PERFORMING POLICY ANALYSIS FOR MUNICIPAL AGENCIES: LESSONS FROM THE NEW YORK CITY—RAND INSTITUTE'S FIRE PROJECT

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ABSTRACT

The New York City-Rand Institute was involved in performing policy analysis for the New York City Fire Department over a period of $7\frac{1}{2}$ years. During this time many changes were made in the Fire Department's operations based largely on the results of the Institute's analysis. This paper discusses some of the changes, proposes some explanations for the success of the project, and describes how the work led to a similar effort to perform deployment policy studies for emergency service agencies throughout the country under federal sponsorship. The paper concludes with some impressions about what the work has taught us about performing urban policy analysis for operating agencies and transferring technology to municipal government personnel.

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Many people, both at The New York City-Rand Institute and elsewhere, acknowledge the Fire Project to be the most successful project at the Institute:

- It is the longest running (it has been in continuous operation since January 1968--when Rand received its first contracts from New York City);
- It has received the most funding from New York City (over $3 million);
- It has had the greatest dollar impact on the operations of a city agency (we estimate that our work has enabled the City to save over $20 million per year with little reduction in the City's fire protection levels).

In addition, the fire work has created a whole new area for the application of systems analysis, and has already received professional recognition. In a competition on the Practice of Management Science held at the 1974 Meeting of the Institute of Management Sciences and the Operations Research Society of America, a description of the Institute's fire work won second prize--there were 80 case studies competing.

In this paper I will discuss some of the things that we have learned over the last years about working with city agencies and helping to change their operations. In particular, I will:

- briefly describe some of the more significant changes implemented by the New York City Fire Department in which our work played a major role;
- present some of my views on the reasons for the Fire Project's success;
- show how the fire work in New York City led to the Institute's receiving contracts from the U. S. Department of Housing and Urban Development (HUD) to spread the results

to cities throughout the country;

- discuss the objectives of the HUD-sponsored work, and show what the work has already accomplished;
- conclude with some impressions about what the HUD and New York City work has taught us about performing urban policy analysis and transferring technology to municipal government personnel.

ACCOMPLISHMENTS OF THE FIRE PROJECT: DEPLOYMENT CHANGES

Of course, there are many ways to measure the success of an effort such as the Fire Project. The determination of success will depend in large part on the criteria that you choose and on your point of view. For example, the success of the Project may be viewed quite differently by the Fire Department and by firemen's unions. Its success may also turn out differently if measured by dollar savings instead of improved fire protection. In this paper I will discuss the Project's success in two ways. First, as a policy analyst, I like to point to the actual changes that have been made in the Department's operating policies.

For example, the New York City Fire Department has made four major sets of changes in their deployment policies, in which our work played a major role. Each of these changes will be discussed separately below.

1969

In 1969, the Department added six part-time units, called "Tactical Control Units," to the force. These units operated only during the peak alarm hours, between 3 pm and midnight. It also instituted, on a pilot basis, a new response policy called Adaptive Response (AR), that reduced the number of companies dispatched to alarms turned in by street box in a small area in the Bronx.

These changes reversed the Department's previous policy of adding full time companies to handle its increased workload, thereby saving the City about $2 million per year. The changes also reduced the workload on the existing fire companies.

<u>1972</u>*

In 1972, six fire companies were disbanded and seven others were permanently relocated. In addition, an improved Adaptive Response policy was implemented on a large scale in high fire-incidence areas throughout the City. These changes resulted in savings of over $4 million per year, a reduction in the workload of fire companies, and a more balanced distribution of fire companies throughout the City.

<u>1974</u>

The third important deployment change occurred in December 1974. The City, in the midst of a budget crisis, required the Fire Department to cut $8.3 million from its budget. Using models developed at the Institute, the Department determined how to cut eight fire companies while minimizing the resulting impact on fire protection.

The firemen's union brought suit in court to stop the cuts, charging discrimination, since many of the companies cut were in ghetto areas. The judge dismissed the case—agreeing with Commissioner O'Hagan's testimony that the companies that were to be cut were chosen in a rational, objective manner.

