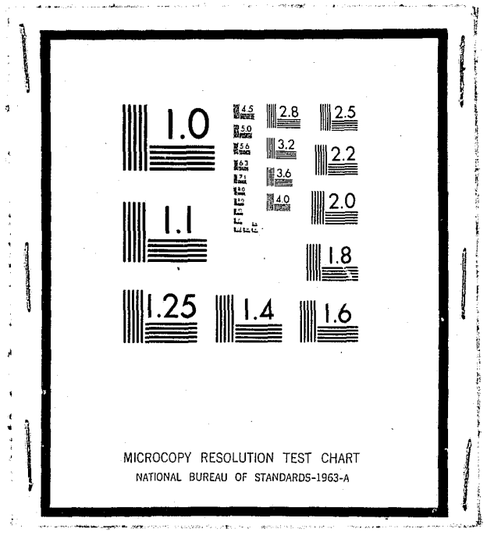

EVALUATION OF SAN FRANCISCO POLICE COMPUTER-ASSISTED DISPATCH PROJECT

Submitted to

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by

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ABSTRACT

This is a report of an evaluation of a LEAA funded project to develop a computer-assisted dispatching system for San Francisco Police Department. This project involved the installation of a new communication center, programming of a computer-assisted dispatch system, and installation of mobile digital terminals in police vehicles. The evaluation originally was intended to stress the impact of the new system on the response time of the police department to high priority calls for service. Actually, the data processing support system provided by the city and county of San Francisco, was not adequate to permit activation of the system for such an operational test. While the capabilities of this system are substantial, additional steps will be required to fully implement the system and to thoroughly evaluate the service it provides. Experience with this project focuses attention on the great difficulty of making arrangements for an integrated city/county computer system to support a police dispatching system when it must compete for limited resources with an expanding number of other computer applications.

PREFACE

The San Francisco computer-assisted dispatching (CAD) project is an extension of project CABLE, which has consisted of three phases and has developed a variety of computer-based information systems supporting field officers, management, and inspectors. This report of evaluation reflects an analysis of the system's capabilities based on a review of documentation, interviews with concerned project personnel, and observation of the preproject system as well as of the new command center.

Limited funding meant that this evaluation was a modest effort in relation to that desired for a major computer-based information system ($3,500 for evaluation of a project costing $588,854). Until recently the objective of the evaluator was to focus on the operational impact of the new system, since it was impossible to perform a detailed technical review of the system components with available funding and since the city had made arrangements for a thorough acceptance testing procedure. As it turned out, the system is not operational, so such an impact evaluation was impossible. The author has included operational baseline information on preproject response time of police units to high priority calls for service. This will permit a comparison when steps have been taken to actually use the computer-based system in an operational mode.

The author wishes to acknowledge the helpful assistance and access to information provided by representatives of the Police Department, City/County Data Processing, the Department of Electricity, and the project contractor, PRC/Public Management Services, Inc. While all the individuals concerned are too numerous to mention by name, the author wishes to specifically acknowledge the continued support of the Deputy Director and "prime mover" of the CABLE project, Director Louis H. Feder, Bureau of Criminal Information. Others, whose assistance was invaluable, include Lt. Ford Long, and Sgt. Ed Hartmann. The vital

contributions of the late Sgt. Dan O'Hara to all aspects of project CABLE will always be remembered. The author also acknowledges the assistance of his colleague, Louis Sullo, who participated in the detailed analysis of the current communications center operation, and who prepared plans for an operational assessment of the new system.

1.0 INTRODUCTION

The computer-assisted dispatch (CAD) project was partially funded by California Council on Criminal Justice Grant No. D-102-72. This grant established a requirement that the result of the funded effort be reviewed by an independent evaluator and that the result of that assessment be reported. This evaluation was conducted during the period between June 1973 and September 1975 by W.R. Partridge. The final evaluation and report was delayed as long as possible in an effort to make an impact-type evaluation. Unfortunately, this proved impossible. A brief biography of the evaluator is enclosed as Appendix B.

This section presents an overview of the CABLE project, a statement of the objectives of the CAD project, and a description of relevant police department procedures as they existed prior to the CAD project.

1.1 Project CABLE

The following is a summary of the three phases of Project CABLE and a description of their relationship to CAD.

CABLE I (September 1970 - October 1971)

- Operational field support system providing for rapid retrieval of person, article and vehicle data.
- Preliminary design of a management analysis module for assistance in management planning and resource allocation.
- Review of police command control requirements and plans.

The CAD component involving mobile digital terminals relies upon the basic field support system developed during CABLE I. However, it provides direct access to information concerning vehicles from the field unit.

CABLE II (October 1971 - September 1972)

- Operational "Location Subsystem" to record and report location and consumption of police resources and assist

in reallocation decisions.

- Development of an "Incident/Case Subsystem" involving automated police report indexing, report distribution and associated crime and management analysis statistics.
- Operational "Geo-coding System" to permit geographically oriented data analysis without burdening officers.
- Field Support (CABLE I) system enhancements.

CAD makes direct use of the geo-coding system to validate address information given by individuals who call the police and to provide such information as cross streets to assist officers responding to the scene for a call of service.

CABLE III (October 1972 - December 1973)

- Programming of the Incident/Case System.
- Design of a Personnel/Time recording system.
- Design and acquisition of a microfilm retrieval system.
- Integration of CABLE subsystems with the Computer-Assisted Dispatch (CAD) system.

The CAD system was being designed so as to interface with incident case and other components of the CABLE system which were being refined during the CABLE III project.

1.2 Operational Problems and Objectives

The San Francisco Police Department's major goal for this project was to increase the speed of its operational services. An associated goal was that of improving record keeping to support management control and resource reallocation. These goals were expressed in the department's grant application as follows:

- Increasing the speed of the police response to the public's call for service. This is to be accomplished by improved message handling capability in the Communications Center, improved ability of the dispatcher to select the

appropriate unit for a call, and field investigation of automated dispatching.

- Complete accurate records are to be kept regarding the field unit activities. Personnel will have the ability to recall the recent activity records of the field units. The data will be automatically stored in an off-line mode for statistical analysis by others.

1.2.1 Communications Center Operations

The primary requirement to accomplish the ultimate goal was to completely modernize and add to the capability of the department's Communications Center. The objectives specified in the grant application were as follows:

- Automation of complaint clerk and dispatcher functions. The Communications Center of the Department will have automated message handling displays for all complaint clerks and dispatcher positions. This will reduce time currently required for writing, date and time stamping, address verification, manual or conveyor transmission of documents, maintenance of status of field units, etc., under the manual method.

- Dispatching of field forces via digital communication. This function should reduce radio channel time required for this function, as well as provide a method to display additional data regarding the call for service automatically or as a result of subsequent activity.

- Reduce radio channel time required for inquiry status and dispatch activity. Increased use of mobile digital terminals will reduce radio channel time required for these activities. Considerable channel time is currently used for phonetic spellings, requesting additional information or clarification regarding assignment or inquiry and administrative requirements, such as status, location, etc.

1.2.2 Field Inquiries

Another objective was to add to the usage of CABLE, State and NCIC systems by facilitating inquiries on vehicles and persons and property from the field. As expressed in the grant application:

Increase patrol force productive time--eliminate delays by allowing patrol units to make digital inquiries. This will result in faster response time by elimination of the voice communications and dispatcher interface. Various function keys available on the mobile digital terminal will also save the officer time, as well as provide additional safety features which can be provided by automatic computer monitoring.

1.2.3 Management Control Reporting

Since the dispatching function will be supported by a computer system, CAD will make it possible to record, process and report almost any type of information relating to the dispatching function and the utilization of field forces. The objective in this regard was expressed in the grant application as follows:

- Provide additional and more accurate management information. Within the current dispatching operation, the information gathered is fragmentary, requires substantial hand coding, contains many errors and omissions rendering the data virtually useless and requires a massive costly effort to convert it into timely, reliable and usable management reports. As a result of this situation, the police department and community are not obtaining the maximum efficiency of its field forces. Since an automated system would provide a timely and accurate detail transaction log as an automatic by-product, valuable management reports reflecting the total activity of the patrol force would be readily available at considerable cost reduction. Proper use of the reports for resource management, allocation and planning could result in further savings or in additional patrol force hours spent in preventive patrol, etc.

