LIMITING THE EFFECTS OF INCIDENTS ON URBAN ARTERIAL ROADWAYS

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Abstract

Non-recurring events such as traffic crashes can generate significant congestion and delay on heavily traveled urban arterial roadways unless adequately managed. Effective management includes traffic control. The process also is integral to intelligent transportation systems (ITS) planning. The Northwestern University Traffic Institute recently completed a study which examined the impacts and management of arterial street incidents to determine what steps could be taken to improve the handling of such events. One important area addressed related to communications and included:

- Response in a manner and with adequate resources to minimize the time an incident affects a scene;
- On-scene coordination to expedite removal of vehicles and debris;
- Effective traffic control at and around the incident, and
- Communication with motorists who may be affected by long duration incidents.

Recommended changes include education of drivers and professionals, legislation, communications, use of new technologies for communications and data collection, advanced planning and coordination of on-site procedures, responsibilities, and priorities.

DESIGN OF THE ARTERIAL INCIDENT MANAGEMENT STUDY

Methodology

Without effective management, non-recurring events on or near heavily traveled urban arterial roadways, such as crashes, traffic stops, disabled vehicles, traffic signal malfunction, or fires can generate significant congestion and delay on these roadways. Effective management of incidents includes both the prompt removal of impediments to travel and efficient control of affected traffic. Actions by responders are integral to intelligent transportation systems (ITS) planning and operation. The Northwestern University Traffic Institute recently completed a study which examined the impacts and management of incidents on arterial roadways, and recommended steps that could be taken to improve the handling of such events. This paper addresses some of the more important issues identified.

A number of approaches were used to conduct the research, including (1) analysis of incident data from police and fire agencies; (2) debriefings of responders about specific incidents; (3) observation and videotaping of incidents; and (4) an incident management simulation workshop involving police, fire, emergency medicine, tow services, public works, insurance, and media professionals, all who share a role for incident management. For the workshop, a series of incidents, based on actual events, were simulated and consensus was sought on specific and general management tactics.

Key Topics

All of the research was summarized in several reports covering the project (Raub, *et al.* 1996a and b). The important topics which addressed issues and recommendations were:

a. Adequate information about the incident to help determine how best to handle it;
b. Response to the incident in a manner and with adequate resources to minimize the time an incident affects a scene;
c. Rapid removal of vehicles and debris;
d. Efficient at-scene command and communication
e. Effective traffic control at and around the incident;
f. Communication with motorists who may be affected by long duration incidents, and
g. Advanced, inter- and intra-agency planning for incident management.

One of the most difficult issues to resolve lay with communications. Included within this classification was adequate information about the incident, handling of on-scene command, and providing information to motorists affected by the incident. This paper is devoted to the topic of communications.

Whether an incident occurs along an urban arterial roadway or on an expressway, the structure of its management is the same. Differences exist in how the phases of the incident are handled between the two classes of roadway and in how drivers are able to react to and avoid the incident. The communications aspect of incident management, however, is similar regardless of the class of highway.

BRIEF EXAMINATION OF THE LITERATURE

Two of the earliest attempts to integrate incident management with detection of incidents on expressways occurred along the John Lodge Freeway in Detroit and the Chicago expressways. The work along the

Lodge Expressway concentrated on detection and notification (DeRose, 1963). Use of closed-circuit television (CCTV) allowed the surveillance team to detect and notify appropriate responders. Chicago added incident management teams to the process of detection and notification (McDermott, *et al.*, 1979 and 1992). They use service patrols which provide appropriate on-scene actions along with equipment to do the work. As a result of this effort, expressway management in Chicago has served as the model for other programs nationally.

Other documented comprehensive efforts directed toward managing expressway incidents have appeared in Minneapolis through the Minnesota Department of Transportation (Lari, *et al.*, 1982) and the Washington State Department of Transportation in conjunction with the University of Washington on the Seattle freeways (Berg, *et al.*, 1992). Additionally, many of the urban areas in the United States have been introducing service patrols designed to help reduce time incidents cause disruptions on expressways. The study of Seattle expressways also led to numerous strategies which could be put in place to reduce the time that an incident affected traffic. Out of the work came an emphasis on planning and training along with proper equipment and response programs (Koehne, *et al.*, 1991).

