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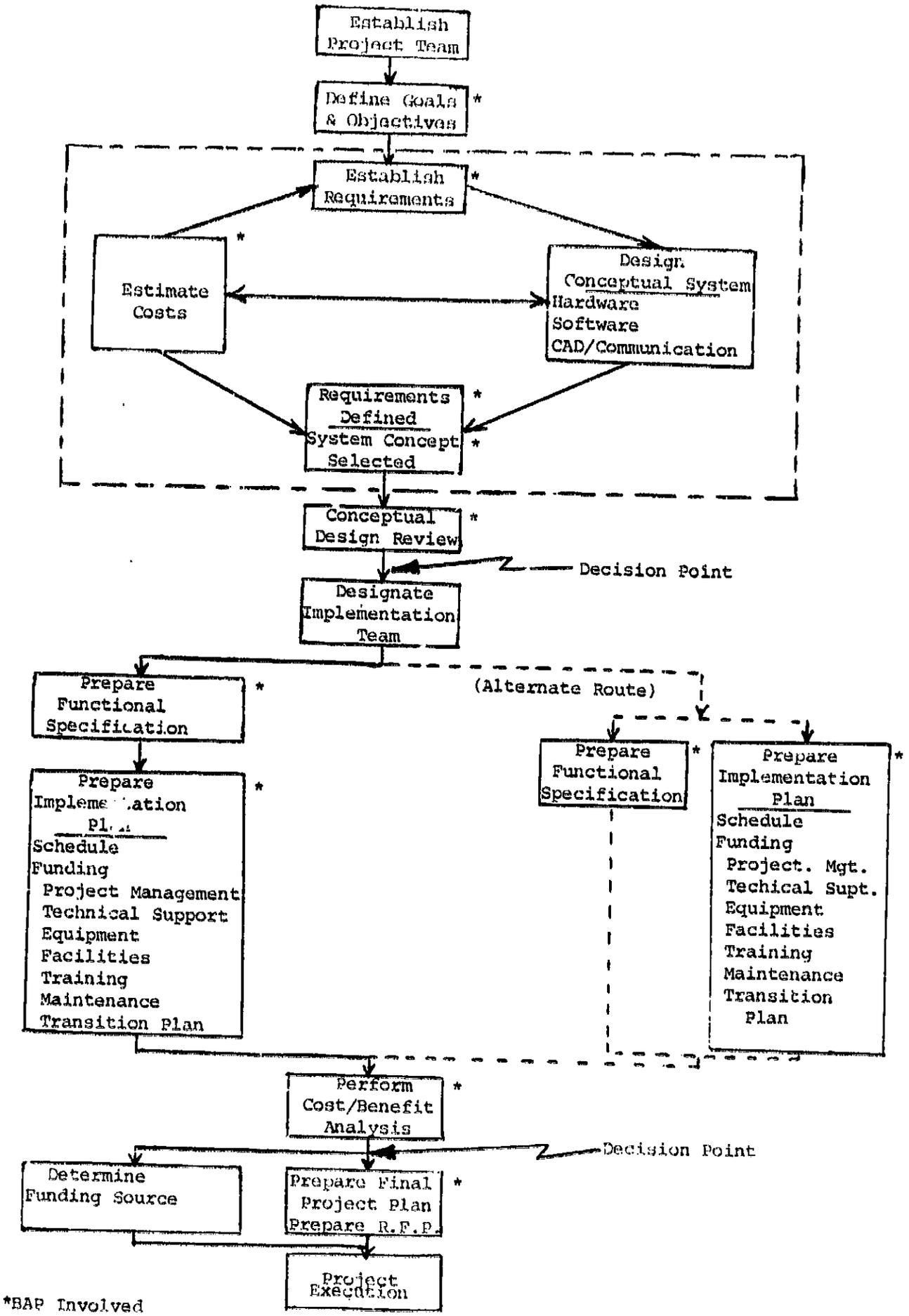
PROJECT FLOW CHART
BALTIMORE FIRE DEPARTMENT DISPATCH AND COMMUNICATION SYSTEM



*BAP Involved

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INTRODUCTION

In early 1977, officials of the City of Baltimore became concerned over the capacity of the Fire Department to respond to fires occurring simultaneously in different parts of the city. Only a few weeks earlier, a school had burned down because fire apparatus could not respond quickly enough to both the school fire and others elsewhere in the city. It seemed obvious to these officials that technology could help the response problem. It had done so in other cities such as San Francisco.[1] But what type of technology? At what cost? And how to insure that things would not go wrong--that a new system would really do the job? (In some other cities, expensive installations had been made, but the operational problems remained unsolved.)[2]

What concerned Baltimore, then, was a situation common to city government--a general feeling that applying technology might help solve a problem, coupled with an apprehension that deciding to go for a technology-intensive solution might be very costly and might not yield good results.

The apprehension of Baltimore was well founded. By 1977, many state and local governments had participated in federally sponsored "technology transfer" programs in which enthusiastic federal scientists and engineers sought to apply advanced technology to their problems. It seemed that whenever a new technology was perfected in a federal research and development program, an attempt was made to bring it to the attention of state and local officials and to urge that there must be a problem which could be solved by application of that technology.

Often the results of these efforts were disappointing. In the rush to identify problems and push technology at them, important factors were overlooked and obstacles were underestimated. Such episodes made state and local officials wary of technology transfer because too often the outcome amounted to a financial and political liability. Even when problems were solved, unanticipated consequences caused a net loss for the state and locality, in the opinion of officials. In short, when there is an excess of "technology push," when inappropriate technology is applied, or when the state or local government cannot "follow through" on the technology due to lack of available money or expertise, the experience of technology transfer may be disastrous or at least very uncomfortable for the state or local government.[3]

Nevertheless, the promise of a technological solution--especially when a problem is urgent--combined with the concern that a state or locality may be accused of being behind the times or uninterested in innovation--prompts state and

local officials to try technology application.

For Baltimore officials, however, the question of whether to chance a technological solution, or to risk keeping the old system with minor changes, did not seem to be an insoluble dilemma. Baltimore had a source of advice and counsel on such questions which lessened the probability that a poor choice would be made. Baltimore had an established relationship for technical assistance with the National Aeronautics and Space Administration's (NASA) Goddard Space Flight Center (GSFC).

In 1974, Baltimore officials noticed an item in the New York Times concerning the assignment of a NASA technology agent to help solve problems in New York City.[4] Why could not NASA do the same for Baltimore, especially since Baltimore was located only 30 miles from the Goddard Center? Baltimore contacted NASA. Within months, Baltimore and GSFC signed an agreement. It provided that GSFC would give technical assistance to Baltimore "to test the feasibility and to measure the effects of utilizing technology in the solutions of problems...that affect the urban environment generally and... administrators in Baltimore specifically."[5]

The general approach of this continuing cooperative venture--known as the Baltimore Applications Project (BAP)--calls for GSFC to "review and analyze" those areas of particular concern to Baltimore officials "for the purpose of applying existing NASA technology or that developed by other federal research and development activities."[6] A GSFC engineer--called a technologist in residence--is assigned to the Mayor's office. The agreement also makes a variety of NASA resources available to Baltimore, including "professional expertise at NASA laboratories."