1.3 Preproject Procedures

In this section, the relevant procedures of the police department as they existed prior to completion of the CAD project will be described.

1.3.1 Communications Center Operations

The Command and Control Center of the San Francisco Police Department receives almost 600,000 phone calls per year from the public. These calls are for requests for assistance, requests for information and offers of information to the police department.

Major activities of the Communications Center can be divided into five processes:

1. Phone calls for police service.
2. Alarms.
3. Officer initiated field check for information.
4. Officer initiated dispatch (on view).
5. Officer initiated call for required assistance.

Phone Calls for Police Service

There are approximately 13,000 calls per day received by the switchboard operators at the Hall of Justice. Many of these calls are directed to other departments in the Hall of Justice. Only 1,600 find their way to the communication center's complaint clerks. Of these, at least 50 percent require dispatches for service.

The switchboard operators usually determine the severity of the call requesting assistance. If the call requires emergency action, the operator transfers the call to one of two hot lines into the communication center. Some 160 hot calls are handled daily.

The center has four to eight complaint clerks on duty throughout the day. They determine the necessary action required on incoming calls. A number of these calls only require forms to be sent out to the callers. The hot lines are usually answered immediately and the information, if immediate service is required, is recorded on salmon colored slips (CR slips) to distinguish them from nonemergency calls (white slips). The San Francisco Police Department has established dispatch priorities for all types of incidents. There are three priority categories, A to C, A being the highest. Highest priority calls go to

the first district dispatcher for an all points bulletin. After assigning a unit for the emergency, the district one dispatcher sends the CR slip to the appropriate district dispatcher by way of the conveyor belt. All CR slips are passed from complaint clerk to dispatcher by way of conveyor belt. There are four dispatchers, each with an assistant. Upon completion of an assignment, the unit notifies the dispatcher of his return to service. The dispatcher logs the time and notes the unit's in-service status.

Alarms

The first district dispatcher has an alarm board located at his console. The dispatcher handles these alarms as high priority (hot) calls and dispatches a unit to check the cause of the alarm. The network of activities follows the same path as all dispatched calls. During the peak hour as many as three alarms have been sounded. A large percentage (as high as 90 percent) of alarms sounded during a day are false alarms.

Officer Initiated Dispatch (on view)

When an incident occurs that requires action from a unit viewing it, the unit contacts the dispatcher and gives the reason for dispatch. The dispatcher then fills out a CR slip, and logs the appropriate times. The remaining network of activities is similar to that of units after arrival at the scene.

Officer Initiated Call for Assistance (tow, etc.)

Often a unit close to the requesting unit will hear the request and will volunteer to assist. However, if this is not the case, the dispatcher assigns a unit to assist or assigns whatever special units are required to assist the field unit. As appropriate, the dispatcher fills out a CR slip and logs the time. The remaining activities have been previously described.

1.3.2 Field Inquiries

The number of field checks have been on the increase since the communication links to the computerized data files have been installed in the communication center. From 300 per day in 1970, the number of inquiries has increased to 1,200 field checks daily.

The field unit calls its dispatcher and requests a field check. These checks can be on license numbers, vehicle registration and individuals. If the system is up, the unit gives the required information to the dispatcher who in turn passes this information written on a CR slip to his assistant to query the system. The information is keyed into the computer system, and responses are usually obtained within seconds. The system searches local, State and Federal data files and responds for each file searched. Time elapsed for information returning to the field unit, however, depends on the activity in the command center and volumes of radio calls. Times as long as 15 minutes and as short as a half minute have been obtained from a field study. Field checks can initiate additional requests for information, officer initiated calls for assistance or officer initiated dispatches.

1.3.3 Management Control Reporting

CABLE I and CABLE II developed a design for management reports which eventually would be generated by the several components of CABLE and CAD. These are related to the Law Enforcement Manpower Reallocation System (LEMRAS). Certain LEMRAS reports have been generated but this activity has been limited, since it is necessary to keypunch raw data required for the reports. The kind of managerial reports which were planned for generation based upon automated inputs are as follows:

- Assignment of manpower to major functions,
- Assignment of manpower within the Patrol Division,
- Assignment of manpower within the police districts,

and

- Justification of departmental budget.

The designed resource allocation subsystem design provides a highly flexible data base from which numerous historical and predictive reports can be generated. This data base is made up of 10 fundamental police activities which are reportable on a time, location and unit involvement basis. Time definitions include day and hour of occurrence as well as consumed time accounting for specific categories of police activity. The 10 categories of activity are:

- Crimes against persons--priority response.
- Crimes against persons--routine response.
- Suppressible crimes against persons (robbery, purse snatching and mugging)--priority response.
- Suppressible crimes against persons--routine response.
- Crimes against property--priority response.
- Crimes against property--routine response.
- Public safety and service--priority response.
- Public safety and service--routine response.
- Traffic.
- Administrative.

The CABLE II resource allocation reports which are planned to be produced initially are:

(a) Workload Prediction-Citywide

This report will forecast the workload for each of the seven police districts by day of week and four hour increments of time. Predicted loads will be expressed in police unit (radio car) hours.

(b) Workload Prediction--Police District

This report will forecast the workload by day of week and four hour increments for each reporting area (a small area roughly equivalent to a census

tract) within each of the seven police districts. Again, the workload will be expressed in terms of police unit hours.

(c) Police Unit Activity Report

All actions expressed in terms of the 10 police activity categories described above will be reported for each radio car for each watch. Number of activities by type and associated consumed time will be reported.

(d) Response Time Prediction Report

A queuing model will be utilized to provide a table which allows prediction of the manner in which response time will be affected by raising or lowering the number of police units assigned to a given area at a given time of day.

(e) Out of Beat Report

This report will define the number of incidents which are responded to by units other than the car assigned to the beat in which the incident occurred. It will further define the specific beat from which the alternative unit was selected.

(f) Histogram of Workload Distribution

This report will be used to analyze expenditures of unit hours by type of assignment. It will provide graphic representation of percentage of calls requiring varying unit hours of work.

Such a full range of reports will be economically feasible only when CAD provides for automated source data collection.

2.0 EVALUATION METHODOLOGY

The original evaluation plan consisted of an assessment of operational impact of the communications and dispatching component of the project, a determination of the significance of adding digital communications to the system, a review of management reporting improvements, and a review of project administration.

2.1 Evaluation Criteria

Operational Impact--A reduction in the response time of high priority calls for service. Ideally, this would be a significant reduction at least consistent with standards and goals of the National Advisory Commission on Criminal Justice Standards and Goals, Report on Police, 1973. Standard 8.1: recommends that

> Every police chief executive should ensure maximum efficiency in the deliverance of patrol services by setting out in written policy the objectives and priorities governing these services. This policy... Should require immediate response to incidents where there is an immediate threat to the safety of an individual, a crime in progress or a crime committed and the apprehension of the suspected offender is likely. Urban area response time -- from the time a call is dispatched from the arrival at the scene--under normal conditions should not exceed 3 minutes for emergency calls and 20 minutes for non-emergency calls...

Standard 23.2 recommends that

> Every police chief executive should immediately ensure that delay time--the elapsed time between receipt of an emergency call and the time of message radio transmission--in the case of an emergency call, does not exceed 2 minutes and in the case of a non-emergency call, does not exceed 6 minutes. By 1978, communications center delay time in cases of emergency calls should not exceed 1 minute and in cases of non-emergency calls should not exceed 4 minutes.

Standard 23.1 makes related recommendations concerning the telephone system. These standards are quoted in full in Appendix note 1.

Field Inquiries--A substantial increase in the number of inquiries made, a reduction in voice channel congestion, and experimental findings in transmitting dispatch messages via digital communications.

Management Control Reporting--The availability of management control reports and resource allocation reports supporting such fundamental changes as revisions in beat structure and schedules.

System Efficiency--Achievement of desired characteristics of any computer-based information system. Such criteria (which are specified below) are in the areas of:

(1) data capture
(2) data processing and storage
(3) report processing and
(4) report analysis.

