III. *Systems Analysis and Development*

Combating fires bears many resemblances to warfare. Fire suppression forces must be deployed effectively so that countermeasures can be taken quickly. Devices that improve command and control at the fireground are urgently needed.

The logical sequence of events involved in a fire, in the absence of an automatic response leading to its suppression, are:

- Ignition of some combustible materials
- Detection of a fire
- Alarm to a fire-fighting organization
- Dispatch of fire-suppression equipment
- Response of men and equipment to the fire scene
- Estimate of the seriousness of the situation (size-up) on the fireground
- Fireground operations (rescue and suppression)
- Overhaul (salvage, cleanup, securing operations)
- In service (release of men and equipment for other assignment)
- Return to quarters
- Post-fire critique

The events can be regarded as demarcation points between separate phases. In actual practice, the duration of a given phase can be quite variable. There can be an overlap of events or a repetition or superposition of a cycle of events.

The fire department becomes involved in a fire at the time the alarm is given. A prearranged response of men and equipment will be dispatched which, in most jurisdictions, is already decided upon as a function of the type of alarm that is received. For example, if an alarm is given for an apartment complex, a specific number of men and equipment are preprogrammed to respond. It will be larger than the initial response to a single dwelling since a more hazardous and complex situation is likely to prevail.

The APL/JHU Fire Group has examined several segments of the fire department operation. Since the investigation had to have the cooperation of fire suppression organizations, the areas of investigation were dictated by the joint interest of local fire departments such as Baltimore City and the Hillandale Volunteer Fire Department in Montgomery County. Two major topics dealt with were:

Fireground Command and Control System
Communications and Response Analysis

Fireground Command and Control System*

In many communities the number of men and units of equipment that will respond to fires may be sizable because of the existence of large apartment complexes and high-rise buildings, hospitals, schools, shopping centers, and commercial structures. The initial response alone can present a formidable challenge to the officer in charge of the fireground operations. In a severe fire many units will respond; not all of the units are visible or in direct communication with a command post, nor are they necessarily all from within the fireground commander's own jurisdiction.

The first requirement for effective fire suppression command is for fire officers to know what is to be controlled and what means are available to them. Under the conditions of stress and confusion induced by the emergency, it often becomes difficult to assess the variables that control the proper deployment of resources. Key decisions may be omitted from the command operation because the officer in charge is not able to appraise conditions rapidly and properly. Often the commanding officer does not have all the essential information at hand to develop the best operational procedures.

It has been stated that prior knowledge of variables associated with an emergency could increase the effectiveness of fire department operations more than any other single factor.[13] For effective emergency command, a fire officer must first have knowledge of pertinent facts and then optimize existing and available tools. The resulting tactical

* Professor H. E. Hickey (University of Maryland) and D. O. Shapiro participated in the developments described in this section.

[13] B. M. Halpin and H. E. Hickey, "Fireground Command and Control Tactics Display Case—Preliminary Report," APL/JHU Report FPP TR 22, Apr. 1973.

or command decisions must then be communicated to support units. Maps, charts, and radio messages are used extensively to assist commanding officers. However, even with such aids, many decisions are formulated without adequate supporting information.

Decision-making abilities vary from officer to officer, depending on his talent, experience, and training, and on the extent and quality of tactical preplanning before emergency situations arise. It is beneficial to place as much information as possible at the disposal of the fireground commander to aid him in reaching sound decisions. The response territory (including street and building layouts), locations of private fire protection equipment, special hazards and water supplies, exposure conditions, and extent of mutual aid support should be available to the fire officer when responding to a given incident.

The problem of handling both prefire planning data and of displaying the disposition of a sizable force of men and equipment in action on the fireground in an economical and reliable way has resulted in the design, fabrication, and evaluation of a fireground command and control system. The system comprises various components that can be used independently. The first component is a portable Tactics Display Case[13,14] that contains aerial photographs of target hazards marked with standard symbols for features of interest (e.g., gas, water, and electric cutoffs, hydrant location, special hazards, blocked entrances) together with magnetically attachable markers for indicating the placement and availability of individual fire-department vehicles. It is thus possible for a fireground commander to assemble an up-to-date display of the fireground and the status and location of the units under his command. The display case can also be used for preplanning and debriefing operations and in training exercises.

