AN APPROACH TO SOLVING MUNICIPAL EMERGENCY SERVICE DEPLOYMENT PROBLEMS

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Municipal service agencies are currently facing severe pressures either to cut back on their services or to increase productivity. In many cities, these pressures are especially strong on the emergency service agencies. These agencies are almost all experiencing rapidly increasing demands while managerial and technological problems are mounting and costs are rising faster than the revenues needed to pay for them. As a result, cities are increasingly recognizing that they need more effective ways of providing these services.

Since 1969, the New York City-Rand Institute has had three contracts with the U.S. Department of Housing and Urban Development which have been designed to develop new methods and approaches to the deployment of emergency service vehicles and to test them, document them and disseminate them to interested cities throughout the country.

This paper will describe the work in general terms, show how it fits into the national policy objectives of HUD, describe what has been accomplished under the contracts, and highlight some of the implications of the work for municipal policy making.

Background

The Institute has just been awarded its third contract with HUD for work on the deployment of emergency services. The tasks in the last two contracts fall into five broad areas:

(1) Improvement, generalization and extension of models already developed at the Institute for analyzing the deployment of emergency service vehicles.

Under contracts with the New York City Fire and Police Departments and the first HUD contract, many models were developed for relating output performance measures, such as vehicle workload and response times, to inputs such as vehicle configurations and dispatching policies. An example of such a model is the simulation model of fire department operations which is a representation inside the computer of what actually happens in the field when alarms are received, fire companies dispatched, and fires put out. The computer keeps a record of the simulated performance of the department under different operating policies. After running the model under one policy this record can be compared to the record produced by another policy, and decisions can be made on the relative benefits of each policy.

(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) Documentation of 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) Documentation of 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) Development of training courses.

The ultimate objective of the HUD contracts is to transfer the deployment analysis methods to municipal personnel who are responsible for the analysis and implementation of deployment policies for emergency services.

The new contract is seen as a key part of the broad Federal effort to strengthen the local government's side of the "New Federalism." This aspect of the contract will be discussed later, but first I want to give you an historical perspective on how we came to be doing this work.

As early as 1969 the Institute's work for the Fire Department of New York was beginning to gain a reputation outside of New York City. At that time Harry Finger, who had just become HUD's Assistant Secretary for Research and Technology, was under considerable pressure from his superiors in HUD and from Congress to demonstrate the payoff which HUD had derived from its extensive expenditures on research and planning. Under the previous administration the research had produced few successes. HUD and Rand had just negotiated a contract for general research on urban problems. But Finger wanted some immediate payoff and a reasonable guarantee of success. Being aware of our fire research for New York City, and knowing that no one else in the Federal Government was involved in such research, he decided that the new contract should focus on emergency service deployment problems.

This first HUD contract ran from 1969-1971. The money was used to pay for the development of some of the basic mathematical models which provided the theoretical foundation for our deployment work in police and fire. This money also supported some valuable police research during the hiatus in our relations with the New York City Police Department, and led to models on which the Police Department is now capitalizing. The work in fire was quite basic and mathematically abstract. It would have been difficult for the Fire Department to support it until it could be shown to be useful and applicable.

By the time this contract ended, in early 1971, several new deployment strategies, based on work sponsored by HUD and the Fire Department, had been successfully put into practice in New York City.

HUD was pleased with the success of the new techniques, but was concerned that the methods would be applicable only in New York City and other large cities. We were convinced that many of the techniques could be applied equally well, and in some cases, even better, in smaller cities. Therefore, we submitted a proposal to HUD for a follow-on contract to extend these techniques and try them out in some smaller cities. The new contract was awarded in May 1972.

Under this contract, which ran through December 1973 (and under the new contract, which is basically an extension), we were to field test in several cities the tools and techniques we had developed for deployment analysis in New York City. These tests would show us which of the tools would be most useful in the smaller cities. Based on the tests, we were to document the useful models and make them available to other cities throughout the country. The end result we hope will be a set of tools for deployment analysis which can be picked up and used in any city.