From 1974 to 1977, BAP assisted Baltimore in over 50 tasks. As Baltimore officials saw it, BAP provided a source of objective help. A sense of trust and mutual respect had developed. The technologist in residence--Thomas Golden-- was regarded by Baltimore officials with esteem. He never tried to push a technology or to appear to have a superior understanding of the city's needs and problems.

He was interested in listening to city officials and finding ways to solve problems through mutual cooperation whether technology was involved or not.

This was the context in which the Baltimore mayor's office asked BAP to assist it with the Fire Department dispatch and response problem.

PURPOSE

The purpose of this report is to present a case study of the Baltimore Fire Dispatch Project. The case study was performed under the terms of NASA-GSFC purchase order S-66151B.

The case study has the following objectives: (1) to describe the Fire Dispatch Project, with special attention to the role and contributions of the BAP, (2) to analyze the process of technology application involved in the project, with special emphasis on the value of an arrangement such as the BAP in increasing chances for successful problem solving in city government, (3) to make findings and recommendations concerning application of technology to urban government problems similar to the Fire Dispatch Project.

SCOPE

This report is limited to a case study of the Fire Dispatch Project. The time period studied is 1977-80. No attempt is made to study the entire BAP program or the general area of urban technology application. Nevertheless, since the Fire Dispatch Project was carried out through the BAP and constituted an instance of applying technology to an urban problem, some attention must be given to these topics in order to fully describe and analyze the Fire Dispatch Project.

Therefore, consideration is given to the nature and characteristics of the BAP, the interaction and interpersonal relationships of Baltimore officials and BAP technologists in residence and the characteristics and elements of the technology application process which bear on the Fire Dispatch Project.

Because this case study has many facets, it is approached from four perspectives corresponding to the interests of government officials or academic observers. These are:

1) Fire service perspective. (Fire dispatch improvement through technology application.)

2) Technology transfer perspective. (Urban problem solution through association of a city and an outside source with expertise in technology.)

3) Public administration perspective. (Urban government and intergovernmental relations--understanding how to apply technology to urban problems.)

4) Innovation perspective. (Capacity to accept and incorporate effective new approaches and methods for conducting urban government.)

METHODOLOGY

The description section of the case study was based on several sources of information. These included: (1) official documents and reports of the BAP, the City of Baltimore, and GSFC, (2) personal interviews with key participants in the Fire Dispatch Project, and knowledgeable observers including officials in the Mayor's Office, the Fire Department, other city agencies, GSFC staff, contractors, and persons in federal agencies, interest groups, unions, community groups and professional societies, (3) newspaper, magazines and community and internal Fire Department newsletters, (4) literature on urban technology application and transfer, including scholarly studies, journal articles and reports of the National Science Foundation and other federal agencies, (5) literature on fire service innovation, (6) literature on urban government, (7) interviews with officials in fire departments in other cities with modernized fire dispatch systems (e.g., Los Angeles, San Francisco).

The analysis, findings and recommendations sections of the report draw upon the sources referred to above and also on the literature of urban technology application, especially works of W. Henry Lambright[7] and R. Yin.[8] These scholars emphasize that successful application of technology in urban government is largely a function of the urban decision-making process. The decision-making process is of especially great significance in determining whether the innovation becomes incorporated or routinized.

SIGNIFICANCE

Improved utilization of technology by urban governments is an important goal of the federal, state and local governments. Experience with technology application indicates that it is very difficult and subject to both expected and unexpected obstacles. Although numerous studies of the general problem and of specific cases of urban technology application have been made, there is little agreement on what are the best approaches for successful application or on what the role of the federal government should be.[9] And, although many of the previous case studies provide important information on the process of technology application, there is general agreement on the need for additional case studies, especially of cases in large cities.

Among the specific reasons for this case study are:

1) Relatively few previous case studies deal with application of "hard technology," as opposed to innovations in education, management, systems methodology, etc.

2) Most previous case studies deal with small and medium sized U.S. cities, rather than large populations of approximately one million or more.

3) This is the first full case study of a BAP project. Previous BAP case studies have been quite limited and have been called "mini-cases."[10]

A full case study of a BAP project assumes added significance today in view of recent federal legislation. Athough there is still much controversy over how the federal government can best aid technology application by state and local government, in October 1980 Congress enacted Public Law 96-480. This law requires large federal research and development (R&D) laboratories to (1) establish offices of research and technology applications to promote use of technologies developed in their laboratories by private industry and state and local government, (2) devote 0.5 percent of their R&D budgets to promote transfer of federal technology, (3) have at least one professional full-time staff member in its office of applications.

BAP is one model, among many, which federal laboratories could adopt in implementing this act. This case study should clarify the advantages and drawbacks of this model.

This case study is significant in view of action by the Reagan administration to reduce funding for technology transfer. With less funding available it becomes crucial to determine which types of technology application are most beneficial to urban communities.

Finally, this case study is significant because it attempts to view the process of technology application from both the standpoint of the provider of technical assistance (GSFC) and the user--the City of Baltimore. Most previous case studies have been provider oriented.

DESCRIPTION

The origins of the Fire Dispatch Project can be traced to early 1977 when a fire engulfed the Roland Park Country School in North Baltimore. Investigation indicated that the fire burned out of control because dispatchers could not locate and dispatch fire equipment in time to save the school.

This inability arose not from lack of competence or slowness of the dispatchers, but rather from the lack of communications and dispatch capacity of the manual system installed

in 1960. With the manual system, in cases where the closest fire equipment was not available, it was necessary for the dispatcher to call each fire station to determine the status of its equipment. Further, the dispatcher was required to locate the address of the fire on a wall map and relate it to the location of the nearest fire station, and then to call that fire station to dispatch equipment. If the nearest equipment was not available at the station called first, the dispatcher would have to locate the next closest station and call, and so forth. When two or more fires or fire alarms occurred simultaneously or even within minutes of one another, the length of time needed to locate and dispatch the necessary equipment could stretch to several minutes. While the manual system worked well enough for instances of isolated fires, it was literally overwhelmed by heavy activity.

With fire alarms in the city growing at a rapid rate, the instances of heavy activity were also increasing quickly. Nevertheless, the motivation to modernize might not have come in 1977 were it not for the fact that the head of the school board in the district in which the burned down school was located was Calhoun Bond, a distinguished attorney from one of the oldest and most influential families in Baltimore. Bond was also head of the Baltimore Fire Board. The Board oversaw and made policy for the Baltimore Fire Department. The Board's three members were unpaid and served part-time. They paid close attention to the Department's operations, including communications and dispatch, but there was little push for change until the school fire. From that point on, however, Bond and other Board members pressured Department personnel to move toward modernization. The Department itself had considered requesting funds for installing a new dispatch system, but had not done so prior to 1977.* The political and financial climate did not seem favorable.

