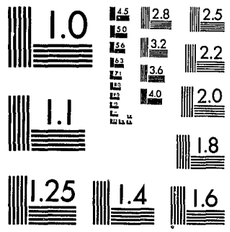

PLANNING BRIEF
FOR
ADVANCED COMMAND, CONTROL AND COMMUNICATIONS SYSTEMS

1200-230

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Prepared for: National Criminal Justice Information and Statistics Service
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1. INTRODUCTION

This planning brief was prepared in response to a request for material to support development of a short range plan for an Advanced Command, Control and Communications Systems (ACCCS) program.* These notes and recommendations are based on visits to law enforcement agencies that have implemented one or more of the following innovations: Mobile Digital Communications, Computer-Aided Dispatch and Automatic Vehicle Location. Sufficient operational experience has been accumulated with these innovations to give preliminary indications of their effectiveness in a CCC system environment, but comprehensive evaluations are not available, and a long range plan has not been developed to assure that these innovations will be fully assessed for incorporation into CCC system upgrades.

Planning information gaps exist in cases in which innovations are used in combination, such as computer-aided dispatch augmented with digital communications to field units; and experience to date indicates that digital "dialogue" for dispatching and status updating is not used to the extent anticipated, such that voice channel congestion and dispatcher work loads are not relieved significantly. Other questions relate to the priority of implementation: computer-aided dispatch vs digital communications.

A lack of technology transfer from one agency to another is noted, indicating a need for dissemination of "lessons learned" to potential new users. Finally, evaluation techniques are not readily available for assessing the performance of system upgrades, and little effort is being spent to develop and apply evaluation techniques. Evaluation in the soft areas such as impact on crime rate and community relations is particularly in need of development. These and other problems should be addressed in short and long range plans.

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*The "Planning Brief for Advanced Command, Control and Communications Systems" has been prepared for the National Criminal Justice Information and Statistics Service, Law Enforcement Assistance Administration (LEAA), United States Department of Justice, in response to a statement of work contained in JPL Report No. 1200-189, dated September 13, 1974 (Task G).

This planning brief develops a framework for short and long-range plans, and describes elements that should be incorporated in these plans. Key to the planning effort is the statement of specific objectives for each of the innovation technologies, and program-wide objectives; these are presented in Section 3. A brief summary of on-going projects is presented in Section 4. A comparison of objectives with project content is then made to identify gaps and overlaps in the overall program (Section 7), and is used as the basis for a recommended short-range plan, (Section 10). This approach can be expanded to develop a comprehensive long-range plan for ACCCS.

2. PROGRAM SCOPE

ACCCS for law enforcement is comprised of the following elements:

1) Digital communications, including mobile digital terminals.
2) Direct access to data files from field units.
3) Computer-aided complaint taking and dispatch.
4) Automatic vehicle location.
5) Computer-aided management report generation, and resource allocation and scheduling.
6) Emergency phone number.

The ultimate goal of the ACCCS program is to develop, test and assess the effectiveness of the above innovations, singly and in combination, in the enhancement of law enforcement operations. The term "in combination" is emphasized because the interactions between the several major elements are complex and not well understood, but all can make a significant contribution if properly integrated into the overall system. The 911 emergency phone number requirement is not addressed specifically in the ACCCS program, but is an obvious major interface that must be accommodated.

The ACCCS program, then, is the ensemble of all projects and supporting technology R&D tasks implemented to achieve the above goal. It does <u>not</u> encompass programs to proliferate implementation of operational systems beyond the development phase.

3. PROGRAM PLAN

Planning approaches for the ACCCS program are illustrated in Figures 1 and 2: Figure 1 addresses planning at the program level while Figure 2 presents a project plan, which is an element in the overall program plan. The methodology need not be discussed in detail, but a few key points are emphasized.

Referring to Figure 1, the overall program for ACCCS is comprised of a number of individual projects plus a supporting technology R&D program, a technical assistance program, and an ongoing evaluation task that serves to assess and redirect the program in response to project results.

Program requirements are established based upon fundamental standards and goals and a statement of general and specific objectives. In preparing this brief, a statement of specific objectives was found to be essential in assessing and recommending changes to the present ACCCS program. The absence to date of a statement of objectives has no doubt impeded the progress of the overall program.

The program plan is formulated to accomplish the general and specific objectives. In addition to a line item summary, which delineates the individual projects, the program includes the following elements:

- Statement of Priorities
- Master Schedule
- Resource Requirements
- Technology Requirements
- An Evaluation Plan
- A Lessons Learned Dissemination Plan
- A Grants Management Plan

A statement of Technology Requirements can be generated after a review of available technology and a comparison with technology needs for the ensemble of projects contained in the line item summary. The statement serves as a basis for formulating the Supporting Technology R&D Program. This component of the overall program plan does not exist, and it is recommended that one be prepared.

An observation regarding the overall ACCCS program plan is the absence of an adequate evaluation plan. A few evaluation reports are available for

FIGURE 1: PROGRAM PLANNING APPROACH

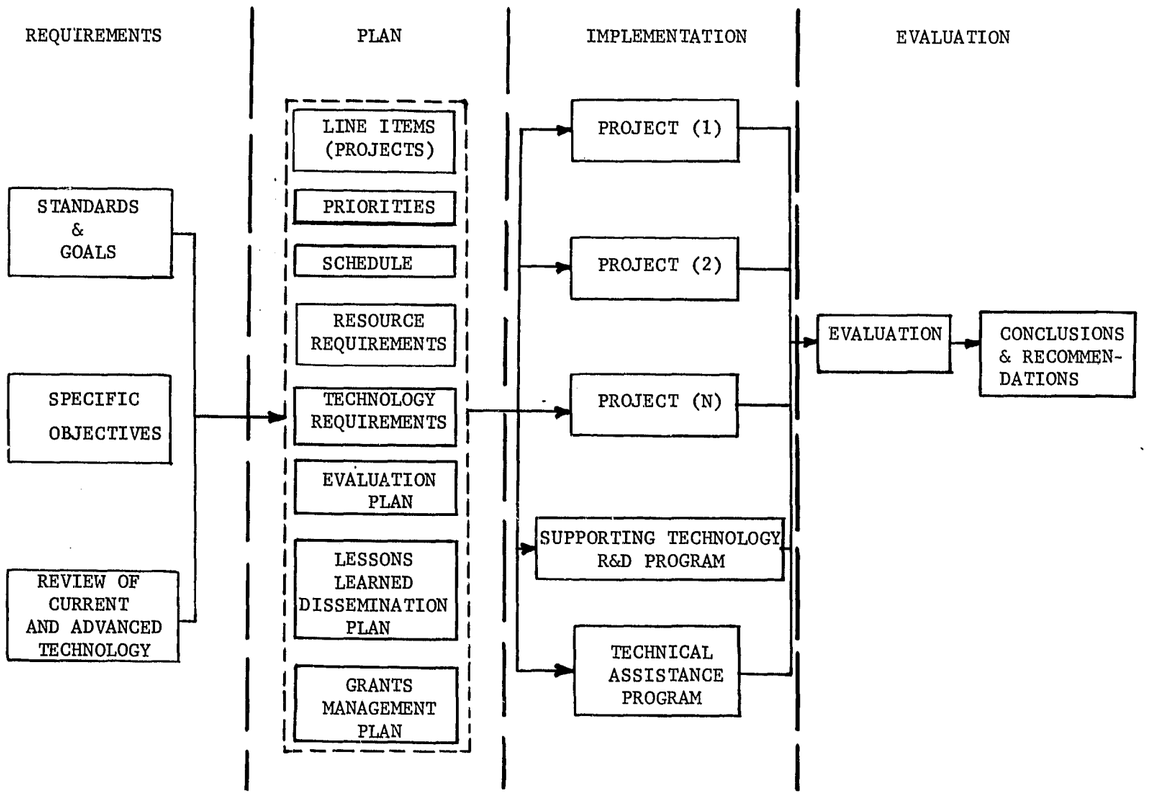
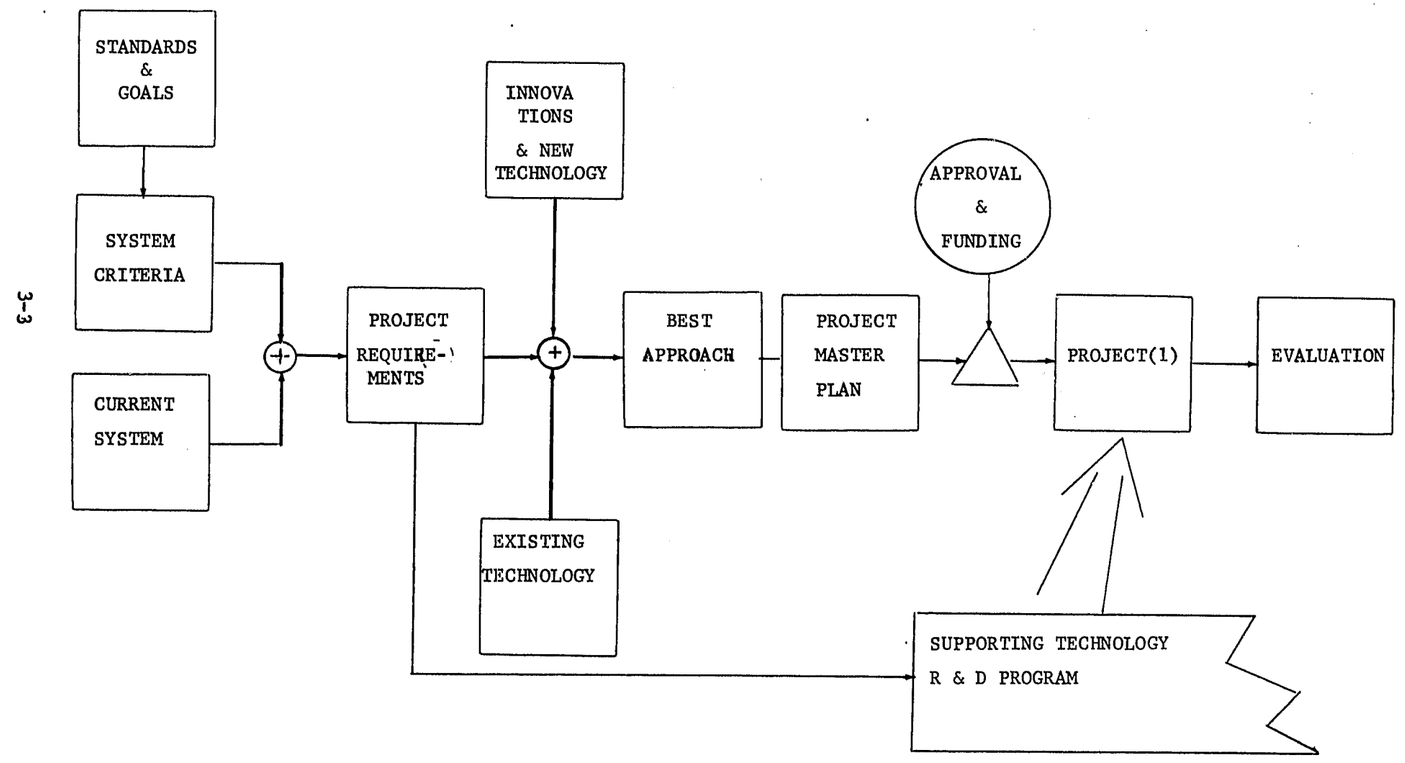