<u>Test Cities</u>

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

We are studying fire engine deployment problems in four cities:

- Denver, Colorado
- Yonkers, New York

- Jersey City, New Jersey
- Wilmington, Delaware

We are studying police allocation and sector design problems in:

- New Haven, Connecticut

We are studying ambulance deployment problems in:

- Washington, D.C.
- St. Louis, Missouri

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 which had been applied to fire and police problems were also applicable to ambulance problems.

What were the deployment problems in other cities? At the beginning our perspective in working with these cities was shaped strongly by what was important and interesting in New York City. 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 which would reduce workload and increase company availability while maintaining or improving fire protection.

Among the Institute's most important accomplishments in New York City have been an adaptive response policy which sends more units to potentially more serious alarms and fewer to potentially less serious alarms, and a method of relocating available fire companies to fill gaps in fire coverage.

These policies are of little or no use in most other cities. In fact, their indiscriminate implementation might actually lead to undesirable results. For example, to combat what they thought was a "false alarm problem," Yonkers had already implemented a reduced dispatch policy, similar to adaptive response, which dispatched one engine company and one ladder company to box alarms which occurred between noon and midnight. But Yonkers has no false alarm problem. While their false alarms have increased dramatically, still they experience 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. New York City's busiest company makes over 8000 responses per year. 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 merely reduces fire protection, and permits fire companies to spend more time in their fire houses. 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 which will come in by box during these hours.

If dispatch and relocation are not the most important policy issues in smaller cities, which policies are?

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

(1) How many units are needed?

(2) Where should the 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 which allowed us to take into account the complex interactions which 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 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 more feasible.

In implementing the models on the computer we made an early decision to make them interactive--i.e., the user can access them via portable terminal or teletype even if he has no computer facilities available to him and knows nothing about computers. Thus, a fire chief or police captain can ask deployment questions and analyze the results instantly while sitting in his own office.

Because we have been trying to answer the same sorts of questions in every city, we have been able to develop a general methodology for dealing with these questions. To illustrate in tangible form how our analysis proceeds, I will show you how we helped Yonkers analyze its fire company deployment problems.

The Method of Analysis

We begin every such study by gathering and analyzing data on calls for service. In most cases the data is available only in hand written form, so it must first be transferred to coding forms and keypunched before it can be fed into the computer.

We look at aggregate historical data to get an idea of trends. We also look at patterns by time of day, day of week, season, and type of incident to get an idea of the demands which are being placed on the service agency.

The most important pattern in determining unit locations is the geographic pattern of incidents. For analysis purposes we divided Yonkers into four "demand regions" as shown in Figure 1. This figure also shows the current locations of all thirteen engine companies and seven truck companies. Figure 2 shows the geographic pattern of total alarms in Yonkers in 1971. The patterns of alarms for structural fires and false alarms are roughly the same.

The question of how many fire companies Yonkers should have is a difficult one which will be discussed briefly a little later. We first assume that Yonkers has the right number of companies. But are those companies currently located in the right places?

If the location of the fire companies relative to the location of the fire alarms is considered, it is apparent that there are indeed more fire companies in the high incidence area and fewer in the lower

