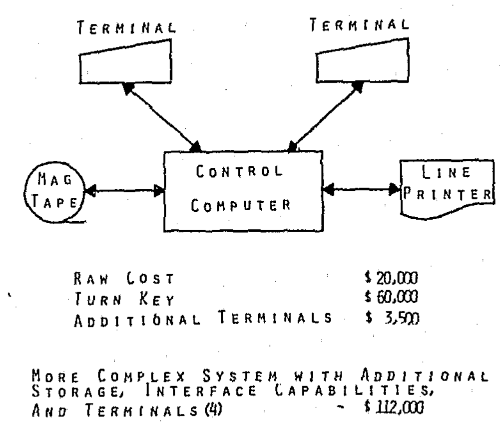
Figure 2
Incident Report

Each complaint station operator has a small television type screen with a typewriter terminal directly in front of them. When a call comes in, the operator obtains as quickly as possible a few simple facts: who is calling, what is happening, where the incident is and what is needed. The operator is aided in this by a canned message sequence which leads him through a prescribed sequence of questions depending on the incident. The information obtained in response to these questions is keyed into the computer via the keyboard. At the same time, the system notes the time the call is received. A typical input format is shown in Figure 2. If the call is an emergency, as the data is being entered, it also appears on a similar terminal in front of the dispatcher. Depending on the operating procedures established, the dispatcher might then take the call over, although little is gained by this transfer in such a system.

A number of software options might be worked into this procedure. They could include subroutines to check address accuracy, identify beats, or determine if there is some obvious omission or mistake in the data.

The dispatcher would have available to him in the computer's memory a list of calls for service awaiting dispatch. These might be denoted by some set of priorities and he would then pick the unit with the highest priority to next dispatch. He might also have available to him a vehicle status summary showing the status of each of the vehicles that he is responsible for.

The cost of such a system is highly dependent on the options purchased with it and the degree of sophistication required. At least four major manufacturers market a line of equipment which should be able to operate in the manner we have indicated. We estimate that a "bare-bones" system would consist of a mini-computer, two terminals, a storage device, and some type of line printer. The costs for such a system are summarized in Figure 3.



Computer Assisted Dispatch System
Figure 3

The benefits of such a system are an increase in the accuracy with which you collect data, a decrease in the time required to process a call and a historical record of the day's activities.

The accuracy accrues because the computer forces the operator to collect the information necessary.

A reduction in time is achieved because the information is shifted between the operator and dispatcher instantaneously. No belts, conveyors, or other mechanical means for transferring the message is necessary. Furthermore, the dispatcher is always alerted to possible critical situations before he actually receives the radio call sheet. A historical record of the day's activities is obtained by virtue of the computer's storage capability. While most departments keep radio call sheets and other data on calls for service, the information is usually in such a form as to make analysis of the data difficult if not impossible. With the computer keeping track of each call and its disposition, an easily accessed and analyzed historical record of the day's activities is obtained.

AUTOMATIC VEHICLE MONITORING

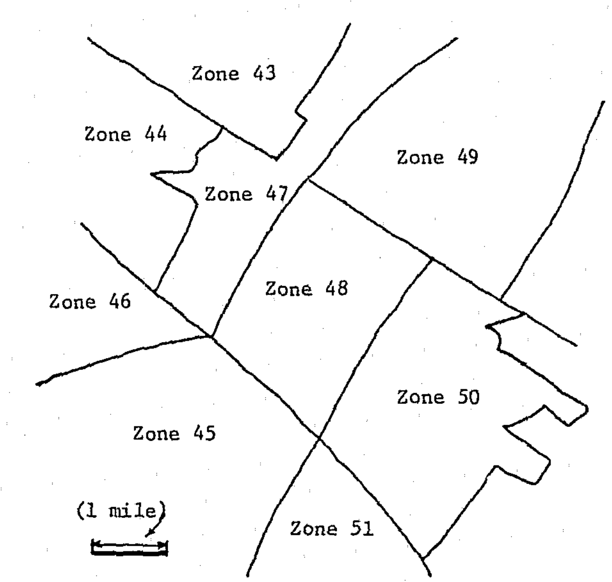
Our attention until now has been focused on speeding up operations in the dispatch center. We now look at a technology, Automatic Vehicle Monitoring (AVM), which can give the dispatcher better information on which to make a decision about which car to dispatch.

For a detailed discussion of AVM systems the reader is referred to [1]. Here we wish to update information in the referenced report and place the use of this technology in the context of our present discussions.

By an AVM system, we mean a collection of electronic or electromechanical equipment which can be used to acquire information about the location of mobile vehicles operating in an urban area. These vehicles may be police cars, fire equipment, ambulances, buses, or even commercial vehicles. However, here we are concerned with police AVM systems.

The key word in the above definition is automatic. This means that the system requires no action or possibly only occasional action on the part of the vehicle operator. Consequently, the system places no additional burden on the operator's time. Furthermore since most dispatch systems require that vehicles report their location from time to time or in the event of specific circumstances, there is even the potential for giving the vehicle operator more time to devote to other matters.

For the most part, the benefits of such a system accrue from increasing the effectiveness with which one controls and dispatches vehicles. If such a system were integrated into a computer assisted dispatching operation then when a call for service was received, the computer could choose the car closest to an incident and dispatch it automatically. Or it might choose the closest car, present this decision to the dispatcher, and if the dispatcher concurred, the dispatcher would dispatch that vehicle. This would reduce the average travel time to an incident and eliminate the probability of an incorrent dispatch.



Beat Pattern
Figure 4

Consider here the beat pattern for a typical Texas city as shown in Figure 4. Assume that one patrol vehicle is assigned to each of the beats. A typical dispatch strategy is to send the vehicle in a zone to an incident in its zone. Let us assume that we get a high priority call for service for someone in zone 48. Given the dimensions here, if this car is free, there might be little advantage in sending anyone but the vehicle in 48. If, however, 48 is not free, then who should be sent. If a city uses interzone dispatching, then the dispatcher will arbitrarily pick someone from one of the contiguous zones or perhaps another vehicle known to be free or thought to be free in the general area. In this case, there is a very high probability that the vehicle which can arrive in the least time is not the one sent, and sometimes, the one which can arrive in the least time is not even in a contiguous zone but is somewhere else.

It is possible using mathematical techniques to analyze the improvement in police coverage one achieves with an AVM system. Such studies have been performed by a large number of people. These studies have pretty much indicated that one can achieve a reduction of 5 - 9% in the number of vehicles needed to provide a specified amount of coverage or that by adding AVM, one can achieve an equivalent increase in protection while holding the number of vehicles fixed. This is a figure one can use to assess benefits. It costs between $100,000 and $200,000 per year to keep a police patrol vehicle on the streets of a typical city. This figure includes the depreciation on the car, maintenance and salary, the latter accounting for a significant percentage of the total. Let us assume that the figure for a particular city is $150,000. If there are 100 cars and if the number of cars is reduced by 7% after employing an AVM system, the savings would be $1,050,000, if the number of cars remain constant, the city would realize 1 million dollars worth of additional coverage.