FIGURE 2: PROJECT PLANNING APPROACH



individual projects, but comprehensive assessments are not available. It is recommended that existing project evaluations be reviewed and summarized in the near future to rate the effectiveness of the projects, and, as important, to determine the effectiveness and adequacy of evaluation techniques and methodology. This topic is discussed further in Section 8, but it is readily apparent that quantitative evaluation techniques are lacking in many areas that are most visible to the political hierarchy and to the community. This task should be accorded a high priority by LEAA.

A key element in the overall program plan is the Lessons Learned Dissemination Plan, which assumes major importance because of the large number of diverse projects encompassed in the program, and because the program is already in "midstream" with several major projects completed or underway. The tendency for current projects to repeat the mistakes and false starts of prior projects in this dynamic environment is readily apparent. The Lessons Learned element would disseminate information about equipments or systems available from related projects, developmental or operational problems encountered, project management problems, and other findings that would encourage planners to avoid costly customized design approaches when standard equipments are adequate. In this regard, it is my observation that perfunctory visits by planners to review ACCCS implementations are inadequate to gain a good understanding and appreciation of the functions, design details, and practicality of the system; too often critical design features are glossed over and the planner promptly reverts to costly customized design approaches. It should be mandatory for a planner to perform a comprehensive assessment of existing designs before committing a project to customized equipments.

The seriousness of this problem can be illustrated by citing several recent trends in system implementations:

1) MDT has proved effective for direct data base queries, but is not a primary means of relieving channel congestion, which is being accomplished by acquiring more channels. Hence, emphasis is shifting from MDTs as a high-priority innovation. Developments in portable radios with digital keyboards is further complicating the MDT picture. A few agencies (Chicago) are considering replacement of conventional car radios with portable units.

2) CAD is coming to be recognized as a high-impact innovation because it affects basic command and control operations to a significant degree. Hence, CAD is being accorded a higher priority.
3) Human engineering aspects of CAD have been and are vastly underestimated as to their complexity and lead time to develop and debug. Costly overruns in software development have been experienced. Displays developed for small, lightly-loaded agencies do not function well when applied to large, heavily-loaded environments, necessitating costly and time consuming software redevelopments during system implementation.
4) All of the above have generated difficult project management problems, which are aggravated by the lack of centralized project management authority (typically, a data processing agency has jurisdiction over the computer systems, and a separate agency may be responsible for the communications system modifications).

Many formal and informal steps could be taken to enhance technology transfer and dissemination of Lessons Learned. Several are suggested in Sections 6, 7 and 9.

A Supporting Technology R&D program is indicated in both Figures 1 and 2. The purpose of this program is to advance the state of the art of various subsystems and equipments in response to requirements reported by user agencies, or where it is evident that certain advances will make significant improvements in system performance, or reductions in costs. Mobile/portable digital communication equipments are particularly in need of design improvements; size limitations in patrol units are incompatible with easily accessible, conveniently operated terminals. In many respects, basic human factors problems have been underestimated in both MDT and CAD systems, which have superimposed display monitoring/keyboard manipulation functions on a previously speech/auditory oriented process. The resulting interactions are not well understood, particularly in stress situations. These are but a few of the areas that should be addressed in a Supporting Technology R&D program.

Program general and specific objectives are discussed in the following section.

4. PROGRAM GENERAL AND SPECIFIC GOALS

A key element in the present planning exercise is the delineation of specific objectives for the program. These objectives provide a basis for comparison with the accomplishments of completed and ongoing projects, so that overlaps and gaps can be identified, and program adjustments made to better accomplish the overall goals.

The general goal of the ACCCS program can be stated as:

Demonstrate the feasibility and encourage the use of innovations in computer-aided command and control and digital communications for the purposes of:

- Discouraging criminal activities and reducing crime rate.
- Improving officer safety.
- Enhancing the effectiveness and resource utilization of law enforcement operations.
- Improving community relations.

Specific objectives are stated for MDT, CAD, AVL, combined systems, and for program-wide goals in Table 1.

TABLE 1: SPECIFIC OBJECTIVES

A. Mobile Digital Communications

1. Demonstrate the feasibility of digital communications for direct data base queries.
2. Demonstrate the feasibility of digital communications for status update.
3. Demonstrate the feasibility of digital communications for dispatch.
4. Demonstrate the feasibility of digital communications for administrative message exchange.
5. Determine screen size requirements in terms of number of displayed characters; determine requirements for and feasibility of paging.
6. Determine keyboard size requirements in terms of number of alphanumeric/special characters and control keys; special functions such as emergency trigger, "call me," "msg waiting," etc.
7. Demonstrate adequacy of screen visibility; physical size of keyboard for ease of manipulation; physical size of overall unit for officer mobility.
8. Demonstrate acceptable error free transmission/reception in typical urban environments.
9. Demonstrate feasibility of shared voice/digital communication links.
10. Determine reliability and availability of mobile terminals.
11. Develop and apply evaluation methodologies for the MDT R&D program.
12. Identify requirements for supporting technology R&D program.

TABLE 1. SPECIFIC OBJECTIVES (Cont.)

B. Computer-Aided Dispatch

1. Demonstrate the feasibility of CAD for Complaint taking.
2. Demonstrate the feasibility of CAD for dispatching and dispatch support functions.
3. Demonstrate the effectiveness and performance of CAD during normal (non-emergency) operations.
4. Demonstrate the effectiveness and performance of CAD during emergency operations (high priority and major disturbances).
5. Establish dispatcher work load as a function of number of dispatches and size of patrol force; establish upper limits of work load; compare to manual systems.
6. Demonstrate the effectiveness and performance of one-stage vs. two-stage CAD; determine requirements for auxiliary stations for data base queries and emergency services.
7. Develop and test display formats, including number of CRTs and formats for each display.
8. Develop and test keyboard layouts, including requirements for and utility of special function keys.
9. Design and test utility of geofile suitable for dispath operations.
10. Design and test utility of prior incident history for dispatch operations.
11. Design and test utility of microfiche data file and display for dispatch operations.
12. Establish effectiveness of shared vs. dedicated processors for CAD.
13. Develop and utilize data captured by the CAD system for management reporting, better use of resources.
14. Determining reliability and availability of CAD Systems.
15. Design and demonstrate effective training programs to facilitate phaseover to computer-aided operations.
16. Design and demonstrate a development "test bed" technique for use by agencies in preparing implementation specs. Specifically, the facility or technique will enable agencies to evolve work station design concepts, including display and keyboards, in a near-operational environment and thereby reduce costly design changes during implementation.
17. Develop and exercise evaluation methodologies for CAD projects.
18. Identify requirements for supporting technology R&D programs.