As fire officials saw it, there was little prospect of funding for fire dispatch modification. The City had other pressing priorities. The interest of Bond and the Fire Board, however, changed the picture. Bond was close to the Mayor and had good access to him (the Fire Chief at the time had a pro forma relationship with the Mayor). City Hall became receptive to the idea.

It was at that time that the Mayor's Office asked for BAP assistance. In 1977, BAP had been in existence for 3 years. It had handled approximately 50 tasks. The dispatch project,

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*Interviews indicated that there was skepticism among some Fire Department officials as to the need for and effectiveness of computer aided dispatch systems.

however, was one of the first to involve help in the investigation of alternative technical solutions that also involved implementation of the chosen solution in an area of high priority. In earlier years, GSFC had concentrated more on tasks emphasizing problem identification and needs assessment. This was to be the first implementation experience.[11]

The approach used by GFSC in the BAP has several significant characteristics. These include: (1) the insistence on "user pull"--that is that the predominant initiative for requesting assistance should come from city officials or community groups, (2) the "technologist in residence" concept--in which the person assigned to help the city is a member of the technical staff of an R&D facility in the immediate vicinity of the city and is assigned to the office of the city's chief executive, (3) continuity of the relationship--the project is considered to be much more than a "one-shot deal" and the tenure of the technologist in residence is expected to continue for some time, (4) high level commitment, high priority--both the chief executive of the city and the R&D facility take an active interest, support the project, and give it high priority relative to other activities, (5) the designation of a high level city official to be the interface with the technologist in residence, (6) the avoidance by the government facility of competition with commercial sources, (7) the lack of "stake" by the government facility in substantive issues--the facility exercises no regulatory authority over the city nor is involved in programmatic relationships--the "stake" is only in assisting the city to solve problems, and (8) non-intervention in the governmental operations of the city.[12]

The request for BAP involvement came from Bernard Berkowitz, the Mayor's Physical Development Coordinator. Berkowitz was the City's liaison with Golden and BAP. Golden, occupied with other BAP projects and realizing that the fire dispatch project was a major undertaking requiring full-time attention, sought a GSFC engineer to handle the assignment. He selected Philip Yaffee, an electrical engineer who had been with Goddard since 1960. Yaffee had worked on a variety of electronics problems and had extensive experience with writing specifications and monitoring contractors. (Later, another GSFC staff member, computer expert Harold Theiss, also became involved in the project.)

Fire Department officials felt that a full computer-aided dispatch and communications system (CAD) should be considered seriously. Many cities were opting for a CAD. Learning of the Department's interest, the State and Local Systems Division of the Motorola Company submitted an unsolicited proposal and arranged for a briefing for City officials on its capabilities in CAD. The briefing was held in May, 1977 at the Baltimore Hilton Hotel. The Fire Department asked Yaffee to attend.

Although the Fire Board was exerting pressure for approval of a new dispatch system, the Mayor was not convinced that the City could finance it. The project would cost several million dollars and require a bond issue. Economic development had a very high priority for the Mayor and City Council and the City had a restrictive legal bonded debt limit.[13] A voice of caution was raised also by the Baltimore City Planning Department. Was a CAD really needed or could minor modifications suffice?[14]

While City officials were deliberating, Yaffee was conducting a survey and analysis of whether a CAD was needed. He visited the Baltimore Fire Department Communications Dispatch Center and reported that 1) the existing dispatch equipment was obsolete, 2) a considerable improvement in speed of response to a fire or ambulance emergency could be obtained by computerized dispatching, 3) maintenance of existing dispatching and communications equipment was difficult because replacement parts were unavailable, 4) considerable time spent in manually preparing reports could be saved by computer application, 5) the physical environment of the dispatchers was conductive to fatigue and stress because of background noise and poor lighting conditions, and 6) gaps existed in certain areas of radio communications coverage.[15]

In addition, Yaffee visited the Virginia Beach, Va., Fire Department where a CAD had recently been installed and had telephone interviews with fire officials in San Francisco, New Orleans, Denver and Boston where CADs had recently been installed, as well as surveying the CAD literature. As a result, he not only was able to note the potential value of a CAD for Baltimore, but could provide better guidance to City officials on how to avoid the pitfalls encountered by other cities.

Yaffee's report and advice was a major input in the decision of Baltimore to go for a full CAD system. Pressure from the Fire Board alone would not have sufficed.[16]

The Mayor and his advisers decided to finance the project partially through bond issues for a total of $3 million, ($1.3 million in 1978 and $1.7 million in 1979). The two-stage process avoided the problem of placing the full amount on the ballot in one year, thus lessening the competition with economic development bonds, as well as others.

Baltimore newspapers and civic groups gave strong support to the bond issues in both 1978 and 1979 and the issues passed in both years by substantial margins.[17]

THE MANAGEMENT PROCESS

Once the decision had been made to go to a full CAD

system,* the question of how to proceed had to be answered. To do so, a city-wide task force was established with Berkowitz as chairman. Membership included representatives of the Fire Department, Office of Telecommunications, Planning Department, Bureau of Purchases, Bureau of Management Information Systems, Bureau of Budget and Management Research and the DAP, represented by Yaffee.[18]

The first question facing the task force was how to proceed with planning for and contracting for the project. One option was to contract out to a single company all work connected with the project including study of the requirements, development of performance criteria and specifications and development and installation of hardware and software. The task force rejected this option, largely on the advice of the Bureau of Purchases and Yaffee; instead, the task force opted for awarding a "study" contract for a needs assessment, development of recommendations for a CAD system and writing performance specifications. These specifications would form the basis for the Request for Proposal for the "implementation" contracts. Both the study and implementation contracts would be competitively bid.

At this point, Yaffee began to render significant technical assistance. (In this activity, he and Theiss worked closely with City officials.) Yaffee developed the overall project plan, statement of work, and work flow chart, as well as the specifications for the study contract. Yaffee was also a member of the committee which evaluated the proposal for the study contract.[19]

In addition, Yaffee and Theiss constituted the technical evaluation committee for review of contractor proposals for the implementation contract. Yaffee also played a key role in guiding Baltimore officials with regard to the scope of the implementation contract and methods for buying equipment. Yaffee strongly recommended a "turnkey" contract as well as a "dedicated" computer for the Fire Dispatch and Communications System.[20] He also endorsed suggestions that Baltimore directly purchase many of the major components of the system, rather than having the implementation contractor do so. This so-called "drop ship" approach reduced costs by eliminating contractor overhead and profit on the $600K equipment purchases. It also insured that City procedures designed to obtain the lowest possible bid were used.[21]

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*When the term "CAD" is used in this report, it refers to a complete communications and computer-aided dispatch system.