The actual benefits which accrue in any real system are, of course, a function of the accuracy of the system. However, accuracy is a rather subjective parameter. Almost any accuracy improvement would be an improvement over the present system most dispatchers use to determine the location of vehicles under their control. In 1972, we discussed system accuracy with Texas police officials. At that time, a number of officials concluded that an accuracy of 1000 feet was satisfactory for most police applications. Recent statements and actions by some of the same officials suggest that significantly greater accuracies will be demanded by police agencies. The Associated Public Safety Communications Officers (APCO) recently estimated that a location accuracy of 100 feet should be provided for law enforcement applications. A number of recent requests for proposals by large municipal police departments have requested accuracies as small as 50 ft. The justification given for this figure is that such accuracy is needed to identify the direction of travel of a vehicle on a limited access highway.

CURRENT AVM TECHNOLOGY

AVM systems can be broken down into three general classes: radio location systems, dead reckoning systems and proximity techniques. Early activity in AVM system development seemed to center on the use of radio location methods for AVM systems. As the result of some rather disappointing experiments conducted by the U.S. Department of Transportation, interest in these radio location techniques seems to have wained in recent years. Current interest in AVM centers on three basic types of systems. They are in no particular order: direct proximity systems using either sign post magnets or low-cost transmitters, Loran C with a local power transmitting station supplementing the existing Loran network or dead reckoning with correction of cumulative errors through the use of a computer stored street map. Experiments and evaluations of these three approaches at the present time are highly encouraging. In fact, a number of major municipal police departments are currently in the process of acquiring one or the other of these systems.

SYSTEMS COSTS

There have been in recent months a host of published reports on projected AVM system costs. Unfortunately, it is difficult to compare costs between systems because the cost is an important function of accuracy and in the systems currently being proposed are a considerable amount of research and development expense. Instead, it makes more sense to talk about the cost per vehicle that manufacturers and proponents of various approaches are trying to achieve. It appears that upper limits in the vicinity of $1,500 - $3,000 per vehicle seem appropriate for most AVM systems under study. We estimate that additional costs for interface and display type technologies will add an additional $50,000 to the cost of a system. This means that using the upper cost figure for a city with 25 vehicles to be instrumented, the net system cost would be in the vicinity of $125,000. In general, as the number of AVM system users increase, one can expect the cost of such systems to decrease.

MOBILE DATA TERMINALS

The final technological approach we wish to discuss is the use of mobile digital terminals. Basically, these terminals are devices which allow a patrol vehicle to exchange information with the dispatch center without using the voice channel in much the same way that two computers transfer information between them. The benefits claimed for such systems include factors such as:

- reduced channel congestion
- faster response by patrol vehicles
- faster and easier access to criminal data banks
- improved command and control
- improved records handling
- improved operational analysis
- increased privacy

To understand best how these benefits accrue, we wish to discuss briefly each of the basic types of mobile terminals and look at how they might be integrated into a command and control system.

There are basically four types of such systems available to us today. These are: status systems, small display systems, large display systems, mobile printers. In the status systems, a small control head would be placed near the radio in each vehicle. On the head would be a half dozen or so keys. By depressing a key, the officer would be able to indicate his current status. Keys would include things such as in-service, out-of-service, in route, emergency, etc. This information would be relayed back automatically by the digital terminal. At the control center, there are a variety of ways this information could be handled. There might be a single entry display for each unit with an alpha-numeric number indicating the status of the vehicle. The cost for this type of display is low, typically in the $300 - $500 range, independent of fleet size. The second approach is to use a multiple entry display. That is some type of display device which presents the status of all vehicles directly on one screen at one time. Normally, this would be located on a map board or in some central portion of the dispatch area. In a sense, the multiple display takes the place of the usual paper log that dispatchers use to keep track of vehicles. The cost of such a display will be in the $5000 - $10,000 range.

For a small incremental cost, one can go from a status only system to a status system with a small display. Such a system would again have a small control head located in the vicinity of the current control head. It would include half a dozen status keys plus the ability to key in a two or three digit number and receive in turn a two or three digit number from the dispatch center. Such an increase greatly increases the flexibility available to the dispatch center since a unit can now automatically transmit up to 1000 different canned status messages. Some of the messages in the canned sequence might include the usual ten code as well as status keys used to transmit well defined changes in activity. The display procedure for this type system would be similar to that for the status only system. We estimate the per vehicle cost for each unit to be in the $600 - $1000 range.

The large display terminals amount to giving the officer in the field direct access to the police computer network. It also provides the capability for the officer to enter directly in the field information concerning reports and to fill out reports from his unit. Such a system alleviates the need for the officer to go through the dispatch center to obtain criminal case history files, license checks, and so forth. It also has a potential for reducing the administrative duties of the officer by gathering information at the time of its occurrence. Such a system can also be interfaced to the automated dispatch facility. A dispatch, for example, might then be addressed directly to the terminal by the dispatch computer in the dispatch center. The dispatcher then merely monitors the messages sent and, in certain instances where human judgement is necessary, may override those messages. The system has the ability to also collect data about events and manually update the time history of each officer's activity. Large display terminals are considerably more expensive than those discussed earlier. Current prices are in the $3700 per vehicle range. Backup software to support this system is in the $100,000 range making a complete system to support 25 vehicles cost in the vicinity of $200,000. To fully utilize such a terminal, the city must already have experience with high speed access to data. It is not necessary, however, that an automated dispatch facility or an AVM system be available. If such a system is not available, it could be incorporated into the system design for the mobile digital terminal system for a reasonable increase in the base cost since some of the computing functions could be shared between the dispatch system and the mobile digital terminals. In fact, we recommend that when designing or specifying an integrated dispatch facility that provisions be made for integration of mobile terminals into the facility at a later date.

CONCLUSION

In this paper, we have presented the major alternatives available to police agencies considering the development of an automated command and control facility. We believe that each department should look at these technologies together as a package and develop long term plans for the step by step implementation of these systems as opposed to acquiring these systems on a piecemeal basis.

REFERENCES

[1] Proceedings of a Conference on Automatic Vehicle Monitoring, Stephen Riter, Center for Urban Programs, Texas A&M University, College Station, Texas 77843.

WHAT CAN LAW ENFORCEMENT GAIN FROM COMPUTER DESIGNED WORK SCHEDULES?[1]

by

Nelson B. Heller, Ph.D.
Nelson B. Heller & Associates
St. Louis, Missouri 6314

INTRODUCTION

The preparation of this paper was supported by Contract Number 4-0709-J-LEAA awarded by the Law Enforcement Assistance Administration, U. S. Department of Justice, under the Omnibus Crime Control and Safe Streets Act of 1968, as amended. Points of view or opinions stated in this document are those of the author, and do not necessarily represent the official position or policies of the U. S. Department of Justice.

HOW IMPORTANT IS THE SCHEDULING AND ALLOCATION OF POLICE MANPOWER?

The National Commission on Criminal Justice Standards and Goals, in its recent Task Force report on the police, has recently stated,[2]

> "Every police agency should implement an allocation system for the geographical and chronological proportionate need distribution of patrol personnel. The allocation system should.... minimize response time to calls for services, and equalize patrol personnel workload. This system should provide for the allocation of personnel to: ... shifts ... (and) days of the week."

> "Every police agency should establish procedures for the implementation, operation, and periodic evaluation and revision of the agency's deployment system."

The same concern for improved scheduling and allocation of police manpower is voiced in "Improving Police Productivity, More For Your Law Enforcement Dollar," the report of the National Commission on Productivity.[3] In its list of "Key Questions" to be posed by law enforcement executives regarding their agencies, the Commission has included,

> "In response to demands for more police protection, do you simply add more patrolmen to the force or do you try to increase police capability?"

> "What hours of the day are calls for service heaviest? Is that when most of your policemen are on duty?"