TABLE 1. SPECIFIC OBJECTIVES (Cont.)

C. Automatic Vehicle Location

1. Develop techniques and systems for AVL.
2. Demonstrate the performance and effectiveness of AVL for law enforcement applications.
3. Develop and demonstrate data transmission techniques compatible with mobile communications systems.
4. Develop and demonstrate a search-by-location capability.
5. Develop and demonstrate displays.
6. Develop and demonstrate a geofile for AVL applications.
7. Determine officer attitudes towards AVL systems.
8. Develop and apply evaluation methodologies for AVL.
9. Identify requirements for supporting technology R&D programs.

D. Combined MDT/CAD/AVL Systems

1. Demonstrate effectiveness and performance of CAD combined with digital communications. Determine those digital communications functions that best support and complement CAD.
2. Demonstrate effectiveness and performance of CAD combined with digital communications and AVL. Determine those AVL functions and performance levels that best support CAD.
3. Determine the impact on dispatcher workload of combined CAD/digital communications/AVL systems. Develop workable dispatcher/terminal/display concepts for these combined systems.
4. Establish desired sequence of implementation for combined systems, i.e., CAD prior to digital communications vs. CAD subsequent to digital communications.
5. Demonstrate effectiveness and performance of combined systems concepts in multi-agency multi-jurisdictional environment.
6. Develop and apply evaluation methodologies for combined systems projects.
7. Identify requirements for supporting technology R&D programs.

TABLE 1. SPECIFIC OBJECTIVES (Cont.)

E. Program-Wide Objectives

1. Demonstrate impact of advanced CCC systems on law enforcement agency operations, and on agency organization, management, and resource utilization.
2. Demonstrate impact of advanced CCC systems on improved community relations and reduced crime rate.
3. Develop and demonstrate techniques for most effective transfer of technology and project management "lessons learned" to potential new users.
4. Demonstrate feasibility of standardizing subsystems and equipments to facilitate technology transfer.
5. Develop and test project evaluation techniques.

5. PROJECT SUMMARIES

Brief summaries of completed or on-going projects are presented in Table 2 for MDT, CAD and AVL. Projects in the planning phase, such as Los Angeles, Portland and others are not listed. While the majority of projects are contained in Table 2, several others have not been surveyed, including Atlantic City, Cincinnati and Toronto; these and certain non-law enforcement systems should be included in a more comprehensive planning exercise. Additional information such as project costs, system loading, e.g., calls for service, and other relevant information also should be included.

TABLE 2: PROJECT DESCRIPTIONS

A. Mobile Digital Communications

	Chicago	Cleveland	Huntington Beach	Kansas City	Minneapolis	Oakland	New York State Police	Palm Beach County	San Diego
1. Base to Mobile	Visual Display (256 ch)	Visual Display (256 ch)	Printer	Visual Display (256 ch)	Visual Display (256 ch)	Visual Display (64 ch)	Visual Display (256 ch)	Visual Display (256 ch)	None
2. Mobile to Base	Text	Text	Status	Text	Text	Text	Text	Text	Status
3. Direct Data Base Query	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No
4. Status	No	No	Yes	No	No	No	No	Yes	Yes (15 units only)
5. Dispatch	No	No	Yes (Printer)	No	No	For Backup Mode Only (Display)	No	Yes (Display)	No
6. Shared vs. Dedicated Channel	Shared	Ded.	Ded.	Ded.	Ded. (Originally Shared)	Shared (Used Primarily for Digital)	Shared	Ded.	Shared
7. Car-to-Car Communications	No	Yes	No	Yes	Yes	Yes	No	Yes	No
8. Incident/Acitivity Reporting	No	No	No	No	No	No	No	Limited	No

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TABLE 2: PROJECT DESCRIPTIONS (cont.)

B. Computer-Aided Dispatch

	Dallas	Glendale	Huntington Beach	Las Vegas	NYC (Sprint)[1]	Oakland[2]	Palm Beach County	San Diego	Seattle	Shreveport
Type	2-Stage	1-Stage	2-Stage	2-Stage	2-Stage	2-Stage	1-Stage	2-Stage	2-Stage	2-Stage
Number of Displays										
Complaint	1	1	1	1	1	1	1	1	1	1
Dispatcher	1		2	2	-	1		2	1[3]	2
Keyboard[4]	Std	Std	Std	Std	Std	Std	Std	Std	Std	Std
CPU	Shared	Ded.	Ded.	Ded.	Shared	Ded.	Ded.	Ded.	Ded.	Ded.
Files										
Geofile	No	No	Yes	No	Yes	No	No	No	No	No
Incident History	No	No	Yes	No	No	No	No	No	No	No
Normal Ops										
CBO Disp	Dig.	---	Dig.	Dig.	Dig.	Dig.	---	Dig.	Dig.	Dig.
Disp Car	Voice	Voice	Dig.	Dig.	Voice	Dig.	Dig.	Voice	Voice	Dig.
Emer Ops										
CBO Disp	Dig.	---	Voice		Dig.	(Not	---	Dig.	Voice	
Disp. Car	Voice	Voice	Voice		Voice	used)	Voice	Voice	Voice	

(1) Electronic conveyor belt only; dispatcher does not use CRT/keyboard.
(2) Used for backup mode dispatching only.
(3) Converting to dual CRT display.
(4) Standard typewriter keyboard with limited number of special function keys.

TABLE 2: PROJECT DESCRIPTIONS (Cont.)

C. Automatic Vehicle Location

	St. Louis	Montclair
Type	Dead reckoning	Sign post
Data link	Mobile radio (dedicated ch)	Mobile radio (shared ch)*
Accuracy	50-100 ft.	1000 ft.
Display	Map	Map and printout

*Dedicated channel allocated subsequently.

6. PROJECT RESULTS

Project results are summarized in Table 3 by comparing them to the specific objectives listed in Table 1. The degree to which the objectives have been met is indicated, and trends in design approaches and in the relative priorities assigned to the various innovations are noted. For example, more emphasis is being focused on computer-aided dispatch because of its critical impact on the overall command and control system, whereas, mobile digital communications is receiving relatively less attention, due in part to the fact that digital communications is not the solution to relief of voice channel congestion; additional channels are becoming available in many cases. Also, the development of portable digital terminals may initiate a trend away from the 3-radio system: in-car voice, in-car digital, and portable. Regardless of the outcome of this "fly off", agencies may be reluctant to make firm commitments until the issue is clarified.

Automatic vehicle location systems are subordinated to computer-aided dispatch, and will not see wide-scale use until CAD systems are well established.

The important observation is that all of these important innovations are evolving toward operational status, but are subject to changes in design approaches and priority of implementation. This environment places obvious burdens on project management.

The general results of the review indicate:

A. Mobile Digital Communications

The feasibility of MDTs for rapid direct access to remote crime information files is well established; this is perhaps the primary application of MDTs. Use of digital communications for dispatch is less well established, but the printer-in-car approach is reasonably successful. Digital status updating is less successful because dispatchers do not trust the system, partially because of officer safety considerations, and because field units do not update status on a consistent basis. Digital links do not yet alleviate voice traffic to an appreciable extent.

Many operator/terminal interaction problems remain, and the physical design of MDTs leaves much to be desired.

Comprehensive evaluation of digital communications are lacking.

B. Computer-Aided Dispatch

Feasibility is well established for complaint taking. Dispatching is also feasible, although display formats and operator/terminal interface design are undergoing numerous changes and improvements (e.g., more information displayed simultaneously, use of dual screens). Dispatcher work loads not evaluated, not well understood. Lack of technology transfer from one agency to another (new users reinvent the dispatch work station terminal). Display terminal formats repeatedly changed during system implementation with costly software redevelopments. Performance under stress conditions, i.e., emergencies, not adequately demonstrated.

Shared CPU usually not satisfactory. Geofiles not adequately streamlined for CCC applications. No experience with incident history files.

Management reporting and resource allocation systems not developed and utilized with few exceptions.

Inadequate evaluation program. Supporting technology R&D program tasks not defined or initiated.

C. Automatic Vehicle Location

Feasibility not verified in Montclair. Current St. Louis test program should provide partial feasibility demonstration. Equipments, design approaches not well developed or demonstrated.

D. Combined MDT/CAD/AVL Systems

Limited experience with CAD plus MDT systems. Feasibility of printer-in-car approach reasonably well established. Channel congestion is not relieved appreciably because dispatch follow-up and status monitoring still performed by voice. More operational experience required to demonstrate effectiveness.

E. Program-Wide Objectives

Evaluation program not established; few projects have adequate evaluation. Supporting technology R&D program requirements not identified, or tasks initiated. Technology transfer not effective; remedies not developed and put into operation.