Yaffee and Theiss also guided Purchasing and Fire Department officials on questions of reasonableness of cost for equipment, software and modifications proposed by the implementation contractor and vendors.[22]

Each of these specific BAP activities was considered vital to the project by Baltimore officials. The participation of BAP provided Baltimore officials with a sense of confidence in their management of the project as a whole.

STATUS OF PROJECT

The CAD project in Baltimore is divided into three phases: (1) fixed station communications (completed), (2) computer-aided dispatch equipment installation (scheduled for completion by mid-1981), (3) mobile and portable communications (to be completed during 1982). Two bond issues for partial financing ($1.3 million in 1978; $1.7 million in 1979) were approved by Baltimore voters by substantial margins. The entire project is estimated to cost $4 million. Implementation is proceeding on schedule. No cost overruns or major technical problems have been experienced.

ROLE OF CONTRACTORS

An important aspect of CAD was the role of the two contractors. The "study" contract was awarded to Atlantic Research Corp. of Alexandria, Virginia. The Baltimore evaluation team, of which Yaffee was a member, recommended ARC because it appeared to have a good grasp of the requirements, had relevant experience and was the low bidder. The study contract called for the contractor to do a needs assessment, to recommend the approach by which the implementation phase should be carried out and to write detailed performance specifications.[23]

ARC's performance of these tasks was viewed by Baltimore officials with mixed feelings. Although the ARC final report and specifications were accepted by Baltimore and full payment was made to the contractor, some Baltimore officials were less than satisfied. Some Fire Department staff felt that ARC personnel spent too little time working at the Fire Department sites, and did not consult sufficiently with Fire Department personnel or with Yaffee and Theiss. As a result, they noted, the initial user needs survey was incomplete, and the first set of performance specifications as submitted initially by ARC was not sufficiently comprehensive and detailed.[24] (The problem with the quality and completeness of the specifications was considered so serious that the

Bureau of Purchases asked ARC to do more work on them. ARC responded that this would constitute work beyond the original scope of the contract, and that an additional $7,000 would be necessitated for this work, which ARC called "interpreting the specifications." Baltimore officials decided not to spend the additional money.)[25]

ARC's work, however, was complemented and supplemented by Yaffee's activities. Yaffee was very interested in getting the best idea possible of the actual needs of users. (According to BAP philosophy, this is one of the principal tasks of a technology agent.) Yaffee and Theiss also "reviewed" the performance specifications as written by ARC. In actuality, Yaffee and Theiss spent considerable time "going back and forth" with ARC over the specifications, with the result that the original specifications were significantly modified both in scope and level of detail.[26] The final specifications as issued in the Request for Proposals were excellent for their comprehensiveness, precision and level of detail, according to Fire Department and Bureau of Purchase officials, as well as Motorola (the contractor). Motorola officials stated that the quality of the specifications contributed to their ability to prepare a responsive proposal and to keep cost estimates low.[27] (When some other prospective bidders were asked by the Bureau of Purchases why they did not bid on the implementation contract, they stated that the specifications were so tight that they knew they lacked the capability to do the job.*)[28] Only two proposals from Motorola and Eagle Signal Corp. were received for the implementation contract, although 55 companies expressed an interest and 43 attended the bidders conference.

Yaffee and Theiss constituted the technical evaluation committee for review of the two proposals. They found the Motorola proposal superior to the proposal submitted by Eagle Signal Corporation.[29]

Motorola was well attuned to the needs of Baltimore for a CAD. The company had a long relationship with Baltimore and had kept in close touch with City officials throughout the late 1970's. Upon learning of the Fire Department's interest in a CAD, the company sent an unsolicited proposal to the City and arranged for a briefing of City officials on its CAD capabilities at the Baltimore Hilton Hotel. This activity helped Baltimore in its consideration of whether to go to a CAD and gave Motorola a better understanding of the needs and preferences of Baltimore officials.[30]

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*Some other firms did not bid because they were tied up by other jobs.

The role of Motorola was greater in some respects than simply that of an implementation contractor. After it was awarded a contract, Motorola acted as a source of general advice to Baltimore on matters concerning general management of the project. For example, Baltimore was concerned with keeping total costs below $4 million--a figure which had been presented to the City Council. The Motorola bid was $4.9 million, but in negotiations Motorola, aware of the political problem, suggested that certain major items of equipment be purchased by the City directly, thereby reducing the City's project price to $4.2 million. This so-called "drop ship" approach resulted in a cost savings for the project of $700,000 to the City, since it reduced overhead and profit on these items and resulted in other savings. The strategy was endorsed by the Purchasing Bureau and by Yaffee. (The endorsement by Yaffee was conditional on continuing to hold Motorola responsible for the entire installation--turnkey responsibility--which was done.) Motorola also advised Baltimore on other phases of the project, such as the type of auxiliary computing and communications equipment to acquire.[31] (Subsequently, Motorola informally complained that direct purchase of equipment by Baltimore was causing "interaction and interface problems" and was adding to project costs.)[32] The significant point is that Motorola was a highly cooperative and involved contractor, willing to work closely both with Baltimore officials and Yaffee and Theiss. Relations between Baltimore and Motorola remain excellent. The project, nearing completion, is considered to be doing well and no major technical problems are foreseen.

Acceptance by Fire Department Personnel

Acceptance of CAD within the Fire Department appears good. An in-house, on-the-job training program for present dispatch personnel is in progress. (These are mainly "limited duty" personnel who cannot perform firefighting duties due to injury, illness or other reasons.) It is planned to test personnel following completion of training. Those unable to pass will be assigned to other duties, but it is anticipated that most of the present dispatchers will pass.

The unions--fire officers and fire fighters--have raised no objections to the training program or to the project itself.[33]

ANALYSIS

Technology Application

In the CAD, the problem of the technology application was straightforward in some respects, but very complex in

others. It was generally agreed that proper application of a CAD would aid the ability of the Fire Department to respond to alarms more quickly and effectively. About two dozen U.S. cities had or were installing CAD in 1977. But there were major questions on whether and how to proceed. These were: (1) How badly was CAD needed in Baltimore in the face of other urgent requirements for funds? (2) If it was determined that the need was great enough to warrant funding, how extensive should the system be? (3) What would be a reasonable cost? (4) How could the process of installing a CAD be managed so as to insure successful application, especially in view of difficulties of CAD in other cities (notably Los Angeles, Boston and Denver)?

The answers to these questions could not easily be given by Baltimore officials, especially since they lacked expertise and experience in this area. For the answers, Baltimore relied on Yaffee and the BAP. Without the BAP input it is doubtful whether the Mayor would have agreed to back the project. Without BAP, the user needs analysis and performance specifications would have been less comprehensive. Without BAP, costs for the project probably would have been significantly greater because (1) BAP endorsement of the "drop ship" approach was a decisive factor in adopting this approach. (2) The precision and detailed nature of the performance specifications helped hold costs down. Finally, without BAP, the City might not have utilized a "turnkey" contract or obtained the versatile computer or communications equipment which is going into the system.