Transferability--System characteristics and documentation maximizing the potential value of this system to cities other than San Francisco.

Project Management--Fulfillment of commitments, responsiveness to contingencies, and administrative control.

2.2 Evaluation Baseline

To establish a baseline for a before/after impact comparison, the evaluator timed 50 cases of responses to high priority calls. This was done between the hours of 6:00 p.m. and 1:00 a.m. on three successive evenings, Wednesday through Friday, May 29-31, 1974.

The calls selected were either alarms or calls put through from the switchboard on red-buttoned telephone lines to the complaint area. The time period clocked was between the arrival of the alarm (or the flashing of the red button) and a radio call indicating a unit (whether assigned or not) had arrived at the scene. Only a fraction of eligible

calls were successfully timed, since some calls would overlap one being timed, some arriving units did not call in, and some cases were lost in the confusion.

It is important to note that it was not a routine practice to trnasmit arrival times by radio (although prescribed by general order). The special steps taken to acquire arrival time data undoubtedly created an atypical situation, and this is a source of some degree of invalidity.

The baseline data are reflected in the histogram in Figure 2-1.

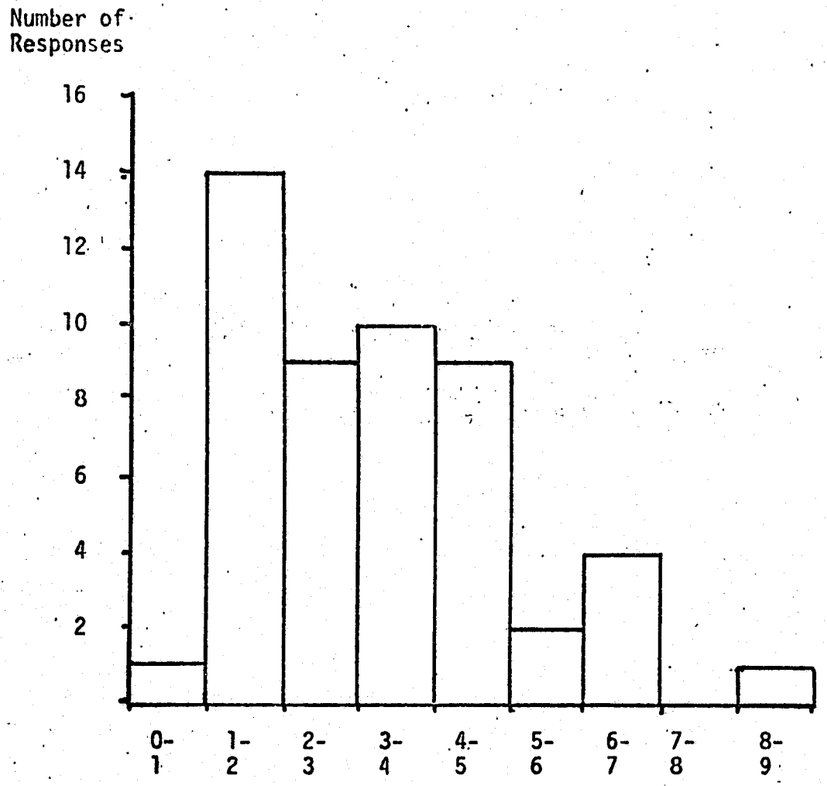

FIGURE 2-1: TIME BETWEEN "HOT" CALL ARRIVAL IN COMPLAINT AREA AND UNIT ARRIVAL AT SCENE

The mean response time was 3 minutes, 15 seconds. The median was such that there were as many cases over 3 minutes as there were under 3 minutes. Raw timing data are listed in Note 2 of the Appendix to enable statistical analysis in comparison with future operations.

3.0 PROJECT EVALUATION

Since it is impossible to assess the operational value of a system that has not reached an operational status, the evaluation had to be made on the basis of the evaluator's judgment of its future capability and upon the functioning of the system in a test mode.

This section presents a brief description of the new system, followed by four evaluation subsections: operational evaluation, system efficiency, transferability and project management.

3.1 System Description

Salient features of the designed system, which is entitled Computer-Assisted Radio System (CARS), are presented here by means of excerpts from the design document prepared by the system contractor (Appendix Note 3).

3.1.1 Communications Functions

The CARS System is designed to assist the Communications Section (CS) in performing their assigned responsibilities. This section briefly describes those functions of the Communications Section which CARS assists. No attempt is made to describe functions of the Communications Section which are outside the scope of the CARS System, e.g., switchboard operation, physical control of PIC radios. The following functions of the Communications Section impact CARS operations:

1. Receipt of Calls for Service--The CS receives calls for service from citizens, police officers, and special agencies such as alarm companies. They record all calls, advise or refer citizens when appropriate and initiate dispatch of mobile units.

2. Mobile Unit Dispatch/Status Control--The CS maintains control of mobile patrol units associated with the nine companies and of selected traffic and crime prevention units. For these units, the dispatcher is responsible for maintaining unit status at all times and for making dispatch assignments.

3. Mobile Unit Activity Recording--The CS is responsible for maintaining a record of radio activity for all mobile units. This activity provides "loose" status recording for all mobile units.

4. Mobile Unit Field Checks--The CS is responsible for making field checks requested by mobile units via the radio channels.

5. Mobile Administrative Communications--The CS relays messages from administrative units to mobile units.

6. Interagency Communications--The CS controls interagency radio and teletype communications.

7. Building Alarms--The CS monitors alarms from various points within the Hall of Justice.

8. CABLE System Coordination--The CS sergeant is responsible for coordinating operation of the CABLE System with EDP.

3.1.2 Communications Personnel

Personnel occupying four types of positions are responsible for performing CARS functions described above.

- Complaint Telephone Operator
- Primary Dispatcher
- Secondary Dispatcher
- Supervisor

This section briefly summarizes the functions and duties associated with each of these positions. A view of each type of console is included. Figure 3-1 shows the overall layout of the new communications facility.

Complaint Telephone Operator--The CARS System utilizes up to eight telephone complaint operators. These operators answer calls from citizens, police, and private agencies. They are responsible for entering data regarding complaints in the CARS terminals, advising citizens, making notifications when appropriate, and preparing mail-out notices. Figure 3-2 shows a preliminary view of a CARS Telephone Complaint Console.

Primary Dispatcher--Each CARS System primary dispatcher is responsible for communication with mobile units assigned to his console. All requests for dispatch of any of these units are relayed to the primary dispatcher. Figure 3-3 shows a preliminary view of a CARS dispatch console.

Secondary Dispatcher--The CARS secondary dispatcher positions are used in periods of peak activity to assist the primary dispatcher. The secondary dispatcher's main responsibilities are PIC communications and providing assistance for field checks. This operator may supplement the primary dispatcher in two additional ways. He may elect to monitor all primary dispatcher output messages. In this way,