This historic work throughout the United States has emphasized both planning for handling incidents and effective communications once the incident has occurred. Both are needed because multiple agencies, sometimes as many as 20, can be involved with the effort (Judycki and Robinson 1992). However, one of the weakest areas remains that of communications.

Initial Notification of an Incident

Although increasing use is being made of detectors coupled with CCTV (for example, the Philadelphia portion of Interstate 95 and all of Maryland expressways), much of the information that can be learned about an incident still must depend upon on-scene viewers. On-scene reports are needed on urban arterial roadways where there is limited presence of loop detectors (except for traffic signal operations) and CCTV. The primary means of communicating remains the land line. The advent of enhanced 911 telephone service (with the location of the telephone displayed at the call-taker station), has improved information about location. However, unless the call taker requests specific information or the caller is familiar with providing appropriate information, this immediacy of notification may not provide adequate information on which to fashion an appropriate response. What usually happens is that a police officer is dispatched, and further actions are based on his or her "factual" information from the scene.

In 1985, United States Cellular Corporation became one of the earliest commercial vendors to integrate the cellular telephone with public safety through the 911 emergency number ("Car-Phone Samaritans," 1992). Formed in Tulsa, Oklahoma under the title Highway Emergency Response Organization, it provided free access to 911 for mobile users. These persons, in turn, were linked directly to the public safety dispatcher through the normal land lines. Because the telephone call might not be originating in an area served by the Tulsa police and fire departments, dispatchers had to determine the correct responding agency and relay the calls.

Currently, cellular 911 is available throughout most urban and suburban areas of the United States and along a large portion of the Interstate highways. Some state police organizations have taken responsibility for handling the 911 calls and rerouting them to the appropriate responder (California Highway Patrol, 1990). In all cases, the 911 call is free to the motorist. More importantly, more motorists are using the cellular telephone to report incidents.

In an attempt also to provide information for traffic monitoring, Houston experimented with using probe vehicles whose drivers were equipped with cellular telephones. They made periodic reports regarding traffic conditions to a special number. The information provided from the 200 volunteers appeared to be useful not only for detecting congestion, but also for incident notification (Levine, *et al.*, 1993). The most significant problem was false reports, the reasons for which could not be determined.

One of the significant problems facing dispatchers who receive mobile 911 calls is that the motorist often does not know his exact location. Signs indicating the names of jurisdictions may not always be posted, especially along the expressway system. Motorists may not be familiar with the milepost numbering system or crossing streets. In the Chicago metropolitan area for example, motorists can drive through multiple jurisdictions within a short distance (including some four-leg intersections which are served by as many as four different police jurisdictions). To make better use of the growing number of cellular observers and to provide persons familiar with the expressways (and thereby help pinpoint the location) the Illinois Department of Transportation formed the *999 ("Star 999") dispatch center as part of its traffic surveillance operations in 1989 (Illinois Department of Transportation, undated).

The *999 service has proven to be a valuable tool for reporting incidents and notifying the correct authority. However, success of the process is dependent upon adequate staffing of a communications center. Automating routing of cellular 911 calls is the next step. Already in testing stages, the process takes advantage of the multiple transmitting antennas to triangulate the source of the call. Once the location has been determined, the call automatically can be routed to the correct dispatching agency. In this manner, the person making the call does not have to know location.

Handling the Incident

Successful and rapid clearance of the incident hinges on the methods employed to handle the scene once responders arrive. Two aspects are critical:

1) coordination of operations and expedited removal of elements which are interfering with traffic, and
2) consideration of traffic movement and how the incident will affect that movement.

Dudek and Ullman (1992) have stressed that managing the scene should not fall on the shoulders of one agency. Coordination demands substantial interagency cooperation. Because the police generally are the first responders, they are the key to ensuring that the coordination occurs.