The BAP role was pervasive. It went beyond technical assistance. Rather, BAP played a vital role in the City's decision-making process on whether to apply technology and how to manage the applications.

The nature of the BAP role becomes clearer when experience with CAD's in other cities is considered. Several U.S. cities have installed CAD in the past 5 years. None had technical advice and guidance from an outside source comparable to that provided Baltimore through BAP. All contracted with private consulting firms to perform studies and develop plans and specifications. Results in these cities has been mixed. In some, all went well. In others, there have been serious problems.* Source of difficulties has been traced to poor project planning and management and inadequate specifications.

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*Boston, Denver and Los Angeles have had serious difficulties with implementation or operation of CAD systems. New Orleans, Memphis and San Francisco have CAD systems which are operating successfully, according to Fire Service authorities.

A review of CAD experience by researchers for the National Fire Protection Association indicated that "the project management during a CAD implementation is particularly complex and critical...the failure to understand and to complete a functional analysis of the overall communications system can cause significant delays and increase costs. Often, the analysis of those functions to be automated is skipped, and little consideration is given to alternatives, tradeoffs, and adequate performance specifications.

"It seems clear that an independent consultant or project auditor should also be a member of the project team...it is essential to have in-house technical staff members who are experienced in real-time, assembly language, or mini-computer processing (if a dedicated or single purpose mini-computer is to be used). Often, such personnel are not available, and the independent consultant can fulfill this role."[34]

Experience with CAD in other cities shows that it is possible to install a CAD with good results without an arrangement like BAP. A highly competent consulting firm can provide the technical guidance and advice needed (e.g., San Francisco relied on in-house expertise and a consultant contractor). But unless the city has strong in-house expertise, it must in effect delegate to the consultant the full responsibility for planning, designing, and installing the system. An arrangement like the BAP, on the other hand, provides a margin of safety for the city. While the city still needs a consultant to perform the highly detailed work of carrying out a study, writing detailed plans and specifications and helping to iron out initial problems, it is not put in the position of relying totally on the consultant. The R and D facility provides a review and audit function, which even if it does not result in significant changes in the consultant's recommendations, provides the city with a sense of confidence. In addition, problems may arise because of non-technical complications, such as satisfaction of needs of diverse users. A consultant may be new to the city and its specific administrative and policy problems. In an arrangement like the BAP, the technologist in residence, because of an understanding of city needs and methods gained over several years can provide guidance which the consultant may not be able to provide due to lack of knowledge of institutional relationships. In addition, an arrangement like BAP provides a city with continuing access to expertise should problems arise in later phases of the project, or after project completion when the consultant contract has long terminated, and the consultant's team has moved on to work in another city.

In the Baltimore CAD, additions were needed to the user needs survey and performance specifications. Had they not been provided by BAP, severe difficulties might have

been encountered during implementation, especially if there had been more bids for the implementation contract and a company with less CAD experience or a less close relationship to Baltimore had won the award. Project costs would have also been higher, especially if Baltimore had to hire consultants to supplement the user needs survey and performance specifications, and if the specifications and procurement procedures had not been tightened.

But beyond these specific acts of assistance and guidance, BAP played a vital role in the decision-making process of the City. It was a neighbor and trusted partner.

The closeness of the location of GSFC to Baltimore was seen both by Baltimore and GSFC officials as an important factor in the effectiveness of the relationship. As a neighbor of Baltimore, GSFC has a natural interest in the well being of the city. Many GSFC employees live in or near Baltimore. Proximity facilitates quick response to requests for assistance. GSFC personnel can spend a few hours in a Baltimore City office and still be available for work that day at the research center. The long term nature of the relationship facilitates building a sense of trust and cooperation. Baltimore sees GSFC as more than a good source of technical advice; rather GSFC has become a partner in solving city problems.

Is this relationship of proximity and trust necessary for meaningful contributions by an outside source of technical guidance? Is the absence of such trust and proximity one of the reasons for the failure of many attempts at technology application (transfer) to state and local governments? These questions will be explored in the conclusion.

Advantages and Drawbacks

From this review of the Baltimore CAD experience, there appear to be several advantages of having a nearby R and D facility provide technical assistance to a city on an on-going basis. These include opportunity to aid a city in a significant way to solve its technology-related problems and to provide to a city the specific expertise it needs to deal with tasks and problems as they arise. For the R and D facility, it provides a chance to foster technology transfer.

This type of arrangement, however, may have important drawbacks. Unless special care is taken, the R and D facility may duplicate the work of private consultants and may be in competition with them. Too much reliance by the city on the R and D facility may thwart the city's capability to develop in-house technical expertise needed in the long run to deal with its ongoing operations. Although the city may obtain technical assistance from the R and D facility at little or

no cost, there is a cost to the taxpayers on a national basis. This type of arrangement may encourage cities to neglect making budget and fiscal provisions for utilizing technology.[35]

The value of the BAP contribution to CAD, then, resulted from the trust which Baltimore officials had in GSFC and the BAP arrangement. Without that trust, BAP personnel would still have given useful technical help, but they would not have played a key role in the policy and management decisions, which, Baltimore officials felt, was the most important BAP contribution.

Therefore, to put the CAD case in perspective requires a closer look at the BAP, since had not BAP existed, Baltimore would not have had NASA help on CAD. The decision-making and management process--and the outcome--might have been quite different.

As discussed earlier, BAP had a number of special characteristics, including insistence on "user pull," continuity, and long-term commitment of the "technologist in residence." It is difficult to say at what point the sense of "trust" had been achieved. The personality and approach of Golden contributed to the building of trust.

Part of the trust was due to the willingness of Golden to listen to City officials and carefully investigate situations before making a recommendation. Often, he would question whether technology would be helpful or appropriate. Above all, he made a genuine attempt to understand the political, financial and administrative problems faced by City officials.

At any rate, by 1977 trust had been established and the assignment of Yaffee, who was universally praised by Baltimore officials both for his technical expertise and interpersonal skills, strengthened the bond.

Thus, it was natural for Baltimore officials to look to BAP, and to rely on its advice beyond the purely technical realm. (The Fire Department had not had previous contact with BAP. After a short time, Department officials were impressed with BAP personnel--Golden, Yaffee and Theiss--and relied on their advice. Asked if they would call upon BAP in the future, Fire Department officials responded affirmatively.)[36]

Therefore, the BAP arrangement was a strong factor in the CAD technology application.