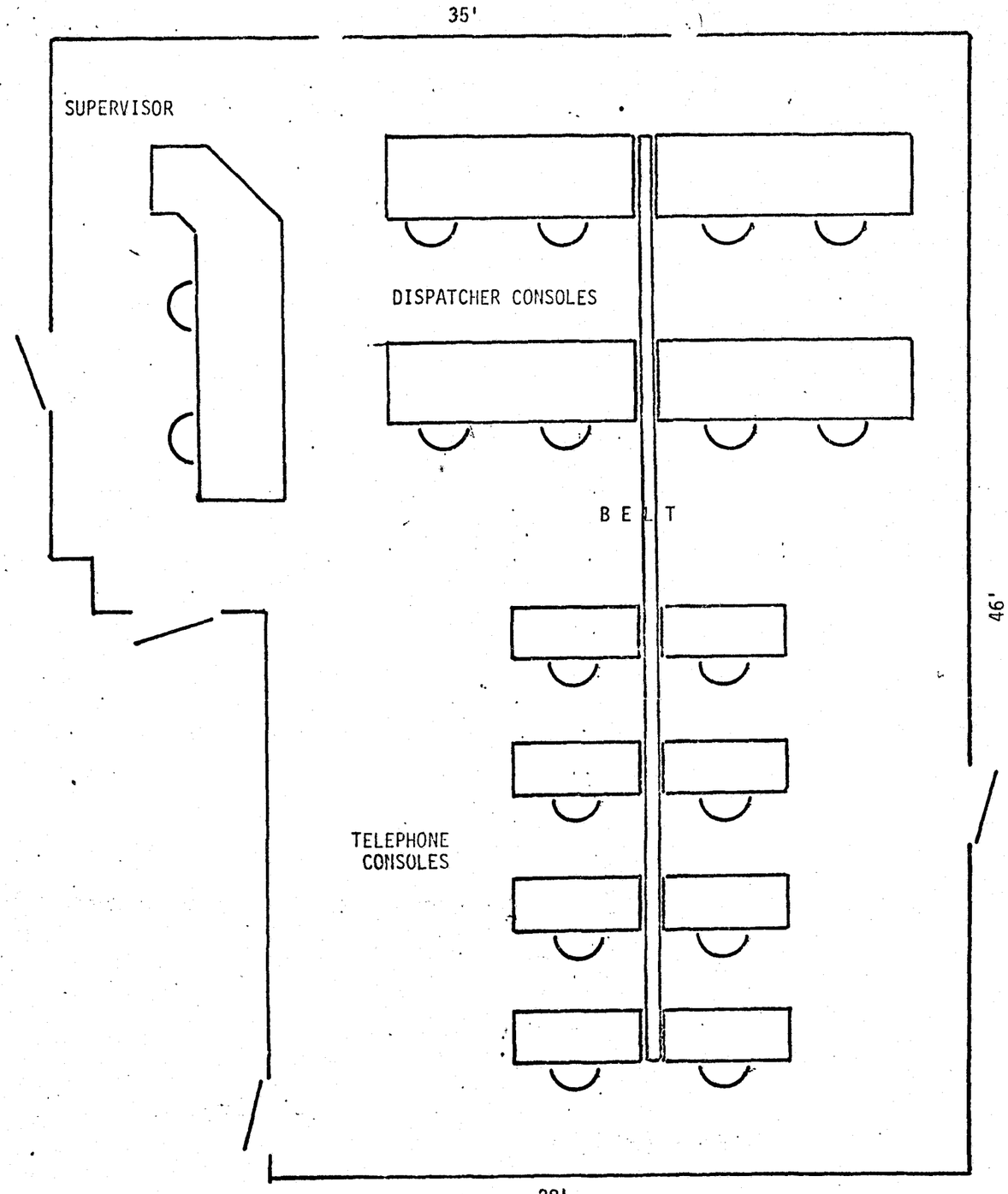

FIGURE 3-1

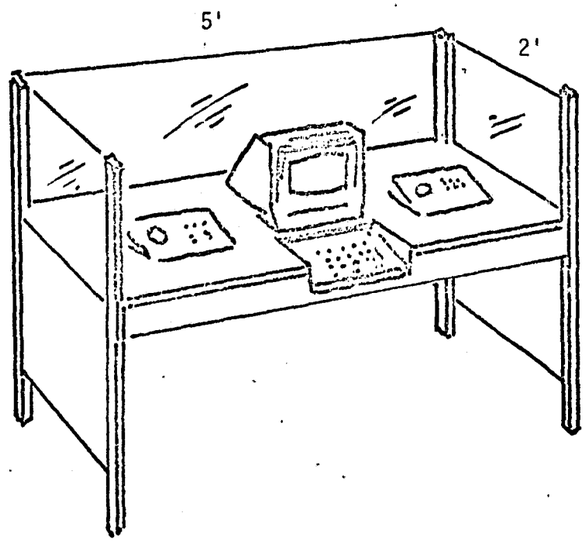

FIGURE 3-2: TELEPHONE ANSWERING CONSOLE

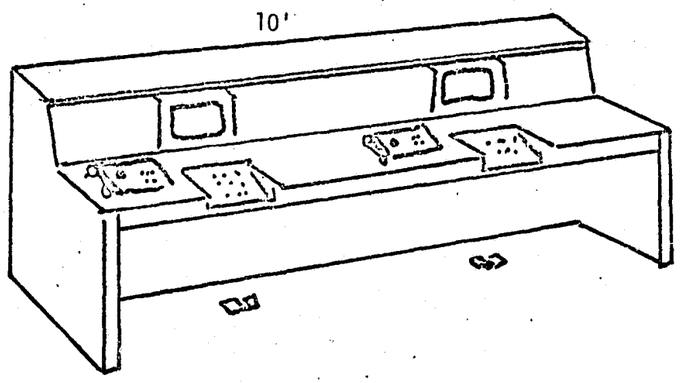

FIGURE 3-3: DISPATCHER AND SERVICE COMMUNICATIONS CONSOLE

any such message may be responded to by the secondary dispatcher. Alternatively, he receives all messages directed to the primary console when the primary dispatcher signs out for a break. The secondary dispatcher uses the same type of console as the primary dispatcher.

Supervisor--The CARS System supervisor is responsible for supervision and control of the CARS system. He can at his discretion take over the function of any CARS complaint or dispatch position, monitor any position, or monitor total system performance. The supervisor is also responsible for monitoring building alarms and interagency radio communications. The supervisor monitors radio system status. His console has panels which allow him to monitor or modify radio system status. The supervisor is responsible for coordinating CABLE system status.

3.1.3 Design Highlights

This section summarizes briefly a number of key concepts of the CARS computer assisted dispatch system. These paragraphs are of necessity incomplete. Their purpose is to highlight features of the CARS system and to stimulate discussion of these features. It also serves as a technical introduction to the detailed system description. The following topics are highlighted in this section:

- Geographic Processing
- Duplicate Complaint Detection
- Beat Definition
- Mobile Unit Selection
- Mobile Unit Identification
- Mobile Unit Classes
- Duty Scheduling
- Periodic Status Checking
- Dispatcher Control
- Reliability
- Logging

Geographic Processing--The Computer Assisted Radio System (CARS) uses the reporting area as its basic geographic unit. San Francisco is divided into 296 reporting areas. Each CARS district or beat is made up of a group of complete reporting areas. No reporting area is split between two beats or between two districts. A complaint is entered in the CARS system with premise address, intersection or common place. The CARS system determines the reporting area from the input. This reporting area is used in all CARS processing.

Duplicate Complaint Detection--CARS automatically detects and screens complaints which are potential duplicates. For each reporting

area, CARS has a list of "adjacent" areas. One complaint is a potential duplicate of another if the two complaints were received within a specified interval and are from the same or adjacent reporting areas. This technique is required to detect potential duplicates when different addresses are reported for complaints occurring on a reporting area or district boundary. When potentially duplicate complaints are detected, the new complaint is returned to the complaint operator with a list of the potential duplicates. The operator must identify the duplicate call or indicate that the new complaint is not a duplicate.

Beat Definition--CARS supports dynamic beat structures. Within each district, beats may change as desired, either automatically or by dispatcher action. CARS allows 98 different beat patterns to be defined. Normally only a few would be used. Beat patterns and the times when each pattern is used are entered on-line. Beats are specified to the CARS system by specifying in order of preference the mobile units that normally service calls occurring in each reporting area. Each reporting area has its own definitions, one for each beat pattern used.

Unit Selection--The units suggested for dispatch are selected using the mobile units assignments described above. Units off duty or out of service are eliminated from consideration. The remaining units are passed to a user-defined unit selection routine. This routine modifies the list according to any special department requirements. The resulting list is presented to the dispatcher for his selection.

Mobile Unit Identification--Mobile units are identified by a mobile unit identification of two to six alpha-numeric characters. The first character of the identification must identify the dispatch group to which the unit belongs. Dispatch groups include the nine districts, headquarters, crime prevention companies, and traffic. Each dispatch group is assigned to one dispatcher.

Mobile Unit Classes--CARS distinguishes two types of mobile units, controlled units and serviced units. Controlled units must maintain accurate status reporting with the communications section at all times and when in-service may be assigned to complaints by communications personnel. CARS provides duty scheduling and periodic status checking for controlled units. CARS mobile unit status summary shows only controlled units. Only controlled units are suggested for dispatch by CARS.