When a portable microfiche reader, displaying important background information on designated hazards, is used in conjunction, the resulting configuration is called the Tactics Display Console. This information would indicate inspection reports, prefire planning data, occupancy data, floor plans, locations of special hazards, priority salvage instructions, or any other information of interest for the various structures that might be involved in fires. The Tactics Console is small enough for mounting in the cab of a fire engine or in a Chief's car.

The most elaborate configuration developed to date consists of a Tactics Console and other instrumentation in a specially designed and outfitted vehicle called the Mobile Tactical Unit for use as a mobile command, control, and communications vehicle. The outfitting of such a vehicle has been a joint project with the Hillandale (Maryland) Volunteer Fire Department (HVFD) who furnished a ¾-ton Ford Econoline van equipped with necessary fire-service devices (sirens, safety lights, and radio) and a mobile telephone for contacts with the Command Center. APL, with the advice of HVFD, designed, fabricated, and installed a

Fig. 21—Mobile command and control van in Hillandale, Maryland, Volunteer Fire Department station house.

Fig. 22—Internal view of mobile command and control van showing aerial photo board and equipment status board, looking from back to front of the van.

[14] B. M. Halpin and H. E. Hickey, "Tactics Case Designed for Command and Control," *Fire Engineering* **126,** Jan. 1973, 50–52.

status display panel, three microfiche readers, a rotating and sliding aerial map board reader, meteorological and hydraulic sensors and display meters, cabinets, chair, hardware furnishings, and a Mine Safety Appliances Co. gas analysis kit.

The Mobile Tactical Unit was formally transferred in March 1974 to the Hillandale Volunteer Fire Department (Figs. 21, 22, and 23) for evaluating the equipment components and the procedures for use under emergency conditions.

Fig. 23—Internal view of mobile command and control van with aerial photo board in position for use, with microfiche readers evident.

Communications and Response Analysis*

No fire department can function efficiently without effective communication. With the cooperation of the Baltimore City Fire Department, a study was undertaken to examine the equipment and procedures used in the alarm and dispatch phases.[15]

Conclusions of the study were that the general alarm and dispatch techniques were adequate to cope with the Baltimore City fire problems for the foreseeable future. However, it was found that the most glaring problem was in outdated communication equipment, especially on the fireground apparatus. The communication equipment available did not have enough channels available to pass pertinent information. As a result, there are built-in bottlenecks for information transfer.

An investigation of the extent, the causes, and possible remedies for false alarms was carried out. Such alarms are becoming increasingly prevalent in cities and put a great strain on available resources. The characteristics of false alarms in Baltimore were reviewed using the street-box alarm data for July 1, 1971 through June 30, 1972. The original data consist of dates and times of day when alarms were pulled, but the time distribution of alarms had not been obtained. In order to look at the spatial distribution of alarms, annual totals of false and fire alarms were compiled for each section of a map grid.

The data compiled for the 1585 street alarm boxes for which there were alarm data were summed for each of the 102 grid sections of Baltimore, and the total false and fire alarms for the year were obtained.

Totals for the entire city are as follows:

Number of boxes reported	1585
Number of false alarms	5488
Number of fires	3009
Total box alarms	8497
Percent false alarms	64.59
Ratio false/fire	1.82
Total alarms per box	5.36
False alarms per box	3.46

Note that these are alarms for street boxes only. About two-thirds of the alarms received by the Fire Department are "silent" (by telephone) alarms, and of these only about 10% are false.

With regard to the false-alarm data, various criteria of false-alarm activity have been tested, and an attempt is being made to group data on a less arbitrary basis and to associate the results with demographic factors.

It was suggested that different types of alarm boxes might show different kinds of alarm data; accordingly, the data were sorted by box type. It was conjectured that quick-pull boxes, because of their relative ease of operation, might have a higher proportion of false alarms. It was found, however, that there is no significant difference in the ratio of false alarms to fires (f/t) between the three-fold and quick-pull circuits, and f/t is lower for sequential circuits. There is a significant difference in alarm densities; the number of total alarms per box is about 50% higher for quick-pull and sequential boxes than it is for the three-fold type. This may be due to the distribution of different box types throughout the city, which has not yet been investigated.

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* Dr. G. L. Ordway and J. W. Hamblen conducted this study.

[15] G. L. Ordway and J. W. Hamblen, "Communication Systems, Equipment, and Message Traffic in a Large Urban Fire Department," APL/JHU Report FPP TR 23, Jul. 1973.