Implications for Technology Applications to Urban Government

The Baltimore CAD case makes it clear that urban technology application is difficult and complex even when the technology in question has been effective in meeting needs of other cities. This is so for several reasons: (1) Each city is different and has different needs and ways of carrying out its urban lifestyle. To be successful, technology application must be fitted to the city's unique nature. For example, the CAD system in Baltimore had to be designed to accommodate call boxes, even though it would have been simpler to eliminate them from the City's streets.* But this was politically impossible in Baltimore. Therefore, Baltimore had to incorporate call boxes in the system and could not utilize as a model another city's system that did not use call boxes. Similarly, the data base for Baltimore would differ from other cities, due to differences in distribution of housing and commercial structures and extent of neighborhood deterioration. Software design, especially with regard to methods for accurately identifying fire locations, must be highly individualized.[37] (2) Each city has varying legal and administrative requirements and procedures. These in turn affect the fiscal and procurement processes. What may be financially or contractually possible in one city may be illegal or impractical for another. Baltimore had to contend with a restrictive bond debt limit, a tight project budget and specific procurement regulations which limited its flexibility and may have reduced the field of bidders for both the study and the implementation contracts. (Some prospective implementation contract bidders stated that the incremental funding aspect of the contract--necessitated by the splitting of bond votes--made them decide not to bid.)[38] (3) The nature of user agencies and interest groups varies from city to city. Patterns of agency co-operation which may work in one city will not work in another, and, if tried, may well damage implementation. (In Baltimore, the Fire Department and Management Information Bureau could not share a computer system for storage of data due to different needs and methods of operation. Such a sharing arrangement was included in early specification drafts, based on practice in other cities, but was altered due to advice given by Yaffee and some City officials.)[39]

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*The value of call boxes as fire alarm devices in the age of the telephone is questioned by some fire officials and they are being eliminated in some cities, especially since their presence is a temptation for youths to raise numerous false alarms.

Recognition of these differences leads to the realization that technical assistance per se is not enough to insure that technology will be applied and incorporated. Much more is needed. BAP personnel were well aware of the multi-dimensional nature of their tasks.

THE CAD FROM FOUR PERSPECTIVES

Fire Service Perspective

Events in the BAP CAD implementation program clearly show that it is indispensible for the fire service to have available competent technical and managerial staff, either in-house or through special arrangement with an outside source. BAP filled this need, although it could have been filled by a consulting firm.

It would have been both difficult and expensive for Baltimore to duplicate with a consulting firm the many capabilities that BAP brought to the project. Clearly, the Baltimore "study contract" was not designed to do so. (The role of ARC actually was quite limited. After delivery of the performance specifications, its role virtually ceased, especially since Baltimore did not give ARC a contract modification for "interpreting the specifications." Neither the Fire Department nor Motorola consulted with ARC after the specifications were delivered. When Motorola wanted clarification of the performance specifications it went to Yaffee and Theiss.)[40]

As to cost, the study contract price was 29 thousand dollars. The cost to San Francisco for its consultant contract for study, performance specification writing and assistance in supervision of the implementation contract was 96 thousand dollars. In San Francisco three man years were provided by the contractor; the City of San Francisco supplied two more years.[41]

In view of the problems other cities have encountered, it appears that from the perspective of the fire serivce, a BAP-type arrangement is desirable along with the use of a consulting firm. Such an arrangement offers a very wide range of technical and managerial competence (including experience with high technology contractors), plus knowledge of the city gained from working on other projects. In addition, it offers the back-up of the resources of a major R&D agency, and, if necessary, of the federal government. (In a number of other BAP tasks, experts from federal agencies other than NASA were made available to Baltimore.)[42]

Urban Technology Transfer Perspective

This case study brings home the point that both Yin and Lambright make in their recent studies--conditions internal to the city play a crucial role in determining whether technology is transferred successfully. Simply having an external source of help is far from sufficient. Yin stresses the need for acceptance by city bureaucrats: Th new practice had to have concrete benefits for service practitioners--e.g., convenience, reduced physical effort, greater potential for promotions, and additional sense of safety on the job.[43]

Lambright points out that "to overcome the fragmentation of local government authority requires coalition building. To build coalitions requires changes in technology and in the city and in its institutions."[44] This, in turn, requires a local "entrepreneur" who can bring divergent political, administrative, professional and interest group forces together in support of the new technology. "The entrepreneur need not be a technically trained individual, though this helps! However it is important that he have access to technical judgement he trusts...."[45]

The role of organizations attempting to give external support to urban technology transfer is important, of course, as both Yin and Lambright recognize. Nevertheless, both studies conclude that unless the internal factors are appreciated and explicitly related to by the external source, chances for providing help are sharply diminished.[46]

In the Baltimore CAD, the internal conditions for transfer were good. The needed coalitions were already in place or were built through the efforts of Bond and Berkowitz, who acted as local "entrepreneurs." Although the leadership of the Fire Department did not champion CAD prior to the Fire Board's interest, the department leadership supported the changes. After initial reservations the Mayor threw his prestige behind the project. All along the way, Bond and Berkowitz--although not technically trained--had access to technical judgement they could trust. This was of great help to them in building coalitions and was a key input into the crucial decisions made by the Mayor and other top city officials. BAP personnel took pains to understand and work with internal factors within the Baltimore city government.

Public Administration Perspective

From the standpoint of public administration, the CAD case is of special interest because of the unique approach used for technology application. The difference was noted by the National Academy of Public Administration in its evaluation of BAP of March, 1977:

"The BAP is particularly challenging since there are few, if any, precedents upon which it can draw. The non-advocacy, diplomatic and facilitative features of the Baltimore Applications Project have been apparent to the (NAPA) panel. The low-key problem-oriented approach for transferring technological ideas is a distinctive departure from the more publicized, glamorous "hawking" approaches."[47]

The NAPA report commented favorably on the BAP emphasis on the "process" of technology application rather than on a blind belief that applying technology can solve problems:

"The choice of technology which might be applied was to be the city official's choice and the problems were those of the particular department or agencies involved. This meant that the technology agent was to be more of a coordinator or facilitator than a typical project director, i.e., he was to be a technological resource and not a manager or implementor of technology. Although specific applications of technology (and hopefully some applications of aerospace technology) were expected, these were not to be the principal objectives of the project. Rather, BAP was viewed more as an experiment or demonstration project with which to determine if a city could use the technology agent in the role of a "technologist in residence."[48]

The CAD case provides an excellent example of this type of institutional approach in full practice. BAP personnel were much more than technical assistants; they were an integral part of the decision-making and management processes, yet, their role was never that of project director, project manager or advocate or implementor of technology. This is especially significant because CAD was a large scale, politically sensitive project with heavy involvement of commercial sources; BAP was involved in the implementation stage. Prior to CAD, BAP had concentrated on tasks emphasizing problem identification and needs assessment. In its 1977 report, NAPA had criticized this emphasis on the ground that the true value of the BAP approach to cities could not be known until it was used in a politically sensitive implementation project in which commercial sources were involved.

"Golden has been very cautious in avoiding tasks which would place the BAP in the position of providing services that are available on a commercial basis. The panel does not quarrel with this general policy, but questions the rigidity of interpretation. To the extent possible, advice and assistance should be provided agency officials, carefully tracking progress on such tasks. This hesitance has been most notable in the one field where NASA probably has the most to offer in the way of technical competence--communications....