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*Additional information on these changes can be found in E. Ignall et al., "Improving the Deployment of New York City Fire Companies," The New York City-Rand Institute, P-5280, July 1974.

Rapid Water

The final change that I want to discuss involves Rapid Water. One of the first and best known of the accomplishments of the Fire Project came in the area of developing and applying new technology to the fire service. The Institute initiated the development and demonstration of a procedure for injecting a long-chain polymer, variously known as "Poly-Ox," "Slippery Water," or "Rapid Water," into hose streams to reduce friction in the hoses. Its use can increase the flow of water through a hose by 70 percent and double the reach of the stream. Firemen can therefore deliver as much water on a fire with light, small diameter hoses as they could before with heavy, hard-to-handle hoses. The lighter hoses can be handled by fewer men, enabling the Department to place one less man on a rapid-water engine.

To date, the City has equipped 80 engine companies with Rapid Water, each manned by 4 men instead of 5, thereby saving the Department about $10 million per year. In time all of the Department's 230 engine companies will be equipped with Rapid Water.

The four sets of deployment changes taken together have resulted in savings to the City of over $20 million per year. Mayor Beame has announced that another round of budget cuts will have to be made in the next fiscal year. Our models will undoubtedly be used once again to minimize their impact on fire protection.

Adaptive Response

Adaptive Response has been mentioned twice as a major accomplishment of the Fire Project. Before going on, I would like to discuss the policy to give you some idea of what it is. Basically, it is a method for varying the number of fire companies that get sent to alarms, so that more units are sent to potentially more serious alarms.

The policy is based on two facts about the incidence of fire alarms in New York City. First, in some areas of the city, during certain times of the day, there is a good chance that, while fire companies are responding to one alarm, another alarm will be received in the area served by those companies. If some of the companies were not sent to the first alarm, they would then be available to respond to the second. This raises the question of how many companies would be needed at the first alarm and led to our discovery of the second fact, that there are predictable variations among alarm boxes in the chance that an incoming alarm will be for a serious fire.

Using the data on alarms that occurred in the years 1967-1969, we predicted the expected proportion of structural fires for each alarm box in the Bronx. We then compared the predictions to actual 1970 data. For example, as shown in Table 1, we predicted for box 2277 that less than 0.5 percent of all alarms would be for structural fires, while for box 2209 we predicted almost 32 percent. In 1970, both of these boxes had just under 100 alarms. In both cases the predictions were quite close to the actual results. Box 2277 had no structural fires while box 2209 had 25 structural fires. A very striking aspect of this example is that both alarm boxes are on the same street--Brook Avenue in the south Bronx--and are about three blocks apart. Under New York City's traditional dispatching policy, if an alarm had been received from box 2277, all of the closest companies would have been dispatched to that alarm. If, in the next few minutes, an alarm had been received

Table 1

STRUCTURAL FIRE PREDICTIONS FOR TWO ALARM BOXES

Bronx Box Number	Predicted Percent Stuctural ('67-'69 data)	Actual 1970 Data	
		Alarms	Structural Fires
2277	0.4	96	0
2209	31.8	94	25

from box 2209, none of the closest units would have been available to respond, and companies from further away would have had to be sent. The essence of Adaptive Response is to send fewer units to boxes like 2277, which have a small chance of signaling a serious fire, and more units to boxes like 2209, which have a high chance of signaling a serious fire.

ACCOMPLISHMENTS OF THE FIRE PROJECT: CHANGES IN THE DECISIONMAKING PROCESS

The second way in which I like to measure the Fire Project's success is by observing the changes that have taken place in the way that the Fire Department makes its deployment decisions. Decisions used to be made by the Commissioner or Chief of Department based primarily on intuition and experience. Sometimes the decisions led to unanticipated results.