Figure 1

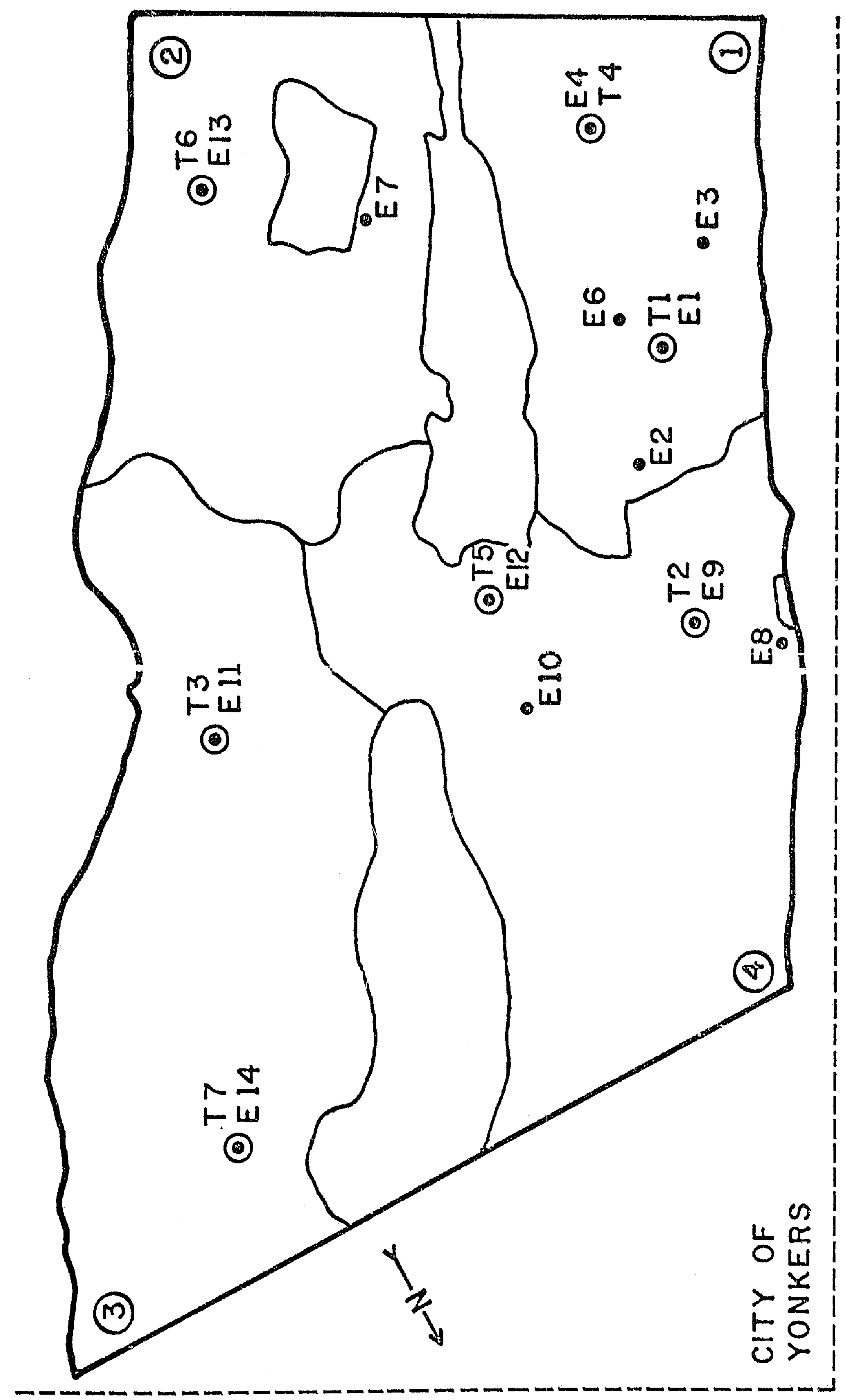


Fig. 1. Current locations of engine and truck companies in Yonkers

Figure 2

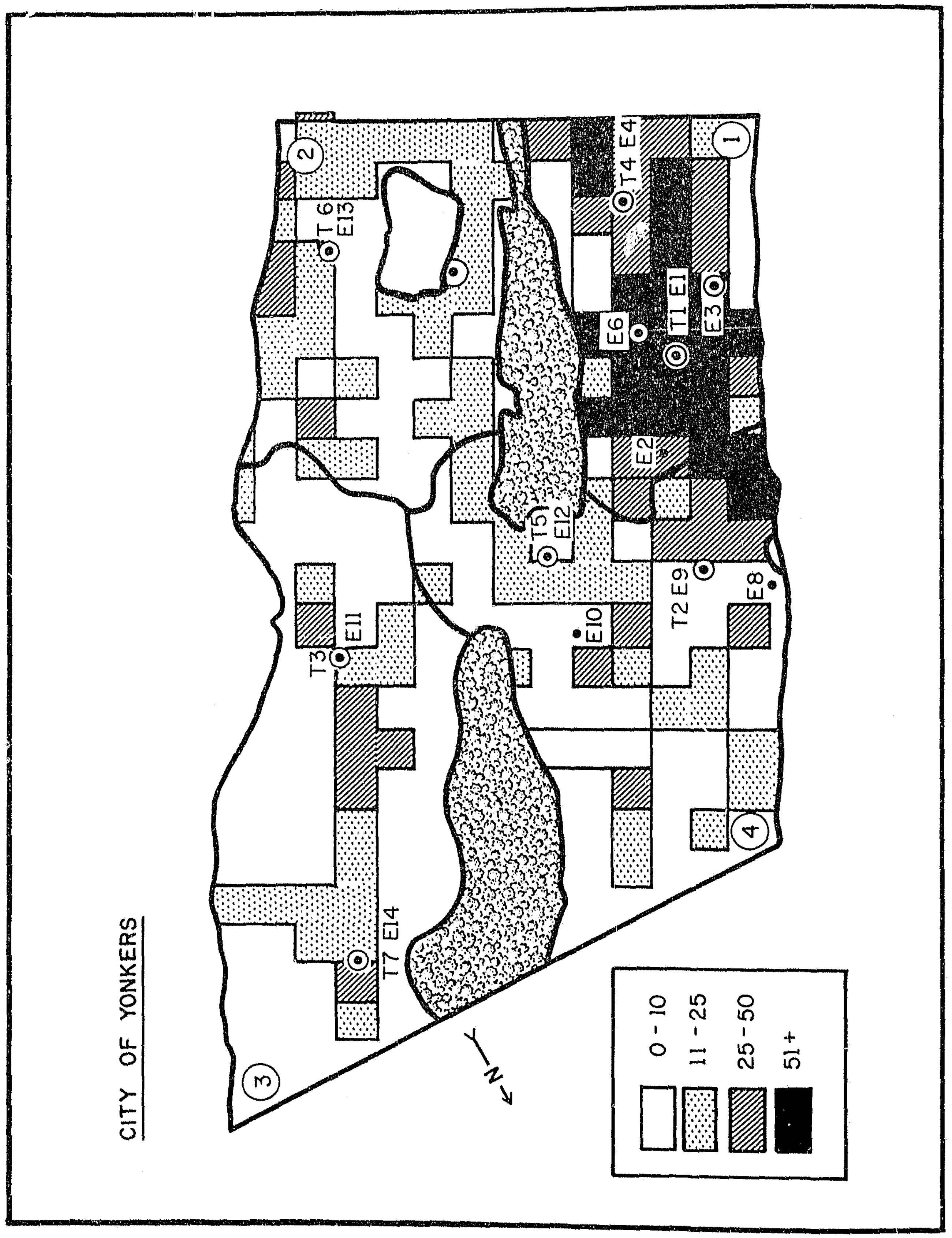


Fig. 2. Yonkers: Distribution of total alarms for 1971

incidence areas. This suggests that the locations may be satisfactory. Most fire departments use just such subjective judgments and rough guesses to choose locations for their fire houses.

But our approach is to present the department with some quantitative measures of the fire protection levels which will result from various fire house configurations. The chief (and the mayor or city manager) then has plenty of information on which to base the final decision.

For example, consider some of the response times which result from the current configuration of fire companies in Yonkers. In region 4, all six fire-fighting companies are located in the southern half of the region (closer to the high incidence area). But, when a fire occurs in the northern part of Engine 9's district it can take up to 5-1/2 minutes for the first unit to arrive. This compares with a maximum first unit response time in Engine 1's district of under three minutes.