It is pointed out in the report that to put one officer on the street 24 hours a day it is necessary to add five to the force to cover the three shifts, weekends, holidays, vacations and sick days. They estimate an expenditure of as much as $80,000 to add one manned post to the available street force.

State legislatures, city councils and police associations also are increasingly concerned with the costs and terms of scheduling and allocation procedures. Many contracts for police service go as far as to include specific restrictions relating to watch (or shift) rotations, watch change hours, and patterns of days off for the officers.

This paper describes a computerized police work schedule design system now available to law enforcement and criminal justice agencies. The computerized system it describes is designed to take much of the work out of schedule design, and to permit schedules to be tailored to the work distributions and specific technical constraints relating to the user agency. A few schedules designed with this system are already in use in police departments in different parts of the country. If, you feel that your department might benefit from further consideration of the computerized scheduling system, you will find instructions for securing further information in the final section of the paper.

WHY IS IT SO DIFFICULT TO DESIGN GOOD POLICE WORK SCHEDULES BY HAND?

Police planners and administrators who have designed work schedules manually have often learned first hand that scheduling can be one of the most complicated, frustrating and time consuming of their planning responsibilities. Why is this so?

SCHEDULES INVOLVE MUCH DETAIL

A work schedule must specify the on-duty and off-duty days and hours for every officer in the scheduled unit. Different units, performing different functions, require their own unique, individualized schedules. Even a fairly small department may have three to six units each operating on a different schedule.

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[2] Standard 8.3, Deployment of Patrol Officers.

[3] See also "Opportunities for Improving Productivity in Police Services" National Commission on Productivity, 2000 M Street, N.W., Washington, D. C., 20508

LARGE NUMBER OF FEATURES TO BE CONSIDERED

A complicated array of consideration is used to judge the acceptability of any work schedule. These may include statutory constraints on features such as paid holidays, number of days worked per year, and hours worked per week. Management-labor negotiations may add further constraints relating to seniority, watch rotation, and off-duty periods. There are also important resource allocation considerations, relating to the achievement of a distribution of manpower over time and space which is proportional to the demand for service. And there are features which may affect morale, such as the number and spacing of weekends off, and the largest number of days in a row an officer must work without getting a day off.

NO PRACTICAL, COMPREHENSIVE MANUAL DESIGN PROCEDURES

No currently available manual schedule design procedure permits control of all the features of interest. Schedules have therefore been designed on the basis of a small number of important features - - using, most often, repeated trial and error procedures until an acceptable compromise is discovered. This can be extremely time-consuming, and the schedule designer has no guarantee that his efforts will lead to a successful schedule.

WHY WAS A COMPUTERIZED WORK SCHEDULING SYSTEM DEVELOPED?

These problems, confronted every year by virtually every law enforcement agency in the country, have motivated the development of a computerized work scheduling system which automatically:

- determines appropriate manning levels for each day and watch,
- constructs suitable sequences of watch assignments, and of days worked and days off for each officer,
- facilitates solution of common problems of schedule administration,
- substantially decreases the time required to design schedules,
- tailors schedules to fit design constraints set by the user's needs,
- produces a set of equally acceptable schedules from which the final selection may be made by the unit commander on the basis of additional, nonquantifiable considerations, and,
- designs schedules which are virtually identical for all officers in the unit, a feature which greatly reduces the likelihood of the lowered officer morale which sometimes results when schedules are not equally desirable.

The computerized scheduling system, only recently developed, has been used to design work schedules for police units in two cities in Missouri and one in Oklahoma. A questionnaire survey of officers in one unit which has employed the new type schedules for more than three years indicates that the great majority of the officers approve the schedules, both overall and with respect to their major attributes.

WHAT TYPES OF SCHEDULES MAY BE DESIGNED?

Most of the major types of work schedules currently used by law enforcement agencies may be designed with the computerized scheduling system. Included are:

- schedules in which all officers are permanently assigned to specified watches (i.e., hours of the day),
- schedules in which all officers periodically rotate watches after specified periods of time,
- individualized schedules in which no two officers have identical on-duty assignments over a complete schedule rotation period,
- group schedules, in which officers work in teams of prespecified numbers, each officer having the same schedule as the others in his team,
- schedules involving overlay watches, in which some officers report for work part way through one watch and work through to the corresponding point on the next watch; some of these schedules provide for overlay watches only some days of the week; and,
- multi-component schedules based on two or more schedules of the same, or different, types (e.g., a schedule in which one group of officers rotates through the day and afternoon watches only, while a second group rotates through the afternoon and night watches only).

WHAT FEATURES OF THE SCHEDULE MAY BE CONTROLLED BY THE SCHEDULE DESIGNER?

When a schedule is to be designed with the computerized scheduling system, the schedule designer meets with the commander of the unit for which the schedule is being designed, after first consulting any appropriate personnel regulations, to determine the requirements which the schedule must satisfy. A partial list of features of the schedule which may be tailored to the needs of the unit follows.

DISTRIBUTION OF MANPOWER IN PROPORTION TO THE DEMAND FOR SERVICE

The level of on-duty manpower each watch and day of the week may be made proportional to the average demand for service, providing increased manning for the busier periods and decreased manning for the less busy periods. This feature can be very beneficial for departments whose demand for service regularly peaks on certain days of the week, and during certain hours of the day. Compared to a schedule with equal manning at all times, the proportional schedule prevents an excess of manpower from being scheduled for the quieter periods of the week, and regularly supplies additional manpower to the busy periods. In doing so, the proportional schedule equalizes the workload per man over the watches, and provides a decreased sensitivity to absences (Particularly on the busy watches). In departments employing equally manned watches, these benefits can only be achieved by hiring additional manpower.

PERIODS OF DAYS OFF

The designer may specify the lengths of the longest and shortest acceptable periods of consecutive days off, called "recreation periods" in some departments. For example, it may be required that a recreation period be at least two days and no more than four days in length. In addition, the designer may indicate any number of paid holidays, or days of compensatory time off for overtime earned, to be scheduled automatically as additional "recreation days."

Recreation periods including a weekend (i.e., Saturday and Sunday) are considered especially desirable by most police officers, both because of the normal concentration of social events on weekends and because of the frequently heavy police workload on Saturdays. Consequently, the design programs include procedures for assuring a maximum number of weekends off, and for spacing them as uniformly as possible over the rotation period. Also, the programs favor schedules with longer weekend recreation periods over those with shorter ones.

PERIODS OF ON-DUTY DAYS

The schedule designer may specify the lengths of the longest and shortest acceptable periods of consecutive days on duty, called "work periods." Automatic control of the length of the longest work period in this manner is an extremely useful feature. In one department in which officers, using a manually designed schedule, occasionally worked 11 to 13 days in a row, the computerized schedule design system was able to reduce the longest work period to eight days.

In addition, the design programs favor schedules:

with work periods of fairly uniform lengths,

in which the longer work periods are separated by shorter work periods, and,

in which the longer work periods are followed by the longer recreation periods, and the shorter work periods by the shorter recreation periods.

WATCH CHANGE CONDITIONS

In a conventional three-watch schedule in which officers periodically rotate watch assignments, for an officer who is scheduled to work both the day preceding and the day of assignment to a new watch, the number of off-duty hours between consecutive on-duty assignments may be as few as zero or as many as 32, depending on the watch rotation sequence. Both situations are considered undesirable in many departments, since the first allows no rest between assignments, while the second amounts to a one-day recreation period. Therefore, the computerized design procedure is automatically restricted to schedules in which officers are on recreation either the day before or the day of the watch change, or both. In short, every watch change is "covered" by a recreation period, leading to off-duty periods of acceptable length at the watch change point; the range of acceptable lengths for these periods may be separately specified by the schedule designer. Incidentally, this procedure makes possible the automatic scheduling of occasional "mini-vacations," recreation periods of exceptional length (e.g., six to eight days).