For example, the Department's traditional response to the burdensome fire company workloads that resulted from the sharp increase in fire alarms in the 1960's was to add fire companies, at an annual cost of $600,000 per company. This was not only an expensive solution, but one that did not work very well. For example, in 1966, Engine Company 82, which achieved national fame in fireman Dennis Smith's book Report From Engine Company 82, responded to over 6,000 alarms and was the busiest engine company in the City. To relieve its workload, the Department created a new company (E85) in July 1967, and put it in the same firehouse as E82. It was expected that E82's workload would be cut in half. But in 1968, E85's first full year of operation, E82 was still the busiest company in the City and E85 was the second busiest (see Table 2). Instead of helping the busy unit, there were now two busy units. (I should point out that between 1966 and 1968 the overall alarm rate in the City took a sharp upward jump. However, even if the alarm rate had remained unchanged, E82 and E85 would still have had the first and second heaviest workloads in the City, but at a level of about 6,000 responses per year instead of 9,000.)

Table 2

WORKLOAD OF ENGINE COMPANIES 82 AND 85

Year	Engine Company	Responses	Rank
1966	82	6,234	1
1968	82	9,111	1
	85	8,386	2

Results from our computer simulation model of the Fire Department's operations showed the Department that this happened because with more companies stationed in the area, more companies were available when an alarm was received, and, as a result, under the traditional dispatching policy, more companies were being sent to alarms. This insight, and other similar ones, have given the Department an appreciation for the usefulness of quantitative methods in planning. They have set up a Bureau, called Planning And Operations Research (PANDOR) manned by several fire officers and civilian analysts, to perform long-range planning and to analyze deployment policies for the Department before they are implemented.

FACTORS IN THE PROJECT'S SUCCESS

I believe that the successes that the Fire Project has had can be traced to four factors.

Project Personnel

The Fire Project, since its inception, has been staffed with people of high caliber, both in leadership and research positions. This is obviously a factor in the success of any undertaking. In our case in particular, it gave us the ability to identify the right problems to work on--problems that could be handled and that were of interest to the Department--and helped us to structure the work so that it developed and built upon itself year after year. In addition to being capable analytically, the staff members were able to communicate the results to the Department in language the Department was able to understand--the importance of which cannot be overestimated.

The Nature of the Fire Department's Problems

The Fire Department problems that we have worked on were natural problems for the application of systems analysis techniques. The system was well-defined and contained few interacting subsystems and few of the unpredictable elements, such as the reactions of people to changes in the system, that make many social systems hard to study.

<u>The Fire Department's Perception of Need</u>

The Fire Department perceived the need for outside technical assistance to help them solve some of their acknowledged problems. In 1968, when we began our work, the Department was faced with unprecedented demands for its services. Annual fire alarms had increased from about 70,000 in 1958 to almost 250,000 in 1968 (see Fig. 1). On a summer evening in the south Bronx, one of the busiest areas of the City, typically about half of the fire companies were unavailable to respond to alarms because they were already busy at other alarms. When a fire alarm came in, only two or three of the five assigned units were available to respond.

Communications channels and dispatching centers were clogged with alarms. The number of fire company responses to alarms was increasing and the men in the busiest companies were being overworked. Increasingly militant unions were demanding, and getting, more fire companies, each at an operating cost of $600,000 per year. In short, skyrocketing alarms were straining the system to the breaking point.

As the Engine 82—Engine 85 example showed, the traditional solutions were not working. So, in 1967, Fire Commissioner Lowery and Chief of Department O'Hagan appealed to Mayor Lindsay for some analytical assistance. In 1968 when the Rand Corporation was asked to begin to work on New York City's problems, the Fire Department was one of the four agencies chosen for initial work. So they knew they had problems, re-