TABLE 3. COMPARISON OF SPECIFIC OBJECTIVES AND PROJECT RESULTS

A. Mobile Digital Communications

SPECIFIC OBJECTIVE	PROJECT RESULTS
1. Demonstrate the feasibility of digital communications for direct data base queries.	Several agencies have substantial operational experience; feasibility is well established by relatively high use rates compared to voice-only system. Impact on crime rate not evaluated.
2. Demonstrate the feasibility of digital communications for status update.	A few agencies have operational experience; feasibility is not conclusively established in that field units do not always report change of status promptly and/or correctly (HB, SD), requiring voice verification. One agency has insufficient number of units equipped to warrant changing the voice status verification procedure, resulting in inconsistent use of the device (SD); also, dispatchers tend to mistrust an "at scene" signal and prefer voice verification because of its vital importance to officer safety. Operational acceptance and reduced channel loading not quantitatively evaluated.
3. Demonstrate the feasibility of digital communications for dispatch.	Only two agencies use digital dispatch (HB, PB); both agencies transmit support (follow up) information and messages by voice, so that channel loading is not significantly reduced. Printer in car is endorsed by one agency because dispatch information is accurate, permanently recorded, and "transportable," i.e., an officer can carry copy of dispatch with him (HB). Convenient for APBs (HB, PB); less repeats of information. Reduced channel loading, reduced response time, printer vs. visual display not quantitatively evaluated.
4. Demonstrate the feasibility of digital communications for administrative message exchange.	Feasibility for APBs and BOLOs reasonably well established (HB, PB). Car-to-car communication used by several agencies, but relatively small channel traffic load. Reduced channel loading not quantitatively evaluated.

A. Mobile Digital Communications (Cont.)

SPECIFIC OBJECTIVES	PROJECT RESULTS
5. Determine screen size requirements in terms of number of displayed characters; determine requirements for and feasibility of	Several agencies have considerable operational experience with data base queries; message length requirements not evaluated; one agency has established a requirement for a 128 ch screen (LA). Two agencies have operational experience with dispatch messages (HB, PB); message length requirements not evaluated. One agency has tested feasibility of paging a small (64 ch) screen with negative results in that information was not easily remembered (LA).
6. Determine keyboard size requirements in terms of number of alphanumeric/special characters, and control keys; special function keys such as emergency trigger, "call me", "msg waiting", etc.	Several agencies have considerable operational experience with mobile to base message content; 256 ch screen seems excessive; small number of function keys is desirable. Greatest uncertainty lies in utility of status keys (see item (2)).
7. Demonstrate adequacy of screen visibility; physical size of keyboard for ease of manipulation; physical size of overall unit for officer mobility.	Screen visibility generally marginal; key size is marginal or inadequate; keyboard compactness is marginal to unacceptable. Standards should be developed.
8. Demonstrate acceptable error free transmission/ reception in typical urban environments.	Transmission/reception is generally error free (LA), but mixed test results have been experienced. Test results should be documented by all agencies so that standards can be developed. Normal equipment manufacturer product improvement programs should resolve specific problems satisfactorily.
9. Demonstrate feasibility of shared voice/ digital communication links.	Several shared voice/digital channel designs have been installed with mixed results. Performance is satisfactory in HB and SD, but digital load is small. One agency experienced considerable interference problems and converted to a dedicated channel (Minn.). In general, agencies have requested and received additional channels for digital links. While this is preferred by the individual agency, the argu-

A. Mobile Digital Communications (Cont.)

SPECIFIC OBJECTIVES	PROJECT RESULTS
	ment that digitization is a panacea for relieving channel congestion is no longer valid, particulary since the degree of digitization realizable in practice has not been established except for data base query. System delay time also has a significant impact on the effectiveness of digitization in relieving channel loading (LA, LEAA studies).
10. Determine reliability and availability of mobile terminals.	Several agencies have considerable operational experience and data on reliability and time to repair. Results should be summarized in a form useful to potential new users.
11. Develop and apply evaluation methodologies for the MDT R&D program.	With few exceptions, the results of MDT projects have not been evaluated, or at least only partially. Evaluation methodology is lacking. Individual agencies are left to their own devices and resources to evaluate projects, and few attempts are made to provide agencies with guidelines, methodologies, and consultant assistance to perform evaluations, particularly in the "soft" disciplines, e.g., impact on crime rate. As a result, most agencies reinvent the wheel when initiating implementation projects involving new technology. Section 8 addresses this problem in more detail.
12. Identify requirements for supporting technology R&D program.	A number of areas requiring further R&D are noted in the above comments. These problem areas have not been synthesized into a systematic supporting R&D program. Equipment manufacturers are addressing selected problem areas, but lack the perspective of the overall advanced CCC system program requirements.

B. Computer-Aided Dispatch

SPECIFIC OBJECTIVES	PROJECT RESULTS
1. Demonstrate the feasibility of CAD for complaint taking	Several agencies have substantial operational experience; feasibility is well established. Impact on overall CCC system not established. Close relationship with 911 requirements noted by several agencies, who are factoring this interface into system design. Use of CAD complaint taking has led to much improved interface with complainants, and more disciplined capture of data (SD).
2. Demonstrate the feasibility of CAD for dispatching and dispatch support functions.	Several agencies have substantial operational experience; feasibility is reasonably well established, but dispatcher console design suffered many shortcomings in early implementations, particularly displays and display formats (PB, Glendale, Seattle). Recent designs are much improved in that two CRTs are used in place of a single "busy" CRT (LV, SD, HB). Dispatcher functions are not well understood; an essentially auditory process has been replaced with combined auditory/visual/manual processes, and the interactions and proper balance between these processes is not well established. More experimentation and operational experience is required in this area. Agencies should be encouraged to develop a limited number of carefully selected advanced design concepts.
3. Demonstrate the effectiveness and performance of CAD during normal (non-emergency) operations.	Several agencies have considerable operational experience during non-emergency operations. The more recent designs perform satisfactorily under such conditions (HB, SD, PB, Glendale). Dispatcher work load measurements are not being performed, however, except for SD.
4. Demonstrate the effectiveness and performance of CAD during emergency operations (high priority and major disturbances).	Agencies have limited operational experience during major disturbances. It is not known how well CAD will perform under high stress conditions, nor at what point the system will saturate or break down.

B. Computer-Aided Dispatch (cont.)

SPECIFIC OBJECTIVE	PROJECT RESULTS
5. Establish dispatcher work load as a function of number of dispatches and size of patrol force; establish upper limits on work load; compare to manual systems.	Limited data exist to establish dispatcher work load models and limits; only one agency is being analyzed (SD).
6. Demonstrate the effectiveness and performance of one-stage vs. two-stage CAD; determine requirements for auxiliary stations for data base queries and emergency services.	Considerable experience is available to compare one-stage vs. two-stage (CBO + dispatcher) design implementations. One-stage designs are reasonably effective in small agencies (Glendale, PB), whereas the larger agencies are universally going to two-stage designs. Three-stage designs, e.g., the LA manual system with CBO, dispatcher and RTO, are not being considered. Two-stage designs should utilize a separate station for data base queries, and possibly ambulance and two requests (Seattle); an additional design approach(es) of the latter type, i.e., "primary" and "secondary" dispatch stations, should be explored.
7. Develop and test display formats, including number of CRTs and formats for each display.	Display formats, and the number of displays, have undergone rapid changes with operational experience. There is a noticeable trend toward multiple screens, one for status and a second for incident/operations management (PB, Glendale, Seattle, SD, LV, HB). A single CRT with many display formats is too "busy" in a reasonably heavily loaded station, and multiple displays are being implemented to alleviate this problem. Further improvements could be made, and seem to offer substantial improvements. For example, dispatchers should be able to use a light pen to call up cases, make car assignments, etc., rather than the keyboard. More experimentation should be performed in this area, emphasizing improved display and ease of assimilation of data with reduced keyboard manipulations. Human engineering is sadly lacking in the design of critical work stations and console/operator interactions (e.g., dispatcher stations).

B. Computer-Aided Dispatch (Cont.)

SPECIFIC OBJECTIVE	PROJECT RESULTS
8. Develop and test keyboard layouts, including requirements for and utility of special function keys.	Keyboard configurations are reasonably well standardized at this point, with a limited number of function keys.
9. Design and test utility of geofile suitable for dispatch operations.	Only one agency has an operational geofile at present (HB); other agencies are developing suitable files. It is apparent that geofiles for dispatch purposes are simpler than those developed for other municipal applications, and simply loading in "the geofile" can lead to many difficulties and large maintenance (update) costs; also, accessing a general geofile through a municipal central processor can lead to response time delays as well as to large software development costs. Agencies should be cautioned to appreciate the full significance of using available municipal geofiles, and determine if a simplified geofile should be prepared for use in the CCC processor.
10. Design and test utility of prior incident history for dispatch operations.	No agencies have a prior incident file in operation. The utility and cost of such a file should be demonstrated as part of an advanced CCC system project. (See comments under (9)).
11. Design and test utility of microfiche data file and display for dispatch operations.	One agency is operating a microfiche file at present (HB). The utility and cost of such a file should be demonstrated in a larger agency.
12. Establish effectiveness of shared vs. dedicated processors for CAD.	Nearly all agencies use dedicated minicomputers for CAD implementations; these perform adequately. One agency uses a shared computer with satisfactory results (Dallas); another has encountered severe developmental difficulties in using a large municipal CPU for its real time file management (SF).