NUMBERS OF ON-DUTY OFFICERS

When the design programs are used to develop schedules whose manpower levels are proportional to the demand for service, individual upper and lower limits may be specified for the number of on-duty officers each watch each day of the week. Thus, for example, if a particular unit requires a minimum of three officers to function effectively, the program may be set to schedule at least three officers for all watches, including those for which a low demand for service might indicate a need for fewer than three officers. Similarly, if equipment limitations make the scheduling of more than six officers for any watch undesirable, the program may be set to schedule no more than this number of officers for any watch. In computing the best allocation of manpower to the watches, the computer programs indicate which watches have allocations restricted by one or the other of these limits. This information may be used to determine which watches ought to be manned, if continuous service is not required.

LENGTHS OF ASSIGNMENT TO EACH WATCH

When designing a rotating schedule, the schedule designer may control the number of weeks of consecutive assignment to any watch. This permits him to avoid periods which are too short to allow the officers time to adjust to their new working hours, and periods which are too long to allow officers some time on each watch during each season.

HOW CAN A ROTATING SCHEDULE PRODUCE MANNING LEVELS EACH WATCH WHICH ARE PROPORTIONAL TO THE WORKLOAD?

It is not difficult to demonstrate that a rotating schedule can be constructed with virtually any distribution of manpower over any number of watches. The procedures for accomplishing this useful objective are incorporated in the schedule design programs. Basically, it is achieved by dividing the work force into an appropriate number of equal sized groups, causing the time spent by each group on any watch to be proportional to the corresponding workload, and properly phasing the rotation of the groups. This will be illustrated for a simple three-watch schedule in which two-ninths of the workload occurs on the night watch (11 p.m. to 7 a.m.), three-ninths on the day watch (7 a.m. to 3 p.m.), and four-ninths on the afternoon watch (3 p.m. to 11 p.m.), a distribution of work quite close to that for police departments in many cities.

Since the workload can be divided conveniently into ninths, the officers in the unit to be scheduled are divided into nine equal or approximately equal groups, numbered from one to nine. During the first week of operation under the new schedule, these groups can be assigned to the three watches as follows,

Group: 1 2 3 4 5 6 7 8 9
Watch: N N A A A A D D D

where N, A, and D stand for nights, afternoons, and days. This assignment generates the desired distribution of manpower, with two-ninths of the officers on the night watch, three-ninths on the day watch, and four-ninths on the afternoon watch. During the second week the groups are reassigned by shifting the group numbers one position to the right in the list, and rotating the final number around to the beginning of the list:

Group: 9 1 2 3 4 5 6 7 8
Watch: N N A A A A D D D

In this manner the distribution of the manpower over the watches has been maintained as desired. Notice that only groups 2, 6, and 9 actually changed watches; the other groups carried on with the previously assigned watch. The assignment for the third and successive weeks are made by successively shifting the group numbers one position to the right and rotating the final number around to the beginning of the list. For example, the assignments for the fourth week are,

Group: 7 8 9 1 2 3 4 5 6
Watch: N N A A A A D D D

At the end of nine weeks each group has rotated once through all the watches, having spent two weeks on the night watch, three weeks on the day watch, and four weeks on the afternoon watch.

The schedule constructed above is not the only one which generates the desired distribution of manpower over the watches. For example, if for some reason an assignment of four consecutive weeks to the afternoon watch is considered too long, the schedule might be rearranged into two full rotations through the watches, as follows,

Group: 1 2 3 4 5 6 7 8 9
Watch: N A A D N A A D D

In this case officers rotate through the three watches once in four weeks and then a second time in another five weeks.

It is also possible to utilize this procedure to develop a proportional schedule in which some groups of officers are permanently assigned to some watches while others rotate. For example, suppose group 8 consists of "limited duty" officers permanently assigned to the day watch, and group 9 consists of officers who attend college in the morning and are permanently assigned to the afternoon watch. The schedule might be,

Group:	1 2 3 4 5 6 7	8 9
	Rotating Schedule	Permanent
Watch:	N N A A A D D	D A

Here groups 1 through 7 work a rotating schedule involving two weeks on nights, three weeks on afternoons, and two weeks on days, while groups 8 and 9 are permanently assigned as indicated.

These examples illustrate how rotating schedules may be designed to distribute manpower over the watches in proportion to the workload. The computerized design programs embody an advanced form of this procedure which allows them to design schedules whose manning levels each watch also vary by day of the week in proportion to the workload each day. An example of this type of schedule is presented in the following section.

WHAT DOES A COMPUTER DESIGNED WORK SCHEDULE LOOK LIKE?

To illustrate the features of a computer designed work schedule, a schedule designed for a 14-man traffic safety unit operating only on the day and afternoon watches is shown below. Information on the distribution of accidents reported to the unit, by day and watch, and on the number of men in the unit, was used by the scheduler as input to the first of the three computer design programs. The resulting output indicated the following distribution of on- and off-duty manpower by day of the week and watch:

Watch	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Day (7 a.m.-3 p.m.)							
On-duty	5	5	5	5	6	5	4
Off-duty	2	2	2	2	1	2	3
Afternoon (3 p.m.-11 p.m.)							
On-duty	5	5	5	5	6	5	4
Off-duty	2	2	2	2	1	2	3

Seven men were to be assigned to each watch, with five of them on duty five days of the week. Friday's heavier workload required six men, while Sunday's lighter workload required only four men. The scheduler was then asked to design a rotating schedule, fitting the manpower distribution, and in which officers were to spend three to four consecutive weeks on each watch before rotating to the next watch. Using the two remaining design programs, the scheduler produced the basic rotation and recreation schedule shown in Figure 1.

The rotation period for this schedule is 14 weeks. Each of the officers in the unit is assigned a number from one to 14. During the first week of operation of the schedule each officer works the assignment for the week bearing his number (shown at the left of the chart). For example, man 6 is assigned to the day watch and is on-duty on Monday, on recreation on Tuesday and Wednesday, and then on-duty from Thursday through Sunday. For the second week of operation each officer is advanced to the next numbered week in the schedule, with man 14 rotating back to week 1. Continuing the example for man 6: he advances to week 7, where his assignment is to work the day watch Monday through Wednesday and to be on recreation Thursday through Sunday.

A careful examination of the schedule will reveal that its work periods vary in length from six to eight days, and its recreation periods from two to four days, with the exception of one longer seven-day recreation period which begins on Thursday of week seven and runs through Wednesday of week eight. This "mini-vacation," occurring once every 14 weeks, was designed into the schedule at the request of the unit commander.

After 14 weeks each officer has rotated once completely through every week of the schedule and returned to his initial week. Since all officers share the same basic rotation and recreation schedule, their individual schedules are identical, with the exception that they lag or lead each other by some number of weeks.

Many other useful features have been designed into the schedule by the computer design programs:

> the proper distribution of on-duty and off-duty manpower by day and watch has been achieved,
>
> officers have been scheduled for three or four weeks on each watch before rotation,
>
> four weekend recreation periods, the maximum number possible, are included in the schedule, with no more than three working weekends separating any pair of weekends off,
>
> every watch change has been covered with a recreation period, completely eliminating off-duty periods of unacceptable length between watches, and,
>
> the maximum length work period, constrained to no more than nine days by the schedule designer, was found to be eight days long; this was, incidentally, two days shorter than that for the manually designed schedule which had been proposed for the unit.