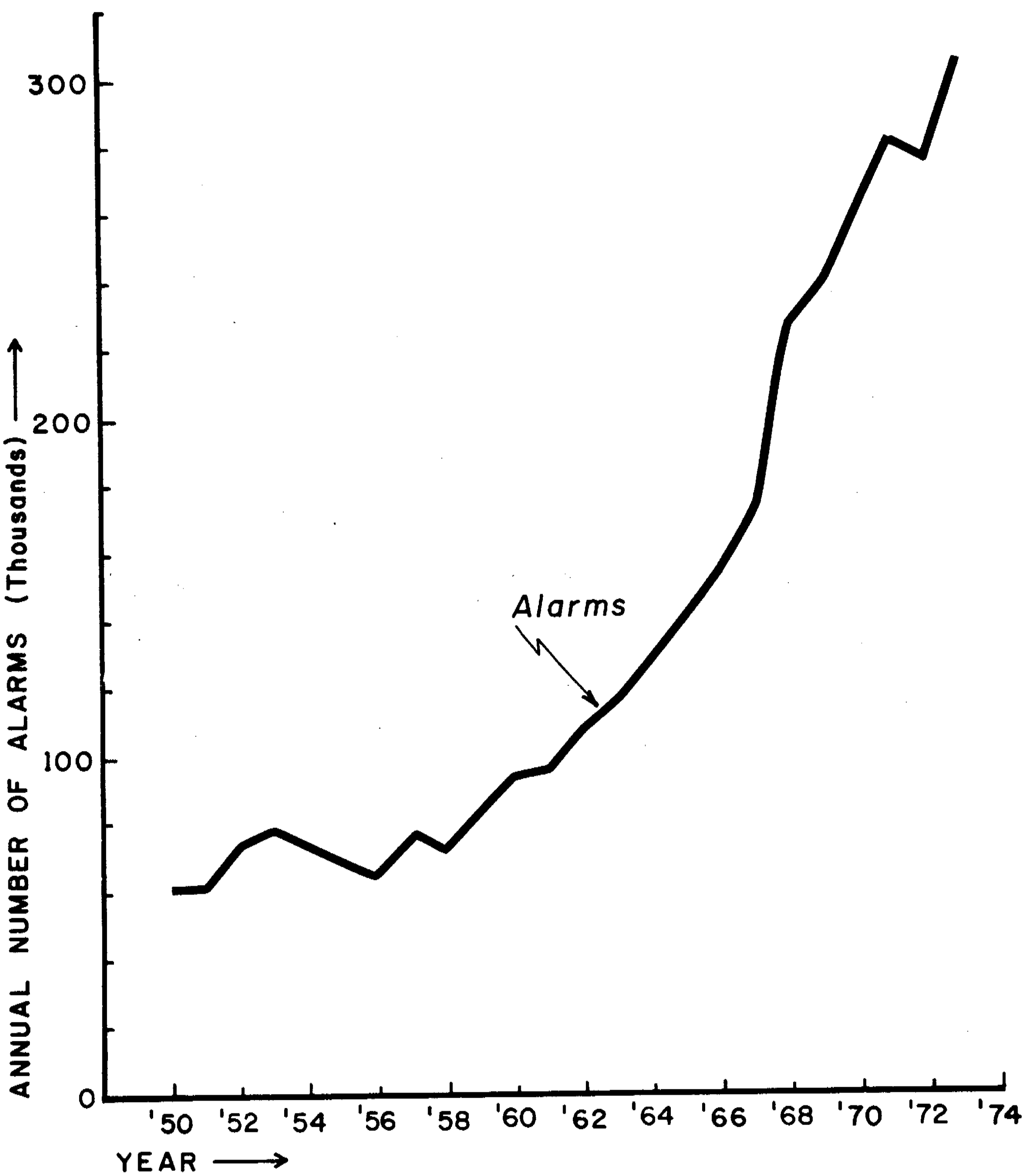

Fig. 1. Annual fire alarms, 1950-1974.

quested assistance, and have been working with us ever since to try to solve the problems.

The Relationship Between the Project and the Fire Department

It is significant that the Fire Project was not a group within the Fire Department working on the day-to-day problems of the agency. Nor was it a group at a university, theorizing about the Department's problems and obtaining analytically neat and elegant solutions of limited practical use. The Project was close enough to the Department to know its problems and the real constraints that are placed on feasible policies, and far enough away to avoid getting side-tracked by day-to-day "crises." The Project members were continuously aware of the problems facing the Department, and recommendations were always developed with implementation in mind.