B. Computer-Aided Dispatch (Cont.)

SPECIFIC OBJECTIVE	PROJECT RESULTS
	and this latter approach should be studied carefully by agencies considering a similar approach. In a very large agency, a preliminary trade-off study indicated a preference for a network of distributed minicomputers, although IBM rebutted with an analysis showing slight advantages for a large, central CPU (this CPU would be dedicated to the CCC system and not shared with other municipal agencies, in contrast to SF). Software costs for the minicomputer network might be greater, and the network controller more complex, however, additional analysis is required in this area.
13. Develop and utilize data captured by the CAD system for management reporting, better use of resources.	Very few agencies have developed management reporting systems and resource allocation procedures using data captured by the CAD system (Glendale is an exception). Agencies should be encouraged to initiate this activity in the very near future, since a prime hypothetical advantage of CAD is enhanced management reporting and resource utilization.
14. Determining reliability and availability of CAD Systems.	Agencies are acquiring considerable operating experience and data on reliability and time to repair. Results should be aggregated in a form useful to potential new users.
15. Design and demonstrate effective training programs to facilitate phaseover to computer-aided operations.	Several agencies have phased over from manual to CAD operations with little disruption to services (HB, PB, SD), primarily because extensive, near-operational training programs were developed and used. These training techniques should be reported and disseminated to potential user agencies to avoid costly duplication of training program development.

B. Computer-Aided Dispatch (Cont.)

SPECIFIC OBJECTIVE	PROJECT RESULTS
16. Design and demonstrate a development "test bed" technique for use by agencies in preparing implementation specs. Specifically, the facility or technique should enable agencies to evolve work station design concepts, including displays and keyboards, in a near-operational environment and thereby reduce costly design changes during implementation.	Little dissemination of lessons learned has taken place from agency to agency, and potential new users repeat the costly process of developing console layouts, display formats and keyboard functions. This situation occurs because new user agencies do not study existing systems in depth, and superficially examine the facility without attempting to operate the stations. In several cases, costly program overruns have been incurred because of software changes made after start of implementation (PB, HB, SD, Seattle, Detroit). The specific objective stated here is intended to remedy this lack of technology transfer by encouraging new users to develop formats and software requirements in a near-operational environment prior to initiating implementation.
17. Develop and exercise evaluation methodologies for CAD projects.	The results of CAD projects have not been evaluated, either in terms of physical results such as impact on the required number of operations personnel, reduction in response time, and improved utilization of field units, or in terms of improved organizational management and service to the community. Few attempts are made to provide agencies with guidelines, methodologies and consultant assistance for evaluations.
18. Identify requirements for supporting technology R&D programs.	A number of important areas requiring further R&D are noted in the above comments, particularly in the CAD human engineering disciplines (also in MDTs to a lesser extent). These problem areas have not been synthesized into a systematic supporting technology R&D program. Equipment manufacturers are not performing necessary human factors experiments inhouse, and tend to sell off-the-shelf systems, which merely perpetuate the problems (Seattle is a good example: dispatch stations designed for a much smaller operation (PB) were required originally, and are now being replaced by dual CRT configurations). Individual agencies spend considerable time and dollars solving the same problems.

C. Automatic Vehicle Location

SPECIFIC OBJECTIVE	PROJECT RESULTS
1. Develop techniques and systems for AVL.	Two law enforcement applications have been implemented to date: St. Louis using a dead reckoning system, and Montclair using a sign post system. Other systems have been developed for non-law enforcement applications, and provide a considerable choice of equipments for law enforcements uses. Other design approaches that may prove competitive are being explored.
2. Demonstrate the performance and effectiveness of AVL for law enforcement applications.	The Montclair installation is inadequate to demonstrate the utility of AVL for LE CCC systems; system performance results were not encouraging. The St. Louis application should provide a workable AVL system, but it is not integrated with the overall CCC system; the supporting communications load is large. The project is being evaluated by Mitre, and the results should be valuable in evaluating its utility for other applications. A significant unknown in all AVL applications is the required location accuracy: 1000 ft is probably adequate for dispatch response time as well as for administrative purposes, whereas 50 to 100 ft may be required for officer safety. The latter requirement holds whether or not the officer is in his car and greatly complicates the question of system design and utility. The St. Louis installation is sufficiently accurate to locate a car to within 100 ft but does not address the out-of-car problem.
3. Develop and demonstrate data transmission techniques compatible with mobile communications system.	Both Montclair and St. Louis transmit location data through the mobile radio systems. Because of the large fleet size and frequent update requirements (one-second intervals), the St. Louis system requires a dedicated, heavily loaded digital channel. If the 100 ft accuracy requirement is relaxed and cars are polled only when calls for service are received, the communications load is greatly reduced. This technique has not been tested, but is proposed by some agencies (HB, LA).

C. Automatic Vehicle Location (Cont.)

SPECIFIC OBJECTIVE	PROJECT RESULTS
4. Develop and demonstrate a search-by-location capability.	This capability is currently not available in Montclair or St. Louis (the latter is continuously polled). The technique is applicable to a poll-for-dispatch mode.
5. Develop and demonstrate displays.	The St. Louis AVL system has graphic displays with a degree of resolution commensurate with system accuracy. Displays suitable for search-by-location techniques are not available (see items 3, 4).
6. Develop and demonstrate a geofile for AVL applications.	Neither Montclair nor St. Louis have geofiles for computing distance and optimal routes to given locations; the latter significantly complicates the overall AVL system.
7. Determine officer attitudes towards AVL systems.	Response in one agency (Montclair) was negative because the system experienced hardware difficulties and was not adequately debugged. St. Louis will provide a good measure of officer acceptance because the tight locational accuracy will force the "electronic sergeant" issue to a test; hopefully, the installation will contribute positively to officer safety and reduced response time, and offset any negative reactions to the "electronic sergeant" feature.
8. Develop and apply evaluation methodologies for AVL.	The Mitre evaluation of the St. Louis project should provide an adequate assessment of the dead reckoning type of system.
9. Identify requirements for supporting technology R&D programs.	Many R&D tasks have or can be identified from the above comments; many of these tasks have a low priority and should not be initiated until results of on-going programs are evaluated. An R&D program should be formulated, however.

D. Combined MDT/CAD/AVL Systems

SPECIFIC OBJECTIVE	PROJECT RESULTS
1. Demonstrate effectiveness and performance of CAD combined with digital communications. Determine those digital communications functions that best support and complement CAD.	Very limited experience has been gained with projects combining CAD and digital communications (HB, Oakland, PB, Seattle, Shreveport). Downlink printers have been used successfully in HB and Shreveport, with reasonably good acceptance by the field units; one agency operates a visual text downlink (PB) with good success; some redundancy in voice/digital messages is noted (HB, PB) as additional information becomes available during the service call. Status update via digital links seems less well established (HB) and considerable negotiation of actual status condition is noted (HB, SD). One agency has a small fraction of its total fleet equipped with digital status update capability, and these units still adhere to the mandatory voice procedures of reporting verbally 10-7, 10-8, and 10-97 status (SD). Digital dispatch is used almost exclusively for low priority calls, and rarely for emergency dispatching. Much additional experience, and perhaps new system concepts will be required before agencies have sufficient confidence in combined systems to make full use of digital communications where officer safety is at stake (confidence in the exact location of the unit, and arrival time at the location).
2. Demonstrate effectiveness and performance of CAD combined with digital communications and AVL. Determine those AVL functions and performance levels that best support CAD.	No experience has been accumulated with combined CAD/AVL systems. This would seem to be a candidate for selected testing after CAD/digital communications systems are further advanced toward operational status. A significant problem area is the imposition of still another display at the dispatcher station. This should be addressed in the supporting technology R&D program prior to project implementation.
3. Determine the impact on dispatcher workload of combined CAD/digital communications/AVL systems. Develop workable dispatcher/terminal/display concepts for these combined systems.	No experience has been accumulated with these combined systems; R&D programs have not been established to deal with the significant human engineering problems involved (see item (2)).

D. Combined MDT/CAD/AVL Systems (Cont.)

SPECIFIC OBJECTIVE	PROJECT RESULTS
4. Establish desired sequence of implementation for combined systems, i.e., CAD prior to digital communications vs. CAD subsequent to digital communications.	Optimal sequences of implementation of combined system have not been developed or demonstrated. MDTs have proved effective for data base queries, but have not served to reduce channel congestion significantly, and, in fact, in most cases are served over newly acquired channels that could also be used to reduce voice channel congestion. Hence, digital communications have been reduced in priority to some extent. Conversely, CAD has proved to have a greater impact on the overall command and control system operation, as well as being fraught with more difficult design problems, particularly in the man/machine interface areas. Until these problems are resolved, as well as those addressed in item (1), it would seem more appropriate to shift implementation priority to CAD systems. Carefully selected supporting technology R&D programs could be especially beneficial in developing more effective CAD design concepts, in contrast to experimenting with design approaches during individual agency implementation projects.
5. Demonstrate effectiveness and performance of combined systems concepts in multi-agency multi-jurisdictional environment.	Little experience has been accumulated in this area except for a relatively small system in PB. Since this may be a prime application for CAD, the experience gained with the South Bay project in the Los Angeles metropolitan area should be monitored closely. The problems of combining advanced CCC system concepts with 911 requirements should be examined further.
6. Develop and apply evaluation methodologies for combined systems projects.	Results of combined CAD/digital communications projects have not been evaluated (see item (17) under CAD).
7. Identify requirements for supporting technology R&D programs.	Several problem areas have been identified that require further R&D, particularly in dispatcher/terminal human factors research, and in the acceptability of digital communications for status reporting where officer safety is involved. In the former area, several projects could well benefit from a unified supporting technology R&D Program by avoiding costly duplication of effort at the

D. Combined MDT/CAD/AVL Systems (Cont.)

SPECIFIC OBJECTIVE	PROJECT RESULTS
7. (Continued)	project implementation stage. Equipment manufacturers are unlikely to address and solve these problems as part of normal inhouse product development programs.