WHAT ARE THE PREREQUISITES FOR COMPUTERIZED SCHEDULING?

If your police department is considering use of the computerized scheduling system, you probably have many questions about the types of information needed as input, the equipment and training required to run the programs, and the related costs. Some likely questions, and their answers, follow.

WHAT TYPE OF WORKLOAD INFORMATION IS REQUIRED?

Ideally, information regarding the average workload for each watch each day of the week should be available. The workload may be measured by the number of calls for police service, the number of crimes reported, or the number of hours spent servicing calls. If no such figures are available:

> they may be estimated by sampling crime or called-for-service records, or,
>
> a "judgment" estimate may be made, based on knowledge of which watches in the week are usually busy and which are usually quiet.

WHAT OTHER INPUT INFORMATION IS REQUIRED?

The following additional information will be needed:

> the watches during the week when officers will be on duty, and their hours,
>
> the number of paid holidays per year received by each officer,
>
> the number of officers in the unit being scheduled,
>
> any special limitations on the number of officers who may be on duty on any watch during the week,
>
> restrictions relating to the lengths of acceptable work and recreation periods,
>
> the number of weeks officers are to be assigned to each watch before rotation (if a rotating schedule is being designed),
>
> the number of weekends in a row an officer may work between weekends off, and,
>
> information on the officers' preferences for different types of recreation periods of varying lengths and including different days of the week.

WHAT TYPE OF COMPUTER EQUIPMENT IS NEEDED?

The computerized scheduling system consists of three computer programs written in FORTRAN IV. They were developed and tested on an IBM 360/65 computer using a FORTRAN G compiler. The load module for the largest of the three programs requires less than 75k of core storage. A run of all three programs requires from six to twelve minutes of CPU time, depending on the complexity of the scheduling problem.

If a police department does not own a computer of this type, considering the infrequent use which would be made of the computerized scheduling programs,

> the programs might be run at a local university, or by renting computer time from a commercial source, or,

the design of schedules might be centralized, for a state or metropolitan area, at a criminal justice facility which owns the appropriate equipment.

WHAT TRAINING AND SKILLS ARE REQUIRED TO RUN THE SCHEDULE DESIGN PROGRAMS?

Most departments will find it convenient to designate one individual, either commissioned or civilian, as coordinator for the design and use of computer designed schedules. In a small department this will be a part-time job, but larger departments may require one or more full-time positions for this work.

The scheduler will have to familiarize himself with the operation of the computerized scheduling system, including preparation of the input data cards, and interpretation of the computer printouts. All of this material is covered in detail in a two volume document entitled, "Computerized Scheduling of Police Manpower." Included is a User's Manual covering procedures for use of each of the three schedule design programs, and containing both input and output for sample schedule design problems. Ideally, the scheduler would attend a brief schedule design workshop to learn and practice the use of the design programs. If this is not possible, self-study and practice with the sample problems will probably suffice. In either case, some familiarity with the use of computer program packages and with work scheduling will be most beneficial.

The scheduler should also be prepared to assist his user units in the solution of problems related to, but not encompassed by, the design of watch rotation and recreation schedules. Such problems include,

- design of vacation schedules,
- design of schedules for supervisory staff when these cannot be identical to those for supervised personnel,
- geographic deployment,
- design of schedules for in-service training,
- determination of the number of officers to assign to a given function or unit, and,
- development of an information dissemination program to inform and involve command personnel, and later to communicate the benefits of computer designed schedules to units slated to begin using them.

The scheduler will continue to serve as a resource to unit commanders once their units have adopted computer designed schedules. In this regard he will provide technical assistance relating to,

- scheduling compensatory days off for overtime earned by individual officers,
- modification of on-going schedules to accommodate changes in the number of officers in a unit, or in department regulations (e.g., relating to the number of paid holidays per year), and,
- determination of appropriate intervals for the regular redesign of schedules.

HOW MUCH WILL IT COST TO SWITCH TO COMPUTER DESIGNED SCHEDULES?

The cost of implementing the computerized scheduling system in a police department currently using manually designed schedules is minimal. The major cost items are:

Computer programs and reports

The computer programs are available to qualified criminal justice agencies free of charge from the Law Enforcement Assistance Administration. There is a small charge for copying them onto a magnetic tape supplied by the user, and for purchase of a tape if none is submitted by the user. The related reports are also available free of charge. A small charge is made for postage and handling.

Scheduler

The position of scheduler should be created, if none already exists. The scheduler may be an individual who was formerly responsible for manual schedule design. With the assistance of the computer programs, the number of manhours required to design a schedule should decrease considerably. This may be offset slightly if the department choses to employ a more sophisticated type of schedule than previously used, relying on the expanded schedule design capability offered by the programs. In addition, the department may incur some one-time costs in connection with training the scheduler to use the computerized system.

Computer costs

The computer costs for schedule design, which are quite low, will vary with the number of schedules designed annually, and their complexity. Experience with the schedule design programs indicates that about six to twelve minutes of computer time are required for each schedule. This time depends on the type of computer used, and the feasibility of the design constraints imposed on the schedule. If the constraints are too severe they may preclude the design of an acceptable schedule (i.e., none may exist). In such cases, this fact is indicated by the programs, and they may be rerun with a more relaxed set of constraints.

HOW CAN MORE INFORMATION ON COMPUTERIZED SCHEDULING BE OBTAINED?

Computerized schedule design should be of interest for many types of law enforcement operations. The characteristics of activities for which it can be particularly beneficial include any of the following:

- a non-uniform demand for service over the periods of the week when service is offered,
- services being offered more than five days per week,
- services being performed more than one watch per day, or,
- situations in which work schedules are renegotiated periodically in connection with labor contracts.

These characteristics are also found in many criminal justice operations outside the realm of law enforcement. Some examples are guard services at custodial institutions, warrant office operations involving extended hours or more than five days per week, and support services for automated or manual records and information systems.

Additional information on the computerized schedule design system described in this paper is available to criminal justice agencies by writing to the National Institute for Law Enforcement and Criminal Justice, Law Enforcement Assistance Administration, Washington, D.C., 20530. Mention the title of this paper, and that of the LEAA project which it summarizes: "Computerized Scheduling of Police Manpower (NI72-018G)."