A second important element in the Fire Project's relationship with the Department was the continuity of effort. The Project was not just a consulting group hired to research a particular problem, produce a report destined to lie on the shelf, and then disappear from the scene. The Project's continuing presence over seven years allowed us to follow through on the implementation of some of the results, and to make sure that they were understood and implemented correctly. It also led the agency to develop confidence in the group, in the work, and in the results. The long time span over which the work for the Department was carried out also provided the Project with a luxury not often enjoyed by most consulting groups: time to think deeply about the system; time to develop complex mathematical models; and time to simplify the models so that they included all the important factors needed for policy analysis, but were simple enough for the Department to use and understand.

The final, and perhaps most important element in the Project's relationship with the Fire Department is the fact that the Fire Project was in a real sense a joint effort on the part of the Department and the Institute. From the very beginning, Chief Officers and other personnel of the Department were part of the research team. The Bureau of Planning and Operations Research—PANDOR—was set up by the Department to act as liaison with the Institute. This provided the Project with immediate access to the accumulated experience of high-level fire officers and information on fire-fighting operations that would have been hard to obtain any other way. Project members could also bounce ideas off members of the PANDOR staff, get operational questions answered whenever they arose, and get PANDOR's help in gathering data that was needed for the mathematical models. The PANDOR staff, and at times Commissioner O'Hagan, were also the source for many of the policy options that were analyzed. Based on their years of experience they had many ideas for solving the Department's problems. But they had no way to evaluate them short of trying them out in the field. We provided them with tools that could be used to evaluate their policy ideas.

Our close working relationship with PANDOR also meant that our policy recommendations had a good chance for implementation. First, the presence of agency members on the project team was a factor in helping the Department to develop a confidence and understanding of the results. Second, PANDOR was able to make sure that the work remained policy-relevant, and that all the real-world constraints on policy options were taken into account.

THE H.U.D. PROJECT

The Fire Project's success with the New York City Fire Department did not automatically guarantee success in any other city. But, we were convinced that many of the analytical techniques that had been developed for New York could be applied equally well, and in some cases even better, in smaller cities. And, in fact, could be applied to other emergency services as well.

Between 1969 and 1971 the Institute had developed some basic mathematical models for police and fire deployment analysis under a contract with the Office of Policy Development and Research of the U. S. Department of Housing and Urban Development. By 1971, the Office of Policy Development and Research was beginning to orient its research program to policy relevant research—the development of tools and techniques that local governments could use to help them to improve their service delivery systems. They liked the successes that we were having with our methods in New York, and we were able to convince them to support our effort to try them out in smaller cities. Their major interest was to produce a methodology for emergency service deployment analysis that could be transferred to the municipal personnel responsible for analysis and implementation of emergency service deployment policies.

This effort has been going on since 1972 under two successive contracts. The contract tasks fall into five broad areas:

(1) Improving, generalizing and extending the models already developed at the Institute for analyzing the deployment of emergency service vehicles.

(2) Field testing the models in several cities. This task is designed to test the applicability of the models in a variety of situations and to develop new models if they are required.

(3) Documenting the models. In this task nontechnical and technical descriptions of the models are to be prepared for use by any interested locality or researcher.

(4) Documenting a general methodology for emergency service deployment analysis. This task calls for a step-by-step description of how to analyze the deployment problems of an emergency service system, from problem definition

through choosing the appropriate models and evaluating alternative policy options.

(5) Developing training courses. Since the ultimate objective of the HUD contracts is technology transfer, the training courses will allow others to learn and teach the methods without our assistance. Between tasks (3), (4), and (5), the objective is to produce a documented set of tools for deployment analysis that can be picked up and used in any city.

Test Cities

The test cities were carefully chosen. Over fifty cities indicated their desire to participate in the study. Six were chosen. They represent a good mix of city sizes and emergency services.

We are studying fire engine deployment problems in four cities:

- Denver;
- Yonkers;
- Jersey City;
- Wilmington.

We are studying police allocation and sector design problems in New Haven, and ambulance deployment problems in Washington, D.C. We have also performed a fire deployment study for Trenton, New Jersey, for which the city itself provided the funds.

It is interesting to note that we had never analyzed ambulance services in New York City. But we were convinced that some of the same models that had been applied to fire and police problems were also applicable to ambulance problems. This turned out to be the case.