Those tasks which appear to impinge on political sensitivities or carry the possibility of some involvement in implementation have been carefully avoided. Some of these may be problems of high priority. 'Playing it safe' precludes the opportunity to test technology application, and may tend, over time, to limit applications to problems of secondary importance. If the purpose of the BAP is to learn, some risks must be taken."[49]

That BAP could get heavily involved in a project like CAD, while retaining its role as a resource, (not an implementor or director) and while retaining the respect and trust of city officials is of significance to those concerned with developing new public management approaches to technology application. The "county agent" has often been put forward as a model for technology application to state and local government, and some technology transfer programs have been patterned, in part, on that model.[50]

The BAP, because it is a continuous institutional, process-oriented approach with objective trusted agents, is closer to, though not patterned after, the county agent model than many of the other urban technology transfer programs.

The county agent has developed over the years into a trusted, objective source of assistance and advice--an integral part of the farmer's daily environment and approach to work; the county agent is "always there" and the same person may serve in the same location for many years. The technology agents in some urban technology transfer programs are often temporary and are considered experimental. Funding is uncertain. They will be there only as long as they can show a track record of technology adoption. There may be a tendency to seek out areas for technology application whether or not the city is ready, politically, financially or psychologically, and whether or not the technology is a "good fit" to the city's physical needs.

In view of the recent passage of the Stevenson-Wydler Bill (PL 96-480), the BAP approach may serve as an especially useful model for other federal R&D laboratories. But federal laboratory officials must be sensitive to the need to work with city officials in building an environment conducive to technology application. Certainly, this case study and the experience with BAP show the importance of developing internal institutional infrastructure. Both Yin and Lambright have noted that internal conditions are at least as important as technical assistance as determinants of successful technology application.

As Yin noted with regard to routinization of numerous hardware technology applications in many cities:

"In contrast to all these internal conditions, external financial and technical assistance in the form of federal grants and awards were consistently found to be unrelated to the degree of routinization. This did not mean, however, that local agencies could as easily innovate without such external assistance. Rather, the lack of relationships was due to the inability to distinguish between two very different conditions--where local officials actively pursue external assistance, and where such assistance is the result of initiatives by a federal granting agency or other external agent. External assistance may in fact be very important to routinization if such assistance follows local initiatives and matches local needs and agendas."[51]

And, as Lambright points out:

"Innovations that reach incorporation are those that represent locally-initiated efforts in response to problems and/or opportunities perceived locally by line agency officials, elected and appointed policy-makers, and clientele groups. The principal institutional mechanism that needs to be identified to ensure adoption, implementation, and incorporation is a strong, locally-based, bureaucracy-centered coalition. It follows that federal technology transfer policy-makers should work toward helping bureaucratic and other entrepreneurs build professionally competent agencies. These agencies should be supported at the local level by additional expertise, politicians, and a continuing clientele market for the service provided by the innovation....

What we are arguing is not only that federal officials become actively involved in promoting such coalitions, but, at the very least, that they should also be increasingly aware that the primary barriers to innovation at the local level are multiple, complex, and interconnected. They must think

about the user-agency in the context of its internal and external support systems. By strengthening such support systems (agency capacity, federal programs, supplier industry, interlocal and intralocal relations), they can work to build an infrastructure for urban innovation."[52]

In the CAD project, Yaffee and Theiss were working partners with city officials and contractors in virtually all phases of the CAD project. They provided essential technical input for major decisions, participating in evaluation and reviews conducted by the city, including procurement source evaluations and supplied assistance to supplement work of city officials and contractors when needed. Their role was one of interaction, collaboration and facilitation of the process by which technology application took place. The role was so important that it made the process much more effective than it would have been without BAP involvement and insured a successful technology application. In short, BAP provided a missing element in the institutional infrastructure of Baltimore city government for applying technology.

Innovation Perspective

The previous discussion makes it clear that innovation in urban government does not occur spontaneously. It must be nurtured, and a conducive environment must be established.

The CAD case illustrated these points. The impetus for innovation came from the Fire Board, but there was skepticism, and hesitancy among other city agencies and officials. Before the CAD was adopted, it was necessary to develop a climate favorable to innovation. The BAP played a key role in developing the climate, both in a general sense through increasing the awareness of Baltimore officials over the years to the potential of technology, and specifically through the information provided by Yaffee on the need for and applicability of CAD to Baltimore's problems. After adoption, innovations must be implemented and incorporated (routinized) before they start contributing to the welfare of a city. In many cities, innovations are abandoned because of implementation or incorporation difficulties.[53] In the CAD case, BAP was crucial in the implementation stage, as evidenced by BAP input to the study and performance specifications and the decision-making process on selection of contractors and project manage-

ment. The availability of BAP during incorporation, if needed, will also help innovation at this final stage.

BAP, with its emphasis on technology pull, on the process of technology application and involvement in developing internal infrastructure, fostered a climate for innovation in Baltimore. Other programs of external assistance to cities should take note of the experience of BAP in fostering innovation. The key to innovation is not outside help, but in the involvement of key persons at the local level. As Lambright puts it:

"The real task lies, as always, at the local level. Unless there is the spirit and reality of entrepreneurship, a push for innovation from outside leads nowhere."[54]

CONCLUSION

The CAD case provides a number of important insights into the process of urban technology application and the role of technical assistance by an external source:

(1) In this case, it was clear that applying the technology was not primarily a problem of developing new technology or modifying existing technology. Rather, the problems were in determining the applicability of the technology, obtaining support for adoption and managing the implementation and incorporation stages. While technical expertise was needed in each of these steps, the primary contribution of the external source of assistance (BAP) was in decision-making and management processes.

(2) In view of this "process" need, the BAP was able to be of crucial assistance to Baltimore because of the special characteristics of BAP, which emphasize user pull, long term commitment, involvement in building coalitions and infrastructure and, as demonstrated by CAD, participation in important implementation projects.

(3) Urban technology assistance from an external source must include more than purely technical guidance. Policy, financial and management problems pose the greatest barriers to technology application for city officials. The external source should be sensitive to these problems and while not taking stands, should be willing to help in the processes required to resolve them.

(4) Building a sense of "trust" between the external source and the city is very important in facilitating technology application or avoiding mis-application.

(5) The city's proximity to the external technology is important (although probably not absolutely essential) in the technology application process. Proximity permits a greater degree of institutional (as well as personal) interaction between the facility providing assistance and the city. If physical proximity is not possible, arrangements to substitute for its advantages should be worked out. These might include a firm, regular schedule of frequent visits by the technology agent, regular TV teleconferences among the technology agents and city officials between visits and a "hot line" telephone connection for response to urgent questions.

(6) The facility providing assistance and the city receiving it should work toward the goal of "partnership in solving problems", rather than emphasizing the distinction of "external" and "internal" parties. The formal agreement which underlies the relationship should be couched in "partnership" rather than in "quid pro quo" terms.