Mobile units which do not maintain accurate status with communications are considered "serviced" units by CARS. CARS maintains accurate records of communications with these units but does not provide duty scheduling status checking or status display.

Records of recent communications with a serviced mobile unit are available from CARS. These records provide "loose" status recording for the serviced units.

Either controlled or serviced units may be assigned to a complaint. When a serviced unit is assigned to a call, it becomes temporarily controlled. The unit must report "10-8" and is subject to periodic status checking until he does so.

Duty Scheduling--CARS maintains records of the time at which controlled mobile units are scheduled to go on and off duty. These records are maintained on a weekly basis with an independent schedule for each day of the week. The schedules are permanent in nature. Once entered, a schedule for a given day is used each week until modified. When due on duty, a unit is automatically made "10-7" and scheduled for periodic status checking as described below. When scheduled off duty, the unit is eliminated from suggested assignments and scheduled for status checking.

Periodic Status Checking--CARS provides periodic status checking to enhance officer safety and to improve quality of status information. Status checking takes place as a low priority activity when dispatchers are not otherwise occupied. Status checking assures that controlled mobile units have radio contact with communications at regular intervals. If CARS has no record of contact with a controlled unit in the specified interval, the dispatcher responsible for that unit is notified of this fact. Dispatchers are also notified when mobile units are due on or off duty.

Dispatcher Control--As described above, each mobile unit will be a part of one dispatch group based on the leading characters of its mobile unit ID. All the mobile units in a group are assigned to one dispatch console; e.g., all "CP" units, all "K" units, and all "C" units. The mobile units are dispatched only from that console. When a high priority call requires that a unit be assigned across dispatcher boundaries, CARS transfers the dispatch record to the proper dispatcher for action. Assignment of dispatch groups to consoles may be changed dynamically from the supervisor's console.

Reliability--A high level of reliability is required for all CARS computer components. A concerted effort is required to improve and maintain CABLE reliability and response times if the CARS program is to be successful. However, no computer system is complete without procedures for recovery from system failure and for operations without the computer system. The CARS system provides these services for total system reliability.

Manual Operation--The CARS project maintains the ability to operate without computer assistance. Each complaint position maintains a time stamp and a supply of C-R slips to be used when the computer system is down. A conveyor is provided to transport C-R slips. Each dispatch console is equipped with a time stamp and a card minder to maintain mobile unit status.

System Recovery--The CABLE monitor provides sufficient software capability to reliably store and maintain CARS system data.

These capabilities include protecting the CARS system from lost of incomplete transactions and providing long-term file recovery.

System Failure Protection--The critical period for a real-time system such as CARS is immediately following a system failure. A decision whether to switch to manual mode must be made. Once the decision has been reached, mobile unit and complaint status must be transferred to the manual system promptly and accurately. The CARS system design must facilitate this procedure and must minimize the chance of losing a complaint or mobile unit status change due to this action. CARS maintains a continuous hard-copy log of primary CARS transactions together with periodic status summaries to facilitate this transition. This log is printed on a terminal in the radio room. At a specified interval, the ID of each unit that is 10-8, a list of backlogged calls, and a summary of controlled units out of service are printed for each dispatcher. In addition, each new complaint is logged as received. The most recent summary with the log of any new complaints is distributed to the dispatchers when the decision to switch to manual mode is made. The dispatcher transfers this data to his card minder to begin manual operations.

Logging--Maintaining an accurate log of communications activity is a basic CARS function. Each radio transmission results in a corresponding CARS or CABLE transaction which satisfies FCC logging requirements and provides a permanent record for the department. All complaint activity is also logged for department records.

The existing CABLE transaction logs provide records of CABLE inquiries and their responses. The INQID field is used to identify the mobile unit requesting the check. With suitable retention of the relevant records, this log satisfies FCC and department requirements.

Each CARS transaction results in an entry in the CARS C-R log. Each such entry contains the date, time, unit, CARS terminal, entry type, and text. These data satisfy FCC and department requirements. It is available on-line for 48 hours and subsequently in batch mode. Summary data will be printed daily with detailed data on request.

3.1.4 System Interfaces

CARS is a part of the CABLE System and has interfaces with other parts of that system. The five CARS interfaces with other CABLE applications are as follows:

1. Incident Case System--CARS provides major inputs to the incident system, shares files with it, and utilizes its inquiry capabilities.

2. Dispatch Ticket System--CARS provides automatic input to the dispatch ticket system.

3. Police Personnel System--CARS provides complaint activity data for the personnel system.

4. Field Support Module--The CARS system provides simplified formats for basic field support functions and makes them available from mobile communications terminals.

5. Administrative Message Support--The CARS system provides direct administrative message switching to and between mobile units.

Incident Case System Interface--The Incident Case System and the CARS system are closely related. The incident system is used to store a history of each complaint. In addition, this history becomes a permanent part of the incident report if one is filed. To facilitate implementation of this feature, each complaint has a case number "reserved" when the complaint is received. If the case number is not requested during, at the end of, or following the processing of the complaint, it will be returned for reassignment in a few days when the complaint data are purged. This will result in incident numbers not being assigned in strictly chronological sequence.

The use of the incident system to store CARS system makes all incident system inquiries available for retrieval of CARS complaint data.

Dispatch Ticket System Interface--At the conclusion of each complaint, the CARS system will make an entry in the dispatch ticket file. This automatic entry will replace use of the EDT transaction. EDT will be used only to capture the dispatch data for periods when the CARS system is down. All dispatch ticket system reports (daily activity, cross-beat, etc.) will function without modification.

Police Personnel System Interface--CARS will provide inputs to the Police Personnel System concerning complaint activity by officer. An index will be provided which will show the units and star numbers of officers answering complaints.

3.1.5 Transaction Summary

Inquiry Functions

Transaction

Query Unit Status Summary
Query Complaint Status Summary
Query Supervisor
Monitor Terminal Activity
Monitor Unit Status Summary
Monitor Complaint Status Summary
Query Complaint Summary
Query Incident Report

Query Incident Summary
Query Incident Location
Query Unit History

Complaint Functions

Enter Complaint

Dispatch Functions

Dispatch Unit
Hold Complaint
Select Complaint
Redirect Complaint
Recall Complaint
Unit In Service (10-8)
Prempt Complaint
Unit on Scene
Assign Assisting Unit
Exchange Units
Self Initiated Dispatch
Assign Incident Number
Set Abnormal Status
Change Radio Code
Record Radio Transmission
Record Emergency Message
Unit on PIC Radio
Unit Return to Car
Order Tow
Transport Subject/Change Location
Arrive with Subject
10-7

Mobile Unit Functions

Name Check
Registration Check (Plate)
Registration Check (VIN)
Hot Check (Plate)
Hot Check (VIN)

System Status Functions

Log on Mobile Unit
Log on Operator
Establish/Clear Cover Unit
Establish Beat Pattern
Establish Dispatch Group
Reset System

System Maintenance Functions

Enter Reporting Area
Clear Reporting Area
Query Reporting Area
Enter Unit Schedule
Clear Unit Schedule
Query Unit Schedule

3.2 Operational Evaluation

3.2.1 System Characteristics

The system was found to have the following characteristics which clearly support its potential achievement of operational objectives:

Communications Section Operations

- The Department has issued a general order establishing maximum "stacking" time for lower priority calls for service and, of course, requiring immediate response to high priority calls. Delay of 10 minutes for medium priority calls and 30 minutes for lowest priority calls is allowed. While Standard 8.1 of the National Advisory Commission on Criminal Justice Standards and Goals recommends a maximum of 20 minutes, such a maximum is debatable.
- The present system handles "hot" calls within the Communications Section in less than 2 minutes and it appears that the proposed system will be able to handle calls in less than 1 minute, consistent with Standard 23.2.
- The telephone system is the most modern available and fully consistent with Standard 23.1. It assures that emergency calls are handled with essentially no delay, and all other calls are handled strictly in accordance with the priority of their arrival.
- The system provides for rapid verification of the existence of addresses and other locations likely to

be reported by a caller. It will facilitate the acquisition of accurate location information while the caller is still on the line.