E. Program-Wide Objectives

SPECIFIC OBJECTIVES	PROJECT RESULTS
1. Demonstrate impact of advanced CCC systems on law enforcement agency operations, and on agency organization, management, and resource utilization. 2. Demonstrate impact of advanced CCC systems on improved community relations and reduced crime rate.	Items (1) and (2) will be comprised of the overall results of the total program of projects. Limited results are available on the impact on law enforcement agency operations; other impacts are undetermined.
3. Develop and demonstrate techniques for most effective transfer of technology and project management "lessons learned" to potential new users.	The principal means of technology transfer is through vendor equipments, and through vendor marketing activities. Both are reasonably effective in a matured field of technology, but less so in the present situation. On site visits by potential new users are relatively ineffective because of the intangibility of software, operational procedures, and project management. Two approaches would improve technology transfer: first, a stipulation in the grant approval that the recipient formally evaluate existing design concepts as implemented by other agencies; this would require potential new users to examine available technology more critically, and, hopefully, reduce the trend to customized design approaches. Secondly, CAD test beds could be developed and made available to potential new users, providing a near operational environment for development of design approaches; in essence, the test bed could be a software package readily adaptable to a single computer terminal with access to a small data storage device. Again, this would enable agencies to evolve workable design approaches <u>prior</u> to system implementation. Additional steps could be taken to expose agencies to available technology.
4. Demonstrate feasibility of standardizing subsystems and equipments to facilitate technology transfer.	Some success has been achieved in standardization in communications and computers. To what extent further standardization could be achieved in CCC systems should be investigated; some positive results might be achieved since equipment designs are not "frozen."

E. Program-Wide Objectives (Cont.)

SPECIFIC OBJECTIVE	PROJECT RESULTS
5. Develop and test project evaluation techniques.	Limited project evaluation is being conducted; the Mitre evaluation of the St. Louis vehicle location system is one of the few comprehensive appraisals being conducted. See related comments in the foregoing sections.

7. PROJECT COVERAGE

Project coverage is assessed in Table 4 by comparing the specific objectives listed in Table 1 with the project summaries given in Table 2. Gaps and overlaps are identified, and comments given about the status of project evaluation, i.e., in many cases data are available to meet the requirements of a specific objective, but the data have not been evaluated and summarized in a form useful to the program manager.

The general results derived from this comparison indicate the following:

A. Mobile Digital Communications

Generally, an adequate number of MDT projects have been completed or initiated to satisfy the program spcific objectives. Overlaps exist in many areas, to the extent that additional project starts are not warranted. Marginal coverage is indicated in demonstrating the utility of MDT for status updates; few agencies have tested this function adequately, and its acceptance for field operations is not conclusively demonstrated. Gaps exist in project evaluation and in identification of tasks for the supporting technology R&D program.

B. Computer-Aided Dispatch

Less experience has been gained with CAD systems and, in general, system concepts are still evolving; however, a marginal to adequate number of projects have been initiated to demonstrate applications and performance aspects of CAD, and project overlaps are noted in some cases. The human factors considerations in work station design have not been addressed adequately, and concepts in this area are still evolving. A gap exists in developing an "operational test bed" technique that agencies can use to develop procurement specs for work stations prior to implementation. Another significant gap exists in development of management report and resource allocation systems based on CAD data files; such systems may prove to be the primary benefit of CAD, and should be developed by the agencies during early phases of the projects. As with MDT, gaps exist in project evaluation and in identification of tasks for a supporting technology R&D program.

C. Automatic Vehicle Location

Project coverage is marginal in most aspects of AVL, however, this may be consistent with the relatively small impact of AVL on ACCC systems, i.e., AVL should be given a low priority until CAD developments are further advanced. Required locational accuracy has yet to be defined rigorously for the somewhat conflicting demands for officer safety, dispatch response time, and general fleet administration. AVL is one area for which provisions have been made for project evaluation (by MITRE).

D. Combined MDT/CAD/AVL systems

Many gaps exist in this area. The complex interactions between the various subsystems, particularly MDT/CAD, are not well understood, and few projects are oriented to resolving these uncertainties. These gaps should be covered by selected additional projects, primarily for an agency(ies) serving about one million people, i.e., one that is relatively heavily loaded. Technology transfer from small agencies (150,000 population) to much larger agencies has not proved feasible in several instances.

E. Program-Wide Objectives

Gaps exist in all areas: general impact of ACCCS on law enforcement agencies; impact on crime rate and community relations; effectiveness of technology transfer; and development and application of evaluation techniques.

Detailed comments on project coverage are given in the following table.

TABLE 4: PROJECT COVERAGE

A. Mobile Digital Communications

AREA	SPECIFIC* OBJECTIVE	PROJECT COVERAGE	EVALUATION COVERAGE
a) Applications Data Base Query	1	Overlap. Several agencies have operational experience. Data available for evaluation.	Query volume measured. Impact on hit rate, crime rate and channel loading not measured.
Status	2	Marginal. Only one agency has operational experience (HB); partial data from SD, Shreveport. Some data available for evaluation.	Acceptance of digital status updating not adequately verified.
Dispatch	3	Marginal. Three relatively small agencies use for dispatch (HB, PB, Shreveport). Some data available for evaluation.	Acceptance of digital dispatch not completely verified. Impact on channel loading, message redundancy not evaluated.
Administrative Messages	4	Marginal. Several agencies have car-to-car message transmission experience; 3 agencies use for APBs and BOLOs (HB, PB, Shreveport). Not used for incident reporting.	Adequate data for administrative message transmission but not evaluated. Use for incident reporting not evaluated.
b) Design Screen Size	5	Overlap. Several agencies have considerable data on message length distribution.	Data not evaluated nor results summarized.

*See Table 1A.

A. Mobile Digital Communications (Cont.)

AREA	SPECIFIC OBJECTIVE	PROJECT COVERAGE	EVALUATION COVERAGE
Keyboard	6	Overlap. Several agencies have considerable data on suitability of various keyboard configurations.	Data not evaluated nor results summarized.
Visibility, Size	7	Overlap. Several agencies have considerable experience with various designs.	Data not evaluated nor results summarized.
c) Performance Error Rate	8	Overlap. Several agencies have considerable data with various designs.	Data not evaluated nor results summarized.
Shared vs. Dedicated	9	Adequate. Several agencies have experimented with both shared and/or dedicated channels.	Data not evaluated nor results summarized.
Reliability, Availability	10	Adequate. Several agencies have experience with various designs.	Data not evaluated nor results summarized.
d) Evaluation	11	Gap.	Overall plan lacking. Survey of required and available methodology and tasks should be conducted.
e) Supporting Technology R&D Program	12	Gap.	Overall plan lacking. Survey of required tasks should be conducted.

B. Computer-Aided Dispatch (Cont.)

AREA	SPECIFIC* OBJECTIVE	PROJECT COVERAGE	EVALUATION COVERAGE
a) Applications			
Complaint Taking	1	Overlap. Several agencies have considerable experience with CBO operations.	Work station loading data not analyzed. Impact on response time, citizen acceptance not evaluated nor results summarized.
Dispatch	2, 3, 4	Overlap. Several agencies have considerable experience with dispatch operations.	Work station loading data not analyzed. Impact on response time not evaluated. Performance during emergency operation not evaluated.
b) Performance			
Work Station Analysis	5	Overlap. Several agencies have considerable data for various system implementations (1- vs. 2-stage; CBO and dispatcher stations; voice and digital dispatch).	Work station loading not analyzed. (See 2-4 above).
1- vs. 2-Stage	6	Overlap. (See (5) above.)	(See (5) above.)
c) Design			
Displays and Keyboards	7, 8	Marginal. Number of displays (1 vs. 2 CRTs) and display formats have experienced continuous change in design approach, e.g., dual screens are replacing single screen designs to avoid "busy" screen problems. An "optimal"	Substantial data available but not analyzed or evaluated. (See 2-4 above).

*See Table 1B.