RANK NO = 2 SOLUTION NO = 9

	MON	TUE	WED	THU	FRI	SAT	SUN
1	R	R	*	*	*	*	*
2	*	*	R	R	*	*	*
3	*	*	*	*	*	*	R
			AFT A / DAY B				
4	*	*	*	*	*	*	R
5	R	*	*	*	*	*	*
6	*	R	R	*	*	*	*
7	*	*	*	R	R	R	R
			DAY B / AFT B				
8	R	R	R	*	*	*	*
9	*	*	*	R	R	*	*
10	*	*	*	*	*	R	R
11	*	*	*	*	*	*	R
			AFT B / DAY A				
12	R	R	*	*	*	*	*
13	*	*	R	R	*	*	*
14	*	*	*	*	*	R	R
			DAY A / AFT A				

RANK MEASURE = 4030802 01002000101 21503 + 0.91

Figure 1

NUMBER OF WEEKEND RECREATION PERIODS = 4

MAXIMUM NUMBER OF CONSECUTIVE WORKING WEEKENDS = 3

MAXIMUM LENGTH WORK PERIOD = 8

NUMBER OF MAXIMUM LENGTH WORK PERIODS = 2

RECREATION PERIOD COMPOSITION

RANK	LENGTH/START	NUMBER
1	4 / FRI	0
2	4 / THU	0
3	4 / SAT	1
4	3 / FRI	0
5	3 / SAT	0
6	2 / SAT	2
7	4 / WED	0
8	3 / THU	0
9	4 / SUN	0
10	3 / SUN	1
11	2 / FRI	0
12	2 / SUN	1

WORK PERIOD RANGE = 2

MAXIMUM - TWO CONSECUTIVE WORK PERIODS = 15

NUMBER OF MAXIMUM - TWO CONSECUTIVE WORK PERIODS = 3

STANDARD DEVIATION - WORK/REC RATIOS = 0.91

WORK PERIOD LENGTHS	7	8	6	7	7	7	7	6	7	8
REC PERIOD LENGTHS	2	2	2	2	7	2	2	3	2	4

Figure 1 (cont)

EVALUATION OF TECHNOLOGICAL INNOVATIONS IN POLICE COMMAND AND CONTROL SYSTEMS

by

Stephen Riter
and
Jan McCoy
Electrical Engineering Department
Texas A&M University
College Station, Texas 77843

INTRODUCTION

Criminal justice planners are plagued with the problem of deciding which of many new technological innovations they should spend their limited financial resources on and in what order these expenditures should be made. Inherent in these questions is the problem of determining if the costs of various innovations justify the net benefits or if other, perhaps non-technological, approaches might yield greater benefits. The problem is complicated by the fact that the avilable information is limited to studies sponsored by LEAA, articles in semi-professional magazines, and material prepared by vendors. Unfortunately, the latter is in many cases the prime source of information.

What information there is, is limited to the apparent first order costs and benefits of a particular innovation. For example, figures on storage capacity, speed, and other technical parameters are readily available from vendors of automated dispatch systems. Such figures would enable an engineer to compare how one vendor's system might compare with another but it would not allow the police administrator to determine the effect of the system on such important first order parameters as:

Apprehension rate
Rate of index time
Response time

Furthermore, the application of technology to new sectors of society inevitably produces side effects on seemingly unrelated factors. In law enforcement it is clear that any new technological innovation might effect such factors as:

Morale
Organization
Training

and effect and be affected by such seemingly unrelated parameters as:

Political climate
Interdepartmental relations
Public media

Some departments have applied technological innovations without considering such factors. In some cases the innovations have not met expectations and in others the new systems have been abandoned as failures because of non-technological factors.

While it is easy to say that planners should evaluate all the effects of technological alternatives before committing resources to a new program, evaluations of this sort are not straightforward. In recent years, there have been a number of attempts to systematize such evaluations. These systematizations have generally been called "technology assessments", although their form and means of application vary from situation to situation. These methods have in common an attempt to integrate the educated opinion of experts in the field as to the probable influence of one factor on another.

PROCEDURE

To develop criteria for police command and control systems, a limited technology assessment was conducted at the Workshop on Police Command and Control Systems.

The innovations were broken into seven specific categories. They were:

1. High-speed access; i.e. the use of digital terminals and high-speed communications equipment to access local, regional, state, and national criminal information files.

2. Automated dispatch systems; i.e. the use of a computer to assist in the dispatch operation.

3. Mobile terminals-limited; i.e. the use of in car terminals with a finite number of status keys plus some type of stored message selection technique.

4. Mobile terminals-full; i.e. the use of in car terminals with full keyboards and cathode ray tube displays enabling the officer to directly access computerized information files.

5. Automatic vehicle monitoring; i.e. the use of electrical or electromechanical sensors to locate the position of police vehicles operating on the streets of a city.

6. Operations analysis; i.e. the formation of an analysis section or team within a department to collect management and other type of resource information and apply well known analytical techniques to this information.

7. Universal emergency telephone number; i.e. the establishment of a single universal emergency number, 911, for a city.

Following the presentation of the material of the first three papers, a questionaire was distributed to each participant. The participants were asked to rate on a scale of 1 - 7 the importance of the techniques discussed to their city. A sample questionnaire is shown as Table 1.

Questionnaire for

Police Command and Control Systems Workshop

November 1, 1974

Name:

City:

Position:

I

In order to assess the relative priorities to be assigned to the operational techniques discussed, would you rank according to importance in your city those listed below. Cost should not be a factor in your ranking.

High-speed access to information	1	2	3	4	5	6	7
Automated dispatch systems	1	2	3	4	5	6	7
Mobile terminals - limited	1	2	3	4	5	6	7
Mobile terminals - full keyboard	1	2	3	4	5	6	7
Automatic vehicle monitoring	1	2	3	4	5	6	7
Operations analysis section	1	2	3	4	5	6	7
Universal emergency telephone number	1	2	3	4	5	6	7

<u>Table 1</u>

The following morning, each participant took part in three assessment exercises. The objective of the exercises was to determine the impact of the technological innovations on police effectiveness, police operations, and police relations with other segments of the city and community. At the end of each session, each group member completed an evaluation form in which he formally evaluated the impact of each innovation on the following factors:

1. Crime prevention
2. Response time
3. Apprehension
4. Rate of index crime
5. Reaction of local citizens groups
6. Relations with press and media
7. Relations with other city departments
8. Acceptance by city administration
9. Local political climate
10. Organizational structure
11. Officer's morale
12. Manpower requirements
13. Training requirements
14. Officer safety

Sample questionaires are shown in Tables 2, 3, 4.

In the previous exercises, the participants were told that cost was not to be considered in their decisions. Upon completion of the previously mentioned steps, the group as a whole was asked to select the one alternative, cost now being taken into consideration, which they would implement next in their city. The form used to do this is shown as Table 5.

RESULTS

The results of the first day's questionnaire are shown in Fig. 1. They show a relative ranking of the techniques as follows:

(1) High-speed access
(2) Operations analysis
(3) Automated dispatch
(4) Automatic vehicle monitoring
(5) Universal emergency telephone number
(6) Mobile terminals - limited
(7) Mobile terminals - full

It was clear from the responses that high-speed access to data was, in the minds of the participants, clearly the most important and effective innovation. Operations analysis and automated dispatch were strong second choices although some departments considered the value of these techniques to be negligible. There was some interest in AVM and little or no interest in 911, mobile terminals - limited, and mobile terminals - full.

The assessment exercises were conducted by Dr. Roger W. Elliot, Dr. William B. Jones, Jr. and Dr. Stephen Riter. Results of the assessment forms filled out by the participants are shown in Fig. 2. The following is a summary of impressions gained from the participants during the course of the discussions and the results of the questionnaires filled out during the exercises.

High-Speed Access

It was generally agreed that high-speed access to computerized files would be valuable, effective and well-received in most departments. The participants felt that officer morale and safety would be greatly increased by the implementation of this feature on a statewide basis. It was also felt that these systems would have a very strong positive affect on apprehension rates. It was pointed out that organizations which currently have high-speed access experienced order of magnitude increases in the use of the data while the percentage of "hits" remained about constant. This implies, of course, that the number of apprehensions also increased by orders of magnitude. It appears that such a high use of data has an indirect positive effect on the prevention of crime. From the discussions, it was learned that as high-speed access becomes available to more and more departments in the state of Texas, there is a possibility that the current information system will saturate because of high demand. It was recommended that steps be taken to plan for the future increased usage of these systems. The cost of operating and sustaining a local system seems to be the biggest problem in selling the package but by stressing the improved performance without an increase in personnel, most evaluators felt that high-speed access would be accepted.