What were the deployment problems in these cities? At the beginning, our perspective was shaped strongly by what was important and interesting in New York City. As indicated above, the driving force behind many of the New York City Fire Department's problems was the high alarm rate. This led to the need to consider policies that would reduce workload and increase companv availabilitv while maintaining or improving fire protection.

Among the Institute's most important accomplishments in New York City was the Adaptive Response policv. But, a policy like Adaptive Response is of little or no use in most other cities. In fact, indiscriminate implementation of such a policy might actually lead to undesirable results. For example, to combat what they thought was a "false alarm problem," Yonkers had already implemented a reduced response policy, similar to Adaptive Response, which dispatched one engine company and one ladder company to box alarms that occurred between noon and midnight. But Yonkers has no false alarm problem in the sense that New York does. While false alarms have increased dramatically in Yonkers in the last few years, there are still fewer than five false alarms per day. And, more importantly, Yonkers has no workload problem. Their busiest company made 1100 runs in 1972. This works out to about 3 responses per day. By contrast, New York City's busiest company makes over 8000 responses per year, an average of about 22 per day. In addition, because of the low alarm rate in Yonkers there is no reason to reduce a response in expectation that the units held back will be needed soon at another alarm.

Therefore, reducing response in Yonkers reduces fire protection, and the saving in fire company responses is not worth the reduction. We showed the city that, by increasing the initial dispatch to two engines and two ladders during these hours, the busiest company would end up making about 1400 responses per year (an average of less than one additional response per day). But, over the course of a year, this response policy will assure a better response to about 100 structural fires that will come in by box during these hours.

If initial dispatch is not the most important policy issue in the smaller cities, which policies are?

We found that, because of the financial crises that all cities are now facing, the issues of paramount importance are:

(1) How many units are needed to achieve various service levels?

(2) Where should those units be located?

These questions kept cropping up in every city and in each of the emergency services.

We had studied these questions for the New York City Fire and Police Departments, and had developed some models that could be used to answer the questions. But, the primary tools in both police and fire were large-scale simulation models that allowed us to take into account the complex interactions that result when more than one incident is being serviced at one time. This is a common occurrence when call rates are high. In Brooklyn on a summer evening there are sometimes 20 or 25 fire alarms in progress simultaneously. In Yonkers, on the other hand, less than two percent of the time will there be even two alarms in progress at the same time in the whole city.

The relatively low call rates in cities other than New York allowed us to make use of much simpler, more static models instead of the simulations in performing the analyses. Thus, the process of explaining the models and the methodology to the cities was made easier, and the goal of making it possible for other cities to perform similar analyses became easier.

Because we have been trying to answer the same sorts of questions in every city, our approach in each case has been quite similar. We use mathematical models to estimate performance levels that would result from implementation of a specific arrangement of emergency service vehicles; i.e., specifying the number of units and their locations, and determining the resulting performance characteristics. By comparing the performance levels provided by one arrangement to those of others, and factoring in political and budgetary constraints, the service agency can decide on the one that appears best.

Of course, we would like to measure performance levels in terms of the ultimate objectives of the emergency services. For example, we would like to be able to estimate the effect of a rearrangement of fire companies on loss of life and loss of property due to fire. But, the present state of knowledge does not permit this to be done. We therefore use travel time or travel distance as our measures of performance for all the emergency services. The assumption is that, for example, for fire companies, faster response will lead to fewer lost lives and less property damage.

The work performed in the various cities has already led to development, and in some cases implementation, of new deployment policies. For example:

- In Washington, D. C., we have shown the ambulance service how it can reduce the average time between receipt of a call and the arrival of an ambulance at the scene by 28 percent during the hours of high demand by redistributing its resources over the day.
- We have shown the city administration in Trenton how it can obtain approximately the same level of fire protection that it now has with 22 percent fewer engine companies.
- In Wilmington, one fire company has already been eliminated and plans have been developed for changing the locations of several others. Funds have already been budgeted for three of the new firehouses.
- Yonkers has purchased sites for the two new firehouses recommended in our Report, and funds for construction of the houses have been allocated in the new budget.