- The system supplements location information given by the caller with other information available in its records, particularly the cross streets associated with an address. It has the capability also of providing additional information, such as danger potential associated with a location to which an officer is being dispatched.
- The system has a capability of reporting the existence of other calls which may refer to the same incident (this is extremely important and must be fully tested in an operational mode).
- The support provided to dispatchers appears to enable the dispatcher to operate in a more orderly manner than has been possible in the past. Specifically, it appears that dispatchers will be able to carefully delay servicing low priority calls in order to keep units available for rapid response to high priority calls.
- The capability of the "jurisdiction" of each dispatcher position to be modified appears to be of substantial value in the event of a future unusual occurrence that might generate an extremely large workload in one segment of the city. In fact, the flexibility of the system appears to hold great promise for valuable support in the case of major emergencies (but these features must be operationally tested and training exercises must be held).
- The system provides for means of supervisory monitoring of all functions of the communications center, which will be valuable from the point of view of training and motivation in the normal mode, and for positive

assistance required in a case of major incidents requiring resource reallocations or other major changes beyond the authority of the dispatcher.

Field Inquiries

- Mobile digital terminals do, in fact, reduce congestion and expedite field checks. Further, they reduce distractions presently being experienced by dispatchers who must handle the inquiry case load.
- A question of cost/effectiveness is something that merits further consideration.

Management Control Reporting

- The capability of the system to serve as input to management control reports is of great potential value.
- CAD has the potential of automatically assigning incident numbers to establish a permanent linkage between dispatch records and resulting incident reports.
- The incident/case subsystem (which provides for full automation of incident reporting paperwork) has been designed so that information generated at the time a complaint is taken and a dispatch made can be automatically included as a permanent part of the incident report. This will facilitate management review, as well as simplify documentation of the chronological record of handling of incidents. It will generate LEMRAS inputs routinely, making it necessary for manual record creation only when CAD is not functioning, which will not only make it cost/effective to generate a wide range of management reports but also will greatly improve data accuracy.

3.3 System Efficiency

The following is an evaluation of the CAD system from the point of view of efficiency criteria in the following areas: data capture, data

data processing and storage, report processing, and report analysis.

3.3.1 Data Capture

The nature of police work requires the capture and documentation of voluminous data. By acquiring some data of management interest, while collecting data required by law, the potential for management analysis exists. The large volume of transactions, however, had led to efforts to minimize capture of data thought not to be necessary. Sometimes special reports are added to normal report requirements to satisfy a current felt management need. These processes lead most large organizations to conclude that data capturing functions are in need of review. The implementation of a major management data system, as in CAD, presents the opportunity to make improvements.

Criteria

The quality of the data capture function is determined by the extent to which it meets the following criteria:

- Elements of data needed are, in fact, captured.
- Data capture is accomplished by the agent (officer or otherwise) best informed to assure accuracy.
- If data are captured by an officer, collection and recording methods are most effective for him, interfering least with his other professional responsibilities.
- Once the Department has captured an element of data it should never have to recapture the same data.

Evaluation

- The system is thoroughly designed such that the need for data is well established.
- The present method of entering dispatch-related data into the management reporting system is to have cadets keypunch such data. The quality has been extremely low and it is an illustration of the importance of having data captured by the best informed and best motivated individual from the point of view of accuracy. The CAD system provides that once the complaint taker validates and enters the data, the data capture will serve all subsequent needs.
- This system reduces recapture of data to a minimum, especially when it is linked to the incident/case system.

3.3.2 Data Processing and Storage

A common situation finds several units within a department, each with different, partially complete records containing, to a varying extent, the same data elements. Operations on such data to compute statistics lead to differing answers, and many other confusing and costly results are obtained. A new management information system should minimize the inefficiencies of most existing systems.

Criteria

The quality of the data processing and storage functions is determined by the extent to which they meet the following criteria:

- Captured data elements are processed through error checking procedures to detect errors and initiate required corrective action.
- Data elements are stored in records designed with adequate consideration to reporting and retrieval needs and to storage costs.
- Data records are stored under conditions of adequate security, considering both importance and confidentiality of data.

Evaluation

- Error checking procedures appear adequate.
- Operational system tests will very likely identify the need for refinement. The data recording approach was designed in relation to planned usage both in operational reports and management reports.
- Security arrangements are found to be typical of those available in connection with integrated data

processing activities. If a dedicated law enforcement computer system could otherwise be justified, arrangements could be made for system security to be markedly improved.

3.3.3 Reporting Processing

Conventional reporting systems often transmit to the supposed user more data than he needs, in a form requiring translation or interpretation, and with a timing that is unsatisfactory. It is usually considered late. Noting that data is collected, in the first place, for one or more users, the report processing function of a management information system is especially critical.

Criteria

The quality of the report processing function is determined by the extent to which it meets the following criteria:

- Case and incident reports are promptly transmitted to all users, following legal and/or management prescribed distribution rules, in the form(s) most useful to the user(s).
- Department management and supervision are provided with information selected as to their specific area of interest, on a timely basis, and containing information likely to support selected management decision processes.
- Where comparisons of data or calculations on data are needed, they are made in accordance with prescribed rules, and to the extent possible made by machine processing.
- Users of the management information system are provided automatically nonroutine or exception reports alerting them to important conditions or facts in accordance with prescribed rules.

Evaluation

- The computer system outputs planned for complaint takers, dispatchers, the communications supervisor,

and, ultimately, field officers using mobile digital terminals have been thoroughly designed from the point of view of user needs.
- Management reporting outputs were designed as a part of other CABLE projects. Since expensive methods have had to be employed to generate inputs, little opportunity has existed to test the quality and usefulness of such reports.

3.3.4 Report Analysis

One of the lessons learned from experience in the implementation of modern management information system is that expectations are often too high. That is, expectations concerning the automated portion of such systems were exaggerated. The collection, processing, storage, reporting and analysis of data reuiqres a man-machine system.

The purposes served by the automated system in CABLE will be served incompletely unless a human report analysis capability is implemented.

Criteria

The quality of the report analysis function is determined by the extent to which it meets the following criteria:

- Analytical capability is built into the automated subsystem to the maximum extent as determined by management's ability to prescribe rules and procedures which apply routinely.
- Officials are provided with staff support sufficient to perform analyses necessary for decision making but beyond that performed by the computer.
- Computer system maintenance and upgrading are provided for, based on adequacy of computer-oriented support and "feedback" from management users and the analytical support staff.
- The analytical support staff facilitates the provision of "completed staff work" to department

officials, i.e., recommendations for action are provided concurrently with reported information.

Evaluation

- The automated subsystem appears to contain those analytical capabilities appropriate for satisfactory handling of the normal dispatching function. After gaining experience with the current system, many innovations would be possible. Examples might be prestorage of dispatching rules for road blocks and intercept strategies in the case of robberies at well-known risk locations. Another example would be special analysis foreseen to be needed in conjunction with unusual occurrences.
- There has been such an extensive delay in bringing the CAD to operational status, very little has been done in the highly important function of supervising resource reallocation potentials created by CAD (as designed) and of the management analysis of resulting control information. The computer system should be considered merely a component of a system, the most important elements of which are decision makers. To the extent that CAD will support management review, resource reallocation, and unusual occurrence handling, the many nonmechanized policies, procedures and resource arrangements have yet to be developed. This is a deficiency that should be overcome concurrently with efforts to enhance computer system response time to enable activation of the computer support to complaint taking and dispatching.

3.4 Transferability

From the point of view of documentation of system designs and programs, the transferability of this system is very good. Since it was necessary to utilize existing city/county computer hardware and

operating systems, highly unique system elements will make transfer difficult.

3.5 Project Management

This project was managed in an excellent manner. Most of the effort was based on a contracted activity in which the bidding involved carefully determined specifications. Arrangements were made to complete an acceptance testing procedure handled primarily by representatives of the Department of Electricity. The Police Department, key members of which have become increasingly well-versed in the capabilities of computer-based systems and in techniques of project management, were particularly effective in working with the contractor, the Department of Electricity, and other participants on this project.