Automated Dispatch

The evaluators agreed that automated dispatch would decrease response time and increase apprehension rate, but most importantly, would improve record keeping. Some felt that the cost of manually collecting information and later keypunching it into computer compatible files would in itself justify the cost of an automated dispatch system. In departments where the data is recorded and never used, it appears that such a system would provide information of an operational nature not currently available. The evaluators agreed that the real benefit of such an automated dispatch system would be then its ability to capture management data. There is a feeling that automated dispatch would be more effective if combined with AVM and a status monitoring system. However, the current costs of such an integrated system might make it prohibitive.

Mobile Terminals

It appears unlikely that mobile terminals of any sort will be innovations which in the short run will be utilized by police departments in Texas. The main advantage of mobile terminals over present voice communication systems is the increased speed with which routine information can be exchanged. A subsequent increase in apprehension rate might be expected. The evaluators felt that digital terminals would have a negative effect on the relationship between the police department and the press and other media in that citizen interest and support would drop because they could no longer monitor police radio channels. It was generally agreed that when in the future high-speed access systems begin to saturate at the dispatch centers, then departments might move toward the use of full keyboard mobile terminals. Such a move appears more likely in areas which already have a history of regional cooperation between departments in the procurement of equipment and the sharing of data.

Automatic Vehicle Monitoring

There seems to be considerable interest in AVM systems but departments generally feel that the systems are still in an experimental state and not worth their current high costs. It was agreed that such systems could reduce the response time and increase officer safety, however, they might have a negative effect on officer morale. Those in attendance felt that this problem could be overcome by stressing the positive aspects of AVM and emphasizing that the privacy of the officer on duty was not being violated. It appears that even in the future AVM systems will be viable only in certain localities due to such factors as geography and cost.

II What is the impact of the innovations discussed on the factors indicated in your city?

Innovation	Crime Prevention	Response Time	Apprehension	Rate of Index Crime
High Speed Access				
Automated Dispatch				
Mobile terminals - limited				
Mobile terminals - full				
Automatic vehicle mon.				
Operations analysis				
Universal emergency number				

Name:

City:

Position:

++ High positive
+ Moderate positive
0 Little or none
- Moderate negative
-- High negative

Table 2

II What is the impact of the innovations discussed on the factors indicated in your city?

Innovation	Reaction of Local Citizen Groups	Relations with Press and Media	Relations with other City Departments	Acceptance by City Administration	Local Political Climate
High Speed Access					
Automated Dispatch					
Mobile terminals-limited					
Mobile terminals-full					
Automatic vehicle mon.					
Operations analysis					
Universal emergency number					

Name:

City:

Position:

++ High positive
\+ Moderate positive
0 Little or none
\- Moderate negative
-- High negative

Table 3

II What is the impact of the innovations discussed on the factors indicated in your city?

Innovation	Organizational Structure	Officer's Morale	Manpower Requirements	Training Requirements	Officer Safety	Response Time
High Speed Access						
Automated Dispatch						
Mobile terminals-limited						
Mobile terminals-full						
Automatic vehicle mon.						
Operations analysis						
Universal emergency number						

Name:

City:

Position:

++ High positive
\+ Moderate positive
0 Little or none
\- Moderate negative
-- High negative

Table 4

Name:

City:

Position:

III

The previous exercises did not consider cost. Cost will be an important factor in the decision to implement or not implement any new innovation. Furthermore, most departments because of budgetary, political, and operational constraints must implement one new innovation at a time. In your city which of the alternatives below with estimates of their costs is it reasonable to implement first. (If one of the alternatives is available in your city, indicate which one)