B. Computer-Aided Dispatch (Cont.)

AREA	SPECIFIC OBJECTIVE	PROJECT COVERAGE	EVALUATION COVERAGE
Displays and Keyboards (Cont'd)		design not yet appeared. This problem should be addressed in a supporting technology R&D program to avoid costly developments within each new project. This is the single most costly source of project overruns.	
Geofiles	9	Marginal. Only 2 agencies have operational files (HB, NYC). Since geofiles are costly to construct and maintain, more experience with minimal dispatch address verification files should be acquired.	Some data available. Not evaluated.
Prior Incident History Files	10	Gap. No operational files of this type.	
Microfiche Data Files	11	Gap. Only one agency operating such a file (HB). Utility not established.	Some data available. Not evaluated.
Shared vs. Dedicated CPU	12	Adequate. All installations have dedicated CPU except two (SF, Dallas). Considerable difficulty is being experienced with the former.	Adequate data available. Not evaluated.

B. Computer-Aided Dispatch (Cont.)

AREA	SPECIFIC OBJECTIVE	PROJECT COVERAGE	EVALUATION COVERAGE
d) Management Reports & Resource Allocation	13	Gap. Several agencies capture necessary data but have not evolved management reporting or resource allocation systems. Since this objective is vital in justifying CAD, additional efforts should be directed to this purpose.	Marginal data available for evaluation. No evaluation attempted.
e) Reliability	14	Adequate. Several agencies have experience with various designs.	Data not evaluated nor results summarized.
f) Training	15	Adequate. Several agencies have experience with various implementations. "Lessons learned" not adequately disseminated.	Data not evaluated nor results summarized.
g) Development Test Bed	16	Gap. This is one of the most critical gaps. Inexpensive, easily/quickly implemented "test beds", or test bed techniques are not available to new users; many agencies do not develop CBO/dispatcher work station designs prior to project implementation, resulting in costly redesigns during or after implementation (HB, PB, Seattle, Detroit, etc.). Many solutions could be found, but the problem is not being pursued. The human engineering aspects of CAD are grossly underestimated.	Limited data available but not evaluated or disseminated.

B. Computer-Aided Dispatch (Cont.)

AREA	SPECIFIC OBJECTIVE	PROJECT COVERAGE	EVALUATION COVERAGE
h) Evaluation	17	Gap.	Overall plan lacking. Survey of required and available methodology and tasks should be conducted.
i) Supporting Technology R&D Program	18	Gap.	Overall plan lacking. Survey of required tasks should be initiated.

C. Automatic Vehicle Location

AREA	SPECIFIC* OBJECTIVE	PROJECT COVERAGE	EVALUATION COVERAGE
a) Systems and Equipments	1	Marginal. Two agencies have operating systems; non-law enforcement agencies have developed additional systems and equipment (Montclair, St. Louis). Other technical approaches may be competitive and should be tested.	Montclair results unfavorable. Mitre is evaluating St. Louis' system.
b) Effectiveness for Law Enforcement	2	Marginal. See (1) above. Adequate to demonstrate effectiveness for dispatch operations (response time); marginal for proving effectiveness for officer safety. Not integrated with CAD.	See (1) above.
c) Data Transmission	3	Marginal. St. Louis approach requires very large data band width; other techniques have far less communications load.	See (1) above.
d) Search-by-Location Capability	4	Gap.	
e) Displays	5	Marginal. St. Louis system not tested in CAD environment. Displays for locate-for-dispatch only not tested.	See (1) above.
f) Geofile	6	Gap.	

*See Table 1C.

C. Automatic Vehicle Location (Cont.)

AREA	SPECIFIC OBJECTIVE	PROJECT COVERAGE	EVALUATION COVERAGE
g) Officer Acceptance	7	Marginal. St. Louis system will test "electronic sergeant" reaction. Other approaches having locate-for-dispatch-only should be tested.	Montclair system not favorably received by officers. See Item (1).
h) Evaluation	8	Adequate. Mitre evaluation of St. Louis system should contribute significantly to evaluation methodology.	See Item (1).
i) Supporting Technology R&D Program	9	Gaps. Many subsystem areas need further R&D. Program should be phased in gradually, however, depending on results of St. Louis project.	Not evaluated. See Item (1).

D. Combined CAD/MDT/AVL Systems

AREA	SPECIFIC* OBJECTIVE	PROJECT COVERAGE	EVALUATION COVERAGE
a) CAD/MDT	1	Gap. Only three agencies have operational experience (HB, PB, Shreveport). Degree of acceptance varies; seems best suited for low priority dispatches, with voice/manual backup mode for emergencies. No large agencies have implemented a combined system.	Limited data available. Impact on dispatcher work load, channel loading, and response time not evaluated. Feasibility for emergency dispatcher not evaluated. Feasibility for large, heavily loaded CCC systems not evaluated.
b) CAD/MDT/AVL	2, 3	Gap. No systems operational.	
c) Sequence of Implementation	4	Marginal. Several agencies have limited operational experience, but results inconclusive; priorities are changing due to less emphasis on MDT; CAD has greater impact on CCC system design and operation, but impact on overall operation effectiveness is difficult to quantify.	Limited data available; can provide some guidelines for establishing priorities. Not evaluated.
d) Multi-agency, Multi-jurisdictional	5	Gap. Only one application (PB). Additional applications should be implemented since potential payoff is large.	Limited data. Not evaluated.

*See Table 1D.

D. Combined CAD/MDT/AVL Systems (Cont.)

AREA	SPECIFIC OBJECTIVE	PROJECT COVERAGE	EVALUATION COVERAGE
e) Evaluation	6	Gap.	Overall plan lacking. Survey of required and available methodology and tasks should be initiated.
f) Supporting Technology R&D Program	7	Gap.	Overall plan lacking. Survey of required tasks should be initiated.

PROJECT COVERAGE

E. Program-Wide Objectives

AREA	SPECIFIC* OBJECTIVES	PROJECT COVERAGE	EVALUATION COVERAGE
a) Impact on LE Operations and Effectiveness	1	Gap. Impacts can be quantified in selected areas: channel loading; CBO and dispatcher work station loading; data base query rates. Impacts on resource utilization, and on agency organization and management cannot be quantified at this point.	Quantifiable impacts not evaluated.
b) Impact on Crime Rate, Community Relations	2	Gap. Impacts difficult to quantify (an exception may be the impact of MDT on vehicle related crimes).	Not evaluated.
c) Technology Transfer	3	Gap. Many areas can benefit by an effective "lessons learned" dissemination plan: design approaches, training, project management. Technology transfer is lacking.	Not evaluated.
d) Standardization	4	Gap. High payoff if feasible. No standardization-oriented tasks initiated.	Not evaluated.
e) Evaluation	5	Gap.	Overall plan lacking. Survey of required and available methodology and tasks should be initiated.

*See Table 1E.

8. EVALUATION

The previous sections have pointed out the many gaps that exist in project evaluation. While it is beyond the scope of the present brief to survey evaluation methodology and recommend a specific program to develop and apply the requisite evaluation techniques, the general nature of the problem can be indicated by citing the experience of one agency in preparing its project summary report (HB).* Specific and general objectives were developed by the agency in compliance with the grant application guidelines; these objectives are listed in Figure 3. The specific objectives deal generally with the physical performance of the upgraded command and control system, whereas the general objectives deal with the more nebulous factors related to the impacts on crime rate and community relations.

The final report submitted by the agency compared the project results with the objectives, giving some interesting observations about the limitations of the evaluation techniques. As shown in Figure 3, the methodology is generally adequate for measuring the impact on the physical performance of the upgraded command and control system, but inadequate for measuring the impact in the more general areas of crime rate and community relations; i.e., the success in meeting the specific objectives could be assessed, but the success in meeting the general objectives could not be quantified. As the figure points out, the factors associated with the general objectives are much more visible to the community and to the political heirarchy, raising the dilemma that the factors not visible to the public can be evaluated, whereas the visible factors cannot.

It is recommended that tasks be initiated to assess and augment our capabilities in this area.

*See Table 2A, B for a project summary.

FIGURE 3: EVALUATION TECHNIQUES AND LIMITATIONS

	CAN IMPACT BE QUANTIFIED	IS IMPACT VISIBLE TO AGENCY	IS IMPACT VISIBLE TO POLITICAL HEIRARCHY	IS IMPACT VISIBLE TO COMMUNITY
SPECIFIC OBJECTIVES				
IMPROVED C & C COMMUNICATIONS	YES	YES	MARGINAL	NO
REDUCED RESPONSE TIME	YES	YES	MARGINAL	MARGINAL
INCREASE INVESTIGATION INFO	YES	YES	NO	NO
BETTER UTILIZATION OF RESOURCES	YES	YES	YES	NO-MARGINAL
GENERAL OBJECTIVES				
REDUCE CRIME	NO-MARGINAL	YES-MARGINAL	YES	YES
IMPROVE COMMUNITY RELATIONS	NO-MARGINAL	MARGINAL	YES	YES
IMPROVE OFFICER SAFETY	YES-MARGINAL	YES-MARGINAL	MARGINAL	NO
FEASIBILITY OF CAD	YES	YES	MARGINAL	NO

9. SUPPORTING TECHNOLOGY R&D PROGRAM

An outline for a Supporting Technology R&D program is given in Tables 5 and 6. The purpose of this program is to advance the state of the art of various subsystems in response to requirements reported by user agencies, or where it is evident that certain advances will make significant improvements in system performance, or significant reductions in costs.