For reasons this evaluator could not determine, problems developed having the effect of providing inadequate support of the city/county data processing requirements, both hardware capabilities, machine time for testing, and system/programmer support. There was no evidence available to this evaluator that City/County Data Processing personnel were less than fully cooperative. The problem seems to reflect an inherent difficulty of bringing to bear adequate data processing capabilities within a government agency that must meet demands from a variety of city/county activities. Still, the support was inadequate, the data hardware and operating system performance does not support CAD, and there is some indication that City/County Data Processing does not assign this system a high priority for City-funded support in the future.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

4.1.1 Evaluation

Operational Impact

The communications center is fully operational and is reportedly operating substantially to the satisfaction of the Department of Electricity and the Police Department. The computer-aided dispatching function is not operational because the City/County hardware and operating system cannot provide the required response time. For this reason, it is impossible to evaluate actual or even potential operational impact in terms of overall response time between a call for service and the arrival of a unit on the scene of a high priority incident. An analysis of system capabilities indicates that the system is likely to have significant operational impacts, not that response time will be reduced significantly, for it is already quite fast, but that the total dispatching operations will be handled more efficiently with implementation of the proposed system.

Field Inquiries

A large number of field inquiries were made using mobile digital terminals. Accordingly, a certain amount of radio congestion was avoided, but this has not been a problem in San Francisco. A certain amount of distraction, which radio inquiries cause to dispatchers, was avoided.

Management Control Reporting

No benefits were achieved in relation to management control reporting because the system could not be made operational. The potential is great.

System Efficiency

The proposed computer-based information system rated very high in relation to criteria for system efficiency.

Project Management

Project management was handled in an excellent manner.

It was, however, inadequate to assure the availability of city/county data processing hardware, software, and personnel requirements.

4.1.2 Importance of Response Time

Response Time Study

In the "baseline" study, timing of 50 cases of "hot" calls during peak evening hours, disclosed that response time averaged 3 minutes 15 seconds. The range is indicated by the fact that 25 percent were over 4 minutes and 12.5 percent were over 5 minutes. The longer duration calls were linked to congestion in the system caused by many concurrent high, medium and low priority calls. While this speed may be surprising to many, it remains unsatisfactory from several points of view, including comparison with recently published Standards.

Coping with Congestion

Congestion during peak service hours is responsible for critical operational problems. One can identify a range of theoretical solutions: (1) a large number of field units; (2) a policy of indefinite delays in servicing low priority calls; and (3) a balancing of reasonable service in the low priority area with rapid servicing of "hot" calls, both with limited field resources. Clearly, the third solution is the only practical one, but it is difficult to achieve.

Computer Assisted Operations

Optimal performance within the Communcations Section can be achieved only when constantly updated information is conveniently available to Section operators, and when they can easily change such information as they make decisions. When the computer system becomes operational, it can serve as a continuously evolving inventory of such information. With such a system, clerks can divert duplicative calls and improve the accuracy of incident location data. More importantly, the system can provide for a more orderly and controlled process of stacking and servicing of calls. To carry out this process of optimal use of field resources, operators must conduct a continuing dialogue with the computer system. Such an orderly operation could facilitate higher

level resource allocation decisions: redeployment, activation of extra units, calls back to victims to explain legitimate delays, closer supervision of available units, and early warning of impending extraordinary conditions. All of these services assume the ability to constantly use the system without delays in individual transactions.

Machine Delay Analysis

The number of complaints serviced during a 24-hour period varies widely, but has been estimated to average at least 800. A minimum of 2 transactions on the computer system are required to support each complaint. Being realistic, in roughly 15 percent of the cases the number of transactions will be 3 or 4. Also, where there is stacking during peak periods affecting, say 30 percent of all calls, the dispatchers will add about 3 more transactions per complaint. Hence, we might estimate the daily transaction count as 2,500. If, for example, 10 seconds could be reduced from the machine response time, 7 man-hours of waiting time could be avoided each day. That does not account for additional delays caused by queues and the interaction of such congested messages with demands placed on the computer system by nonpolice applications. All such delays increase the overall response time of the police to the public.

Critical Human Factors

Delays in man-machine systems create human-factor problems that might prove more serious than lost man-hours. The machine response time deficiencies will interact disadvantageously with certain human physiological and psychological characteristics. At a minimum, this will substantially add delay to the system. It could cause chaotic system failures. Such failures would be most likely to happen under conditions of stress--at precisely the worst time. Notes 4 through 11 in the Appendix briefly summarized research results that constitute fair warning of the potential impact of problems of attention span, distractions, vigilance, confusion and stress involving the people in the system.

4.2 Recommendations

System Activation

The CAD system is an excellent example of one of several computer-assisted dispatch systems being implemented in major cities in the United States. It should be made fully operational. Consideration should be given to achieving this through one of two means: (1) improving the integrated hardware and operating system within the current city/county data processing organization to the point where adequate service can be provided; or (2) acquiring a separate computer hardware and operating system capability for law enforcement and activating CAD on such a system. Despite the continued efforts of City/County Data Processing over the past 5 years, they have not been able to provide needed support to the Police Department. Both departments should examine the alternatives, giving due weight to potential improvements in service, security and cost afforded by recent developments in the mini-computer industry.

Thorough Evaluation

To be consistent with one of LEAA's responsibilities, arrangements should be made for a careful evaluation of the implemented system. The only way this can be achieved is to support a schedule and plan for evaluation which will enable the evaluation to be designed before the system is finally implemented, and will enable the evaluation to be completed after the system is operational. Consideration should be given to arranging for the design of the evaluation by one qualified contractor (independent of the City/County of San Francisco), for data collection to be accomplished primarily by the City/County and, finally, completion of the evaluation by yet another contractor. Such an approach would provide for independence and professionalism in the evaluation.

It is recommended that the Department assign units equipped with mobile digital terminals to selected districts, leaving comparable districts without them, and collect data for comparisons, such as:

- Inquiry volume
- Traffic warrants served
- Revenue associated with warrants
- Stolen cars recovered
- Radio congestion

Such comparisons would help answer an important question: Given the attractive features of the mobile terminal, how can the cost be justified?

Data System Development Requirements

While there is substantial evidence of cooperation by City/County Data Processing on this project, as well as on other components of the CABLE program, experience here seems consistent with rather widespread experience indicating the great difficulty agencies have in fulfilling commitments made by data processing organizations. They seem to be able to justify their activities when they fail to meet schedules, fail to meet commitments as to such things as machine time, fail to provide an adequate hardware/operating system, and fail to arrange for training and motivation of their own personnel to take over necessary programming details and system maintenance responsibilities.

LEAA should consider this fact when funding computer-system projects, attempting to assure adequate planning and funding of additional data processing capabilities or alternative sources of such services. This is not an indictment of data processing personnel; it is a comment on the incompleteness of funding coverage. Major systems, such as CAD, put stresses on the resources of multiple departments within government--in this case the Department of Electricity and Data Processing, as well as the Police Department.

General

This project has been exceelent in most of its aspects. Its shortcomings merely add further evidence to support a recommendation often given to LEAA--where innovation is involved, LEAA should fund

fewer, larger programs, with adequate provision for evaluation.

APPENDIX A: NOTES

1. Standards 8.1, 23.1 and 23.2 recommended by the National Advisory Committee on Criminal Justice Standards and Goals are quoted, for reference, as follows:

STANDARD 8.1 ESTABLISHING THE ROLE OF THE PATROL OFFICER

Every police chief executive immediately should develop written policy that defines the role of the patrol officer, and should establish operational objectives and priorities that reflect the most effective use of the patrol officer in reducing crime.

1. Every police chief executive should acknowledge that the patrol officer is the agency's primary element for the deliverance of police services and prevention of criminal activity.

2. Every police chief executive should insure maximum efficiency in the deliverance of patrol services by setting out in written policy the objectives and priorities governing these services. This policy:

a. Should insure that resources are concentrated on fundamental police duties;

b. Should insure that patrol officers are engaged in tasks that are related to the police function;

c. Should require immediate response to incidents where there is an immediate threat to the safety of an individual, a crime in progress, or a crime committed and the apprehension of the suspected offender is likely. Urban area response time--from the time a call is dispatched to the arrival at the scene--under normal conditions should not exceed three minutes for emergency calls, and 20 minutes for non-emergency calls;

d. Should emphasize the need for preventive patrol to reduce the opportunity for criminal activity; and

e. Should provide a procedure for accepting reports of criminal incidents not requiring a field investigation.