- In Denver, the Mayor recently approved a plan for redeploying fire companies that will save the city $1.25 million yearly, with almost no degradation in fire protection levels.
- In addition, at the request of the U. S. District Court for the District of Columbia, we evaluated the equity of the distribution of fire companies in Washington, D.C. We found that there was some basis for the allegation by residents of Anacostia that they were receiving poorer fire protection than the residents in other residential parts of the city. The court has not yet reached a decision in the case.

TECHNOLOGY TRANSFER

I would now like to turn to what HUD values most in this work—its focus on technology transfer. This focus has led us to develop a unique and effective operational approach, which is based on what we learned about transferring technology in our work with the New York City Fire Department.

The Federal Government has been moving in the direction of replacing categorical grants to cities by revenue sharing, block grants and other aspects of the "New Federalism." At least in Washington's view, these relatively unrestricted large grants leave cities a great deal of discretion in what they can do with the money. Even among those who share the beliefs underlying this "decentralization" there is a fear that the money will not always be wisely spent, and that there will be few incentives to improve local managerial and decisionmaking capabilities.

However, even with incentives, it is widely, and probably correctly, felt that most cities lack the ability to develop, test, and apply methods for carrying out such improvements. HUD has created a new program, the Community Development and Management Research Program, within its Office of Policy Development and Research, to introduce local managers to useful and usable management tools, and to try various approaches to building local managerial capacity.

Our contract falls within this program, and embodies two important elements that the program emphasizes. The first element, the testing of new management methods in representative communities to determine their usefulness, is one I have already discussed. The second essential element is the development of a local capacity to deal with problems without the assistance of outside consultants. We are meeting this objective in three ways:

(1) We work jointly with a local project team in each city. The team is responsible for doing much of the work and for drawing up the recommendations.

(2) We are fully documenting the tools and techniques used in the analysis for all levels of users, from a general nontechnical overview for managers, to user manuals for analysts and data processing personnel.

(3) We are developing training courses to transfer the deployment analysis methodology to municipal personnel.

The second and third items are self-explanatory. But I want to expand on why we work with the local project teams. Our aim is to enable them to understand the methodology, make the decisions, and perform similar analyses in the future without our help. We plan to work with each team through to final implementation. This is the same approach that I described earlier as having worked so successfully in New York City. I feel that it is the only way to make sure that the results of a study get implemented and produce lasting benefits.

The team's composition may vary based on the city's interests and available talent, but in order to increase the chances of getting recommendations implemented the team should include representatives of the city's administration and the service agency, including representatives of interested unions. For example, in Wilmington the project team included the Mayor's Assistant for Public Safety, a budget analyst from the Mayor's office, the

Chief of the Fire Department, the head of the firefighters' union, and several firemen. In Yonkers the Budget Director and Assistant City Manager were involved. These teams are not deliberative bodies that act on reports we submit. The team members do a large share of the actual work—gathering data, evaluating output from the models, and determining final recommendations. An important side result from the team approach is that it shows the usefulness of having a planning capacity within the service agency, and provides a nucleus around which such a planning group can be built. As a direct result of our work, the Wilmington Fire Department hired a civilian management analyst to continue the work already begun.

The team approach is also designed to avoid the result of a more traditional study recently made of the Milwaukee Fire Department. In this case the Mayor's office hired the consulting firm; the Department had almost no input to the study; and, after the study was published, with conclusions the Fire Department found unpleasant, the Department published its own report rebutting the consultant's study point by point.

Based on our experiences in New York and the HUD test cities, it is not clear that the ultimate objective of being able to transfer the mathematical models and methodology to a city without outside technical assistance can be realized. Cities will have to be able to attract and hold onto top-level in-house analysts to do this work for them—something that they have not been very successful at doing up until now. They will also have to feel the need for and see the usefulness of the systems analytic approach to deployment problems, as the Fire Department of New York did in 1968. While the number of cities that meet these prerequisites for successful use of our methods and models is not that large, it is growing. Our success is developing the models, document them, and implementing them in a number of cities, is giving other cities an incentive to follow along this path.

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