The essential elements (i.e., line items) of the program can be stated for each of the major subsystems of ACCCS, as indicated in Table 5. For each line item, a specific project can be initiated, as illustrated in Table 6. Mobile/portable digital communication units are particularly in need of design improvements because size limitations in patrol cars are incompatible with easily accessible, conveniently operated terminals. In many respects, the basic human engineering problems have been underestimated, since the necessity to operate a keyboard and read information from a display intrudes upon the basic functions of surveillance and voice communications. The design of display terminals and keyboards for CAD operators is similar human factors problems, and heavy project overruns have been experienced because display formats were evolved during (and not prior to) system upgrades, necessitating costly software redevelopments.

It is recommended that a list of tentative R&D projects be developed, and priorities established by estimating the potential benefit of the technology improvement to the overall ACCCS. The list would also serve to coordinate the advanced technology tasks sponsored elsewhere with the system projects discussed herein.

TABLE 5: SUPPORTING TECHNOLOGY R&D PROGRAM NEEDS

1. DISPATCH
   - DYNAMIC ALLOCATION OF BEAT ASSIGNMENTS
   - TACTICAL SITUATION DISPLAYS
   - SHORT-TERM FORECASTING OF CALL FOR SERVICE LOAD
   - CAD/AVL INTEGRATION
   - TECHNIQUES FOR CALL ALLOCATION WITH TEAM POLICING
   - OPTIMAL CALL ALLOCATION TECHNIQUES FOR MULTI-AGENCY SYSTEMS
2. PATROL UNITS
   - FIELD IDENT CAPABILITY
   - FIELD BOOKING
   - HEADS UP DISPLAYS
   - MICROPROCESSOR/DATA BASE SUBSYSTEMS
   - SLO SCAN VIDEO/FACS
   - VEHICLE DESIGN
3. COMMUNICATIONS
4. AVL
5. MDT
6. COMMAND & CONTROL CENTER

TABLE 6: SUPPORTING TECHNOLOGY PROJECT

NEED: IMPROVED FIELD UNIT UTILIZATION BASED ON DYNAMIC BEAT ASSIGNMENT. APPLICATIONS TO MULTI-PRECINCT, MULTI-DIVISION, AND MULTI-AGENCY (COOP) SYSTEMS.

GOAL: DEVELOP HARDWARE, SOFTWARE AND OPERATIONAL PROCEDURES FOR DYNAMIC FIELD UNIT ASSIGNMENT.

TASK:
1. ACQUIRE DATA ON INTER-AREA FIELD UNIT MOVEMENTS
2. ACQUIRE DATA ON CCC SYSTEM LOADING
3. DEVELOP OPERATIONAL PROCEDURES AND SOFTWARE
4. DEVELOP AND TEST IMPLEMENTATION
5. EVALUATE

SCHEDULE: 18 - 24 MONTHS

10. RECOMMENDED LINE ITEM PROJECTS

Table 7 presents a recommended set of line item projects, covering the specific objectives listed in Table 1. These projects address only the R&D requirements for ACCCS, and not the proliferation of equipments for widespread operational use. I believe that considerable additional R&D projects should be completed and evaluated before major system buys are initiated. This belief is supported by the observation that design approaches are evolving rather rapidly in several major areas, and that it is premature to set design standards at this time. Also, careful evaluation of ongoing or completed projects have not been completed nor the results readily accessible to potential new users. Two to four years may be required to reach some degree of stability in system design approaches.

It is recommended that a more comprehensive long-range plan be developed to guide and unify the ACCCS program.

A schedule of the major projects is given in Figure 4.

TABLE 7: RECOMMENDED PROJECT (LINE ITEM) SUMMARY

		DATE
NEW PROJECTS		
1.	Develop and demonstrate CAD plus mobile digital communications for a medium-sized city. MDT should be capable of receiving digital dispatch messages and transmitting status updates. San Diego has a good operational CAD system, and a partially implemented MDT system to support this project.	1976-1977 (FY 76 start)
2.	Develop and demonstrate CAD plus mobile digital communications for a large city. Initiate subsequent to Item (1), or on a partial basis if sooner.	1977-1979 (FY 77 start)
3.	Develop CAD plus mobile digital communication plus AVL for a small city. Huntington Beach has a good, operational CAD plus MDT system to support this project.	1976-1977 (FY 76 start)
4.	Develop CAD plus mobile digital communications plus AVL for a medium-sized city. Initiate subsequent to Items (1) and (3). Initiate on a partial basis if applied to a large city sooner.	1977-1980 (FY 78 start)
5.	Develop CAD plus mobile digital communications for a medium-sized, multi-agency, multi-jurisdictional consortium. The Los Angeles South Bay cities program is suitable for this purpose.	1975-1977 (FY 75 start)
6.	Demonstrate AVL for a medium-sized city. St. Louis is suitable for this purpose. Displays, geofiles, location accuracy requirements can be demonstrated by this project.	1974-1975 (FY 74 start)
PROGRAM SUPPORT TASKS		
7.	Initiate a technology transfer or Lessons Learned dissemination project. The planning guideline manuals project (JPL) is contributory to this plan, but should be supplemented by seminars, and by agency personnel exchange programs. The Supporting Technology R&D program will also contribute.	1975-1976 (FY 76 start)
8.	Initiate a program evaluation project. Specific tasks include: survey and summarize results of current projects; survey evaluation methodology; extend evaluation methodology to cover gaps.	1975-1976 (FY 76 start)

TABLE 7: RECOMMENDED PROJECT (LINE ITEM) SUMMARY (Cont.)

PROGRAM SUPPORT TASKS (Cont.)	DATE
9. Initiate a project to determine feasibility of subsystem/equipment standardization.	1977-1978 (FY 77 start)
10. Initiate a Supporting Technology R&D program. Survey current projects for requirements; incorporate results of items (7) and (8). Tasks should include: human factors analysis for displays, formats, and keyboards for complaint board and dispatcher stations; same for MDTs; work load analysis under normal and emergency (stress) conditions; development of a test bed to support above tasks; AVL equipments and techniques.	1975- (FY 76 start)
11. Develop a long range plan for advanced CCC systems. The elements of this plan are discussed in Section 3. A survey of all on-going or planned projects in ACCCS should be made to support this project.	1976- (FY 76 start)
SPECIFIC EVALUATION TASKS	
12. Evaluate CAD plus mobile digital communications for small city. Huntington Beach and Palm Beach County suitable for this project. Tasks should include channel loading measurement (voice and digital), dispatches handled digitally, status updates handled digitally, dispatcher work station loading.	1976- (FY 76 start)
13. Evaluate MDT utilization for queries, dispatches, status updates. Tasks should include measurement of query rate (compared to voice query rate), impact on hit rates, and impact on crime rate (at least GTA). Physical features and performance should be evaluated. Agencies suitable for evaluation include Kansas City, Minneapolis, Cleveland, Palm Beach County, Oakland and others.	1976-1977 (FY 76 start)
14. Evaluate CAD. Develop criteria for measuring effectiveness of CAD. Compare dispatcher work load per station with manual system. Evaluate effectiveness in supporting management report, patrol force allocation, response time, reporting accuracy, and impact on agency operations. Agencies suitable for evaluation include Huntington Beach, San Diego, Seattle, Dallas, Shreveport, Palm Beach County and others.	1976-1977 (FY 76 start)

TABLE 7: RECOMMENDED PROJECT (LINE ITEM) SUMMARY (Cont.)

SPECIFIC EVALUATION TASKS (Cont.)	DATE
15. Evaluate geofiles for CAD; determine essential elements (with and without AVL). Suitable agencies are Huntington Beach and St. Louis.	1976-1977 (FY 76 start)
OPERATIONAL PROJECTS (See Section 4)	
16. Determine continuing support requirements for on-going projects, such as additional MDT buys for Minneapolis, Cleveland and others.	

FIGURE 4: PROJECT SCHEDULE

	On Going	FY 76	FY 77	FY 78
Develop and Demonstrate MDT for:				
Query	PB, NY, Chi, Oak, Minn, KC, Cleve			
Status	HB, SD, Shreve			
Dispatch	PB HB Shreve			
Develop and Demonstrate CAD for:				
Small City	PB HB Shreve			
Medium-size City	SD, Sea			
Large City			2	
Develop and Demonstrate AVL for:				
Small City	Montclair			
Medium-size/Large City	St. Louis (6)			
Develop and Demonstrate CAD + MDT for:				
Small City	PB HB Shreve			
Medium-size City		1*		
Large City		(2)**	2	
Multi-Agency, Multi-Juris Consortium	South Bay (5)			
Develop and Demonstrate CAD + MDT + AVL for:				
Small City		3		
Medium-size City				4

*Indicates project number; see Table 7.
**Implement on partial basis only in FY 76.

10-5

END