(7) While a city may be able to make a successful technology application without a BAP-type arrangement, chances for success are increased when such an institutional cooperative arrangement is utilized. The use of a consulting firm to handle detailed study and specifications work is recommended. Even the most capable consultant contractor however may be unable to provide advice and assistance on certain aspects of a problem, especially when these involve input for decision-making on policy, management or procurement issues.

NOTES

1. In the past ten years, several U.S. cities have installed computer aided communications and dispatch systems (CAD). San Francisco's system is operating well and is considered successful by Fire Protection authorities. Successful systems are operating also in Memphis and New Orleans. Letter dated May 4, 1977 from Philip Yaffee to Thomas Burke, Chief, Baltimore Fire Department. The author of this report viewed the San Francisco CAD in operation and interviewed Robert Rose, Chief, Planning and Research, San Francisco Fire Department, on April 16, 1980.

2. Los Angeles experienced several difficulties with its CAD. Although planning began in 1968 and a contract for installation was awarded in 1971, the system was not operational as of May 1981. In tests held in 1980, CAD response time was 112 seconds compared to manual system response time of 103 seconds. Difficulties have been attributed to: (1) starting too early in terms of state of the art and trying to push the technology too fast; (2) poor performance specifications; (3) a dispute with the implementation contractor over the extent of contractor responsibility for a "turnkey" operation; (4) delays in building a city hall annex in which the CAD equipment was to be housed. Site visit to Los Angeles Fire Department and interview by author with Chief Durkee, CAD Project, L.A.F.D., April 17, 1980 and telephone interview of May 8, 1981. Boston, Denver and Detroit have also had serious problems in planning for or installing CAD. See Yaffee letter of May 8, 1977, op. cit. Telephone interview with officials of Detroit Fire Department, April 16, 1981. In Detroit an attempt was made to have both the Police and Fire Departments use the same CAD. This was not feasible.

3. For discussions of these issues, see W. Henry Lambright, Governing Science and Technology (New York: Oxford Univ. Press, 1976), Ch. 4, and Technology Transfer to Cities: Processes of Choice at the Local Level (Boulder, Colorado: Westview Press, 1979), esp. Ch. 1 and 9; Richard Nelson, The Moon and the Ghetto (New York: W.W. Norton, 1977).

4. H.J. Peake and T.S. Golden, "The Baltimore Applications Project: An Experiment in Technology Tranfer," 1979 Engineering Management Conference Record (Washington, D.C.: Institute of Electrical Electronics Engineers, 1979) p. 55. The technology agent assigned to New York City was a contractor employee. Mr. Thomas Golden was a career NASA staff member. In contrast to the BAP, the arrangement for technical assistance from NASA to New York was not based on a formal agreement calling for a long-term relationship. When an accident (unrelated to his duties as technology agent) caused the death of the New York City technology agent in 1975, he was not replaced and the arrangement ended.

5. Memorandum of Understanding NASA-Baltimore Applications Project, dated April 25, 1974.

6. Ibid.

7. Lambright, Technology Transfer to Cities (see Note 3).

8. R.K. Yin et al., Tinkering with the System: Technology Innovation in State and Local Government (Cambridge, Mass.: Heath Lexington, 1977). Also see Yin, "Life Histories of Innovations: How New Practices Become Routinized," Public Administration Review (Jan./Feb., 1981), pp. 21-28.

9. For a discussion of these questions, see Science and Technology: Annual Report to The Congress of the National Science Foundation (Washington, D.C.: U.S.G.P.O., June, 1980), pp. 45-51. As the report states: "Some analysts, noting the general frustration on all sides with the accomplishments of Federal dissemination systems, urge a greater commitment to capacity building. Others, interpreting the data differently and noting the limits of Federal resources and a need to keep the Federal Government doing what it apparently can do best, suggest that a concentration on research and development and dissemination is more appropriate. There is no empirical evidence to resolve this argument." For detailed analyses of these different views, see Feller, I. "Science and Technology in State and Local Governments: Problems and Opportunities." Paper prepared for the National Science Foundation, The Five-Year Outlook: Problems, Opportunities, and Constraints in Science and Technology, Vol. II, June 1979, and Yin, R. "Science and Technology in State and Local Governments: The Federal Role," Paper prepared for the National Science Foundation, The Five-Year Outlook: Problems, Opportunities, and Constraints in Science and Technology, Vol. II, June 1979. Feller favors capacity building; Yin favors dissemination.

10. For mini-cases, see The Baltimore Applications Project: A New Look at Technology Transfer: Report of a Panel of the National Academy of Public Administration (hereafter referred to as NAPA Report), (Washington, D.C.: NAPA, March, 1977) pp. D1 to D17.

11. The NAPA Report had urged BAP to become involved in a high priority, "politically sensitive" implementation project in order to test whether the BAP approach is viable in helping solve the most crucial and demanding urban problems, NAPA Report, pp. 61-62.

12. The most recent full explanation of the BAP approach is given in Thomas S. Golden, The NASA/Baltimore Applications Project: An Experiment in Technology Transfer (Greenbelt, Md.: NASA/GSFC, March 1981, NASA Technical Memorandum 82110).

13. In 1977 Baltimore was permitted to issue bonds up to $35 million per year. Of this amount, however, $20 million had to be for projects which were "self liquidating"--would generate sufficient income to repay the debt incurred; $15 million could be for other, non-income-generating projects. The CAD fell into the latter category.

34. Stanley Phillips and Dave Russell, "The NFPA CADS Project," Fire Command (June 1979) pp. 22-23.

35. For a detailed evaluation of BAP, see "The BAP: A New Look at Technology Transfer: Report of a Panel of the National Academy of Public Administration" (NAPA) (Washington, D.C.: NAPA, March 1977). NAPA recommended that Baltimore consider cost-sharing the salary of the technologist in residence. (In 1980, Baltimore established its own Office of Technology.)

36. Interviews with Crockett and O'Brien and with Herbert Catterton, Acting Chief, Baltimore Fire Department.

37. Interview with Rose.

38. Interview with Zemansky.

39. Interviews with Yaffee and O'Brien.

40. Interviews with O'Brien; Motorola personnel.

41. Interview with Rose.

42. See BAP Annual Reports for 1978, 1979, 1980.

43. R.Y. Yin, "Life Histories of Innovations: How New Practices Become Routinized," Public Administration Review (Jan./Feb., 1981) p. 27.

44. Lambright, Technology Transfer to Cities, pp. 164-165.

45. Ibid., p. 162.

46. Both authors cite a number of cases to support this conclusion.

47. NAPA Report, p. 4.

48. Ibid., p. 13.

49. Ibid., pp. 61-62.

50. These include Public Technology, Inc., and its Urban Technology System.

51. Yin, "Life Histories," p. 27.

52. Lambright, Technology Transfer for Cities, pp. 167-168.

53. Yin, "Life Histories," and Tinkering with the System (see Note 8).

54. Lambright, Technology Transfer to Cities, p. 165.