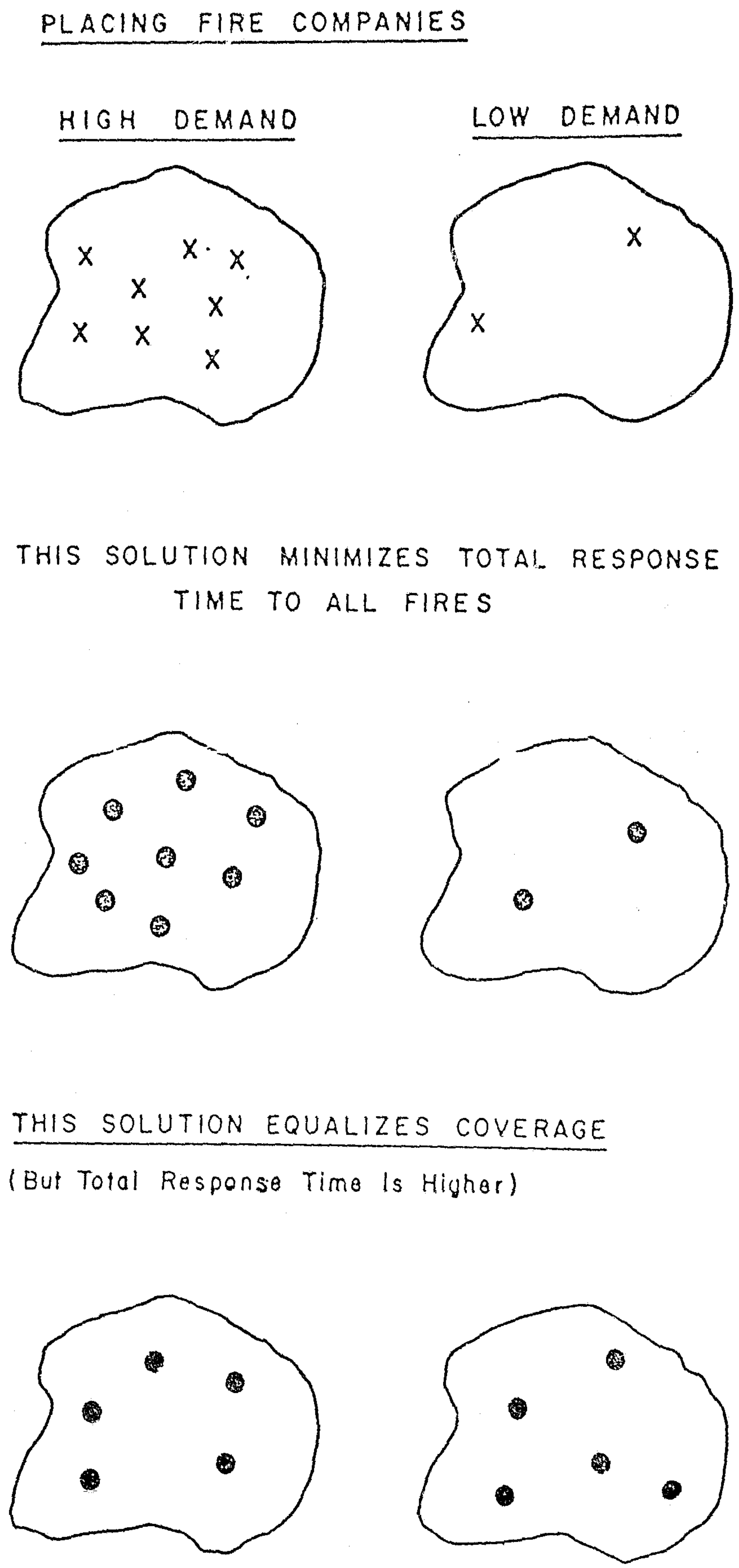
Is this fair? Is this the most effective distribution of the fire department's resources? It may well be. These are difficult questions, and their answers depend strongly on local values and priorities. Few fire department performance standards currently exist, and those that do are quite arbitrary. In addition, the fire department has several objectives, some of which directly compete against each other.

For example, consider the hypothetical city shown in Figure 3 which has been partitioned into two regions of about equal size, but which have very different fire alarm experiences. One region has a high incidence of fire alarms, the other, a very low fire alarm rate. How should the city's ten fire companies be allocated between the two regions?

One fire department objective might be to minimize the total response time to all fires which occur in the city. In this case the companies should be placed close to where the fires are expected to occur. As a result, eight companies would be allocated to the high demand region and only two to the other region.

The problem with this solution is that, when a fire does occur in

Figure 3



the low demand region it may take a very long time for the fire companies to arrive. The residents of the low demand region probably would not stand for such a poor level of service. They pay their taxes (in fact, they probably pay more taxes than the people in the high demand area) and they are entitled to some reasonable level of service. They shouldn't be so severely penalized for being careful and not having a lot of fires.

Another objective, which represents the other extreme, is to make the average response time to alarms the same in each region. The result in this case would be to locate five companies in each region. This may be a more equitable solution, but the problem is that the workload on the companies in the high demand region would be great, response times to actual alarms would be long, and the units in the low demand region would be sitting in their fire houses most of the time.