Alternatives currently available ____________________

Alternative chosen ____________________

Alternative

A. Regional high-speed information system

Fixed cost	$ 10,000/terminal
Variable cost	$ 2,400/year

B. Automatic Vehicle Monitoring System

Equipment costs $125,000

C. Automated dispatch system

Equipment costs $ 65,000

D. Status monitoring system

Equipment costs $ 50,000

E. Automated dispatch system and status monitoring

Equipment costs $100,000

F. Automated dispatch system and automatic vehicle monitoring

Fixed cost $190,000

G. Mobile terminal - full keyboard

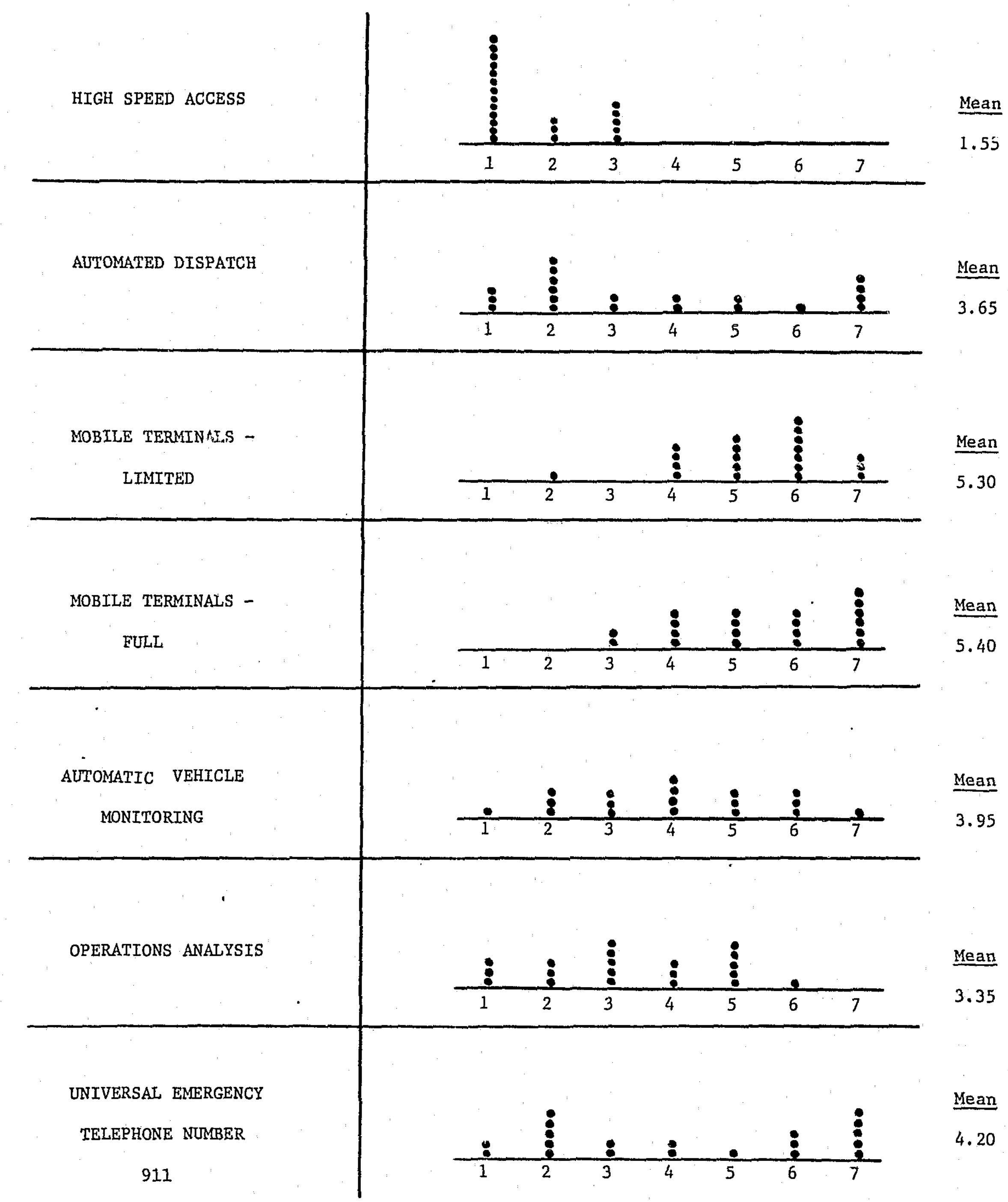
Fixed cost $192,000

H. Operations analysis

Salary & Overhead $ 24,000/year

Table 5

Figure 1



● - One response

	Crime Prevention	Response Time	Apprehension	Rate of Index Crime	Reaction of Local Citizens Groups	Relations with Press and Media	Relations with other City Departments	Acceptance by City Administration	Local Political Climate	Organizational Structure	Officer's Morale	Manpower Requirements	Training Requirements	Officer Safety
HIGH SPEED ACCESS	Mean - 1.05	Mean - 0.63	Mean - 1.68	Mean - 0.84	Mean - 0.95	Mean - 0.74	Mean - .63	Mean - 1.26	Mean - 0.84	Mean - 0.58	Mean - 1.58	Mean - 0.16	Mean - 0.53	Mean - 1.63
AUTOMATED DISPATCH	Mean - 0.79	Mean - 1.32	Mean - 1.21	Mean - 0.74	Mean - 0.63	Mean - 0.42	Mean - .47	Mean - 1.00	Mean - 0.63	Mean - 0.26	Mean - 0.74	Mean - 0.32	Mean - 0.16	Mean - 0.84
MOBILE TERMINALS - LIMITED	Mean - 0.21	Mean - 0.11	Mean - 0.42	Mean - 0.32	Mean - 0.16	Mean - -.32	Mean - .32	Mean - 0.16	Mean - 0.16	Mean - 0.05	Mean - 0.26	Mean - 0.05	Mean - 0.21	Mean - 0.68
MOBILE TERMINALS - FULL	Mean - 0.74	Mean - 0.74	Mean - 1.21	Mean - 0.79	Mean - 0.37	Mean - -.26	Mean - .37	Mean - 0.63	Mean - 0.32	Mean - 0.32	Mean - 0.74	Mean - 0.11	Mean - 0.58	Mean - 0.95
AUTOMATIC VEHICLE MONITORING	Mean - 0.47	Mean - 0.89	Mean - 0.68	Mean - 0.47	Mean - 0.79	Mean - 0.37	Mean - .42	Mean - 0.42	Mean - 0.84	Mean - 0.53	Mean - -.47	Mean - 0.21	Mean - 0.05	Mean - 1.47
OPERATIONS ANALYSIS	Mean - 1.05	Mean - 0.84	Mean - 0.79	Mean - 0.63	Mean - 0.74	Mean - 0.68	Mean - .47	Mean - 1.21	Mean - 0.84	Mean - 0.53	Mean - 0.42	Mean - 0.53	Mean - 0.32	Mean - 0.58
UNIVERSAL EMERGENCY TELEPHONE NUMBER 911	Mean - 0.68	Mean - 0.58	Mean - 0.58	Mean - 0.32	Mean - 1.15	Mean - 0.68	Mean - .84	Mean - 1.05	Mean - 0.95	Mean - 0.05	Mean - 0.32	Mean - 0.0	Mean - 0.16	Mean - 0.21

Figure 2

Operations Analysis

There was a generally positive attitude towards some type of operations analysis effort. It was agreed that an analysis section should concentrate on using relatively simple proven techniques. Most departments would like to hire an outside person who has a background in systems analysis and was proficient in programming to operate this section. It was stressed, however, that this person should be an integral part of the police force and could possibly be a sworn officer specifically trained for the position.

Universal Emergency Number

The effectiveness and acceptance of the universal emergency telephone number, 911, was found to be strongly dependent upon the particular city, its size, and the telephone company facilities. It was agreed that installation of 911 would receive a good reaction from the public and would be easy to sell to city administrators. It was felt by many that 911 would increase the time between initial contact with the operator and resulting action because increased public usage might saturate 911 with non-emergency calls. Most participants preferred direct dialing to the police department itself accompanied by a publicity campaign concerned with familiarizing the citizen with the police number.

CONCLUSION

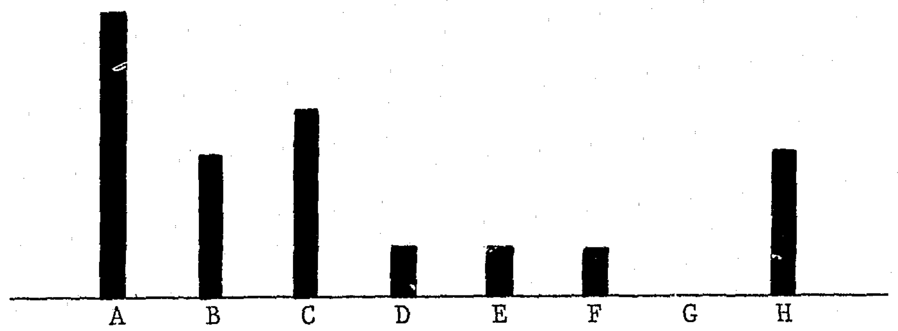
In conclusion, it was generally agreed that high-speed access to data and full mobile digital terminals will both have significant positive impacts on police effectiveness. Both are seen as potential methods for reducing response time, increasing crime prevention, increasing apprehension, and reducing the rate of index crime. It is not surprising that high-speed access is considered to be the most effective innovation that might be implemented. Mobile terminals, however, while being given a low priority in importance, are also considered to be very effective. The former is due to their high implementation costs while the latter results from the fact that they greatly expand the potential of high-speed access systems.

Participants generally agreed that operations analysis is the next innovation that would have a positive effect on police effectiveness followed closely by automated dispatch systems. The group also agreed that the implementation of either high-speed acess or automated dispatch would have a positive effect on officer safety and morale. It should be noted that both high-speed access and operations analysis are innovations which can be easily sold to city administrations because of their overwhelming positive effects and relatively low cost.

In terms of operational constraints, operations analysis and high-speed access required little or no additional expenditure on new manpower, training of personnel or organizational restructuring. In most cases, some thought that the implementation of either of these would result in an actual decrease in manpower and training requirements.

Police departments can expect to encounter no special political problems with any of these innovations. Some felt, in fact, that these techniques may even improve the relationship between the police department and other departments, the press, and the public at large. The exception to this might be the use of mobile terminals where there is presently a considerable amount of non-police monitoring of police channels.

The results of the final questionnaire are also presented for information as Fig. 3. It is not clear that this questionaire is particularly informative because many cities already have some of the innovations under consideration. It does give some indication of what the next choice for each of the cities might be.



A - High Speed Access

B - Automatic Vehicle Monitoring System

C - Automated Dispatch System

D - Status Monitoring System

E - Automated Dispatch System and Status Monitoring

F - Automated Dispatch System and Automatic Vehicle Monitoring

G - Mobile Terminal - Full Keyboard

H - Operations Analysis

█ - One response

Figure 3

END