3. Every police chief executive should insure that all elements of the agency, especially the patrol and communications elements, know the priority placed upon each request for police service.

4. Every police chief executive should implement a public information program to inform the community of the agency's policies regarding the deliverance of police service. This program should include provisions to involve citizens in crime prevention activities.

STANDARD 23.1 POLICE USE OF THE TELEPHONE SYSTEM

Every police agency should develop as a subsystem of its overall communications system a telephone communications component designed to reduce crime through rapid and accurate communication with the public. This design may require an upgraded physical plant and supportive equipment, and procedures to shorten the time of the internal message handling.

1. Every police agency should immediately implement a full-time telephone service sufficient to provide prompt answering of calls for service.

a. Emergency telephone calls should be answered within 30 seconds, and nonemergency telephone calls should be answered within 60 seconds.

b. Procedures should be adopted to control the quality of police response to telephonic requests for service and information.

2. Every police agency should immediately install a sufficient number of emergency trunk lines, in addition to and separate from business trunk lines, to insure that an emergency caller will not receive a busy signal during normal periods of peak activity, excluding catastrophic or unusual occurrences.

3. Every police agency should immediately insure that any misdirected emergency telephone call for police, fire, or other emergency service is promptly accepted and that information obtained from such calls is immediately relayed to the appropriate public safety emergency agency.

4. Every police agency with a full-time telephone service should, by 1976, acquire and operate fail-safe recording equipment that will allow endless or continuous recording of all incoming complaint calls and instantaneous playback of those calls.

5. Every police agency with full-time telephone service should, by 1982, operate that service from facilities designed to be reasonably secure from physical attack and sabotage. This security should extend to overhead telephone trunk line drop-wires running between aerial cables and the full-time telephone service facility.

6. Every police agency should, by 1982, obtain single universal emergency telephone service, and the cost of such service should be borne by the private telephone subscriber.

7. Pilot Automatic Number Identification Universal Emergency Telephone Systems should be installed to assess technical feasibility, cost-effectiveness for police, and public acceptance.

STANDARD 23.2 COMMAND AND CONTROL OPERATIONS

Every police agency should acknowledge that the speed with which it can communicate with field units is critical; that it affects the success of agency efforts to preserve life and property; and that it increases the potential for immediate apprehension of criminal suspects. Therefore, a rapid and accurate communications capability should be developed.

1. Every police agency should immediately install a 24-hour two-way radio capability providing continuous communication between a communications center and field units. Agencies too small to maintain a full-time communications center should immediately arrange for that service to be provided by the nearest full-time communications center of a neighboring public safety emergency agency or a public safety emergency agency operated by the next highest political subdivision in the State.

2. Every police chief executive should immediately insure that delay time--the elapsed time between receipt of a complaint emergency call and the time of message radio transmission--in the case of an emergency call does not exceed two minutes, and in the case of a non-emergency call, does not exceed six minutes. By 1978, communications center delay time in cases of emergency calls should not exceed one minute and in cases of nonemergency calls should not exceed four minutes.

3. Every agency should, by 1975, acquire and operate fail-safe recording equipment which will allow continuous recording of every radio transmission and recording equipment designed to allow instantaneous playback of field unit radio transmission.

4. Every police agency should immediately seek action by the appropriate legislative or regulatory body to regulate private agencies that provide central-station alarm service. Appropriate steps should be taken to minimize field-unit response to the location of any alarm not caused by a criminal attack.

5. Every agency operating a full-time communications center and employing 15 or more persons should, by 1975, install suitable equipment to provide access to local, State, and Federal criminal justice information systems. The minimum suitable equipment should be a teletypewriter capable of being connected to a data base.

6. Every police agency having a full-time communications center should, by 1978, operate from facilities designed to be reasonably secure from physical attack and sabotage.

2. The following are actual response times (in seconds) for the 50 cases of responses to hot calls discussed in section 2.3: 225, 290, 116, 103, 63, 164, 101, 190, 75, 191, 84, 332, 180, 92, 70, 92, 258, 386, 105, 240, 185, 224, 243, 185, 245, 375, 105, 240, 245, 308, 160, 93, 137, 379, 171, 537, 240, 290, 210, 210, 150, 162, 205, 145, 172, 15, 101, 102, 145, 397.

3. Computer Assisted Radio System (CARS) Detailed Design, by PRC/SSDC, Inc., 1974.

4. Hobbs, L.C. and Richard A. McLaughlin, "Minicomputer Survey," Datamation, July 1974. This compares results of surveys conducted in 1969, 1971 and 1974. Several machines met the predicted cost reduction of 20 percent per year between 1971 and 1974. Other evident trends: higher system performance, increase of microprogramming techniques, new types of peripherals and terminals, complex software, and others.

5. Barmack, J.E., and H.W. Senaiko, 1966, Human Factors in Computer-Generated Graphic Displays, Arlington, VA, Institute for Defense Analysis, Study 234, (AD 636 170) A number of improvements in existing man-machine systems were found to be required. Included was reduction in display response-time lag.

6. DeGreene, Kenyon B., Systems Psychology, 1970, McGraw-Hill, New York, p. 461. Research has shown that human performance has characteristics important to system design. People have relatively short attention spans, tend to become bored with repetitive tasks, function largely on the basis of differences in stimuli (including distractions while waiting).

7. Smith, R.P. et al., 1966, "Effects of Temporal Uncertainty on Watchkeeping Performance," Perception and Psychophysics, 1, 293-299. Vigilance is especially important when slow response time or other factors place the operator in a monitoring or "watchkeeping" mode. Human operator's response is slowed not only through inattention, but also through a "surprise" reaction to temporal uncertainty.

8. DeGreene, op cit., p. 215. Assume that demands are made on the operator by various sources of information and noise in the environment. The messages arrive and in a sense form a queue. He can handle only one at a time. The length of the queue is a direct measure of interference that will exist when waiting provides extraneous messages to the operator. The notion of the queue "can serve as a rational basis for attack on the questions of perceptual overload and workload in general."

9. DeGreene, op cit., p. 209. "In an assessment of operator loading, studies indicate that visual distribution of attention is the major indicator of operator workload." In addition to visual attention, operator workload includes auditory input and output and the motor activity imposed upon him by the control elements of the task and by external perturbations.

10. DeGreene, op cit., p. 475. The normal problems of human response time to visual stimuli are important. If attention is permitted to roam, the operator response time will be longer. For example, a minimum glance to read a target outside of the 5 degree arc of clear vision required from 0.6 to 1.0 seconds. Additional delays are caused by operations in the extreme ranges of human performance, which may involve physical disabilities, fatigue, emotional stress, carelessness and inattention.

11. DeGreene, op cit., p. 264,5. A system is considered "stable" if an error does not continue to grow indefinitely. Slow computer response can cause an accumulation of missed status changes. Sometimes a man-machine system operates with instability, especially when there is delay time in the loop, whether caused by man or machine. An example is the problem of "pilot induced oscillation" in which the pilot's corrective maneuvers are too late to check the increasing amplitude of oscillation of his aircraft. "...a human controller by his very presence introduces destabilizing effects into a control system..."

APPENDIX B: RESUME OF EVALUATOR

William R. Partridge has 25 years of professional experience involving management systems, operations research, data processing, personnel development, and general management. He currently is an independent consultant after serving for four years as director of The University of New Mexico Criminal Justice Program. His prior criminal justice experience includes six years as a consultant engaged in a wide range of evaluation projects and system design and implementation programs.

Partridge holds a B.A. degree from Pomona College based on engineering and liberal arts studies. After completing an M.P.A. program at the Maxwell Graduate School, Syracuse University, Partridge obtained an M.B.A. with a concentration in operations research from the Graduate School of Business, U.C.L.A. He is completing Ph.D. requirements at The University of New Mexico.

Partridge is the subject of notice in Who's Who In The West and The Dictionary of International Biography.

END

7 tables/appendix