So you see, there is not a single correct answer to the problem of placing fire companies. In general, fire departments end up with an allocation which is a compromise between these two extremes: placing more fire companies in the high demand regions, but making sure that all regions of the city receive some minimum acceptable level of coverage.

Our approach is to provide the department with the information it needs to determine the trade-offs between alternative fire house configurations.

Returning to the Yonkers example, we showed the Department that, by moving Engine 10 to a location slightly north of its current location, the maximum response time in region 4 would be reduced by a full minute--from 5-1/2 to 4-1/2 minutes. By moving this company further from the high demand region, its relatively low workload would be further reduced and other companies would become busier. However, the Fire Department and the Budget Director agreed that, on balance, moving Engine 10 was a beneficial change. The City, therefore, has already purchased the new site and funds for construction of the house have been allocated in the new budget.

This simple example was purposely selected for illustrative purposes. It is easy to tell that this is an obvious improvement just by looking at the map. But there are other deployment options which had to be evaluated which are not so obvious, especially the question of adding or eliminating companies.

For example, truck response times in region 4 are much worse than engine response times. It might be advantageous to add a truck company in Engine 10's new house. The resulting reductions in average and maximum response times are striking. The maximum truck response time in region 4 is reduced by almost two minutes, from 6.1 minutes to 4.3 minutes. But the new fire company would cost the city over $450,000 per year to operate, and from a workload point of view, it would be one of the least busy companies in the city. Is the improvement worth it? Some improvements could be obtained by moving Truck 5, or by converting Engine 1 into a truck company and moving it to Engine 10's house. Would the resulting degradation of response times and increased workloads in their old districts more than offset the gains?

These are difficult questions, and the answers are certainly not intuitive. But, we are able to demonstrate the effects of such changes in quantitative terms so that rational deployment decisions can be made. In the past, fire departments considering such changes could only guess at the results.

Based on the work which has been done under this contract, other cities are also getting ready to change deployment policies:

- In Washington, D.C., we have shown the ambulance service how it can reduce its response times by an average of half a minute, and in some cases by two minutes or more during the busy times of day. For a serious ambulance call, two minutes could mean the difference between life and death.
- In Wilmington, a recommendation has been given to the Mayor to eliminate two engine companies and move another to a new fire house. These changes are now being negotiated with the firefighters' union.
- In Denver, the Mayor recently approved a plan for redeploying fire companies, which will save the city $1.25 million yearly with almost no degradation in fire protection levels.

Technology Transfer

Now let us return 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.

The Nixon administration has been moving in the direction of replacing categorical grants to cities by "revenue sharing" 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 recently created a new program, the Community Management Program, to introduce local managers to useful and usable management tools, and to try various approaches to building the local managerial capacity.

Our contract falls within this program, and embodies the two important elements which the program emphasizes. The first element is the testing of new management methods in representative communities to determine their usefulness, which has been discussed above. 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 a training course to transfer the deployment analysis methodology to municipal personnel.

In the work so far, the primary emphasis has been on working 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 we have used so successfully in our police and fire work in New York City. In our opinion, it is the only way to make sure that the results of a study get implemented and produce lasting benefits, instead of winding up in a report which sits on a shelf gathering dust.

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. In Wilmington the project team includes 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 are involved. These teams are not deliberative bodies which 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 has appointed its first full-time planning officer, and the Denver Fire Department has 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.

To sum up, the last HUD contract has allowed us to examine the problems of emergency service agencies in selected American cities.

We have found a surprisingly consistent commonality of problems in all of them.

We have developed an approach to carrying out the required analysis which may be the most important and lasting result of the project --it is the only approach which we think stands a chance of working; i.e., to involve all the interested parties in a joint project team.

The final verdict on the success of this project awaits the results of the next fifteen months of work. It is already clear that the joint project team approach works well in transferring technology. But it is not clear that HUD's ultimate objective will be realized--that objective being the ability to transfer the models and methodology to a city without any outside technical assistance. It may be tougher than HUD expects to build a truly independent local capacity. But, as a result of our HUD contracts, we are taking a large step in that direction.

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