Fire and emergency medical services often represent impediment to coordinated efforts. Their policies and practices often do not appear to recognize effect of their equipment and operations on traffic. They can exacerbate the situation by substantially increasing the congestion and likelihood for secondary incidents to occur (Mannering, *et al.*, 1990). In response to charges of unnecessary hindrance of traffic, fire agency management contend they need to protect their personnel; yet, no studies support this contention. As Grezenback and Woodle (1992) noted, there is a need to balance fire scene management and traffic flow. The entire scope of fire scene (including emergency medical services) management on the roadway needs further research.

An assumption often held by those responsible for handling an incident is that once the roadway has been cleared, incident management is finished. However, this assumption ignores the congestion developed by the incident. Traffic flow does not normalize immediately (Guiliano, 1989; Lindley and Tignor, 1979). In addition to a lasting "gapers" delay, the queue still must be dissipated. There remains the need for communication to motorists to help return traffic flow through the site to normal.

Several efforts also are underway to revise the policies and practices, particularly for the public sector. Although rationale for many of these efforts derives from the United States Congress actions including the Intermodal Surface Transportation Efficiency Act (ISTEA) and Congestion Mitigation for Air Quality (CMAQ), the thrust is to speed clearing the scene in order to mitigate the effects of incidents on traffic delay and improve air quality. In his discussion of the importance of personnel in handling the incident, McDade (1992) stated:

> "Effective incident management begins with changes in attitude and focus. The lack of agency focus on incident management in the past years appears to have stemmed from a reluctance at all levels of the public sector to sufficiently change or adopt the traditional highway role ... to include the responsibility of managing complex problems such as freeway incidents (p. 49)."

Traffic Movement

In addition to the need for coordination of efforts at the scene, there remains an ongoing need to open the roadway to traffic as rapidly as possible. "Never should response vehicles block more lanes of travel than necessary or impede the smooth operation of the incident management process" (p. 2-103) (Koehne, *et al.*, 1991). Although this is more crucial on the expressway because of the limited alternate routes for vehicles, eliminating unnecessary lane blockage can be equally important on the urban arterial. Even though alternate routes exist, current traffic loads often limit capacities of the alternates to carry more vehicles. Moreover, many motorists lack familiarity with the alternate routing available and are reluctant to use it.

Treatment of alternate routing for expressways generally has been restricted to the service roads and other nearby paralleling roadways which can handle traffic when alternate routing is required. The National Highway Cooperative Research program (NCHRP) *Synthesis 177* addresses many of the issues related to the use of alternate routes (Dudek and Ullman, 1992). Much of this work expands earlier work by Ullman, *et al.* (1989) in Texas.

Improvements in microcomputers is making the use of dynamic traffic assignment (DTA) algorithms more practical. Some of the earliest work addressing DTA problems appeared in Merchant and Nemhauser's (1978) formulation of discrete non-linear programming. Additional heuristic and analytical models, as well as neural network analysis has been discussed in detail in Mahmassani and Peeta (1993). A System Optimum Dynamic Traffic Assignment (SODTA) model will compute optimum flows along a network, anticipates demand around the incident, and can advise incident managers of the most optimum routing for traffic.

Communicating with the Motorist

Communication with the motorist has long been believed to be critical in helping reduce congestion resulting from incidents. The intent has been to get motorists either to delay their trip or to use alternate routes. A large portion of the work on automated traveler information systems (ATIS), variable message signs (VMS), and highway advisory radio (HAR) assumes that providing information to the motorist will result in successful outcomes, i.e. lessened delays. Many expressways now have media which alert motorists to impending congestion. Systems with probe vehicles will incorporate traveler communications automatically and use this information to reroute drivers as needed (Boyce, *et al.*, 1991; Mahmassani and Chen, 1993).

The airwaves remain one of the best mediums for communicating to the motorists. A survey performed in Chicago found a large percentage of drivers chose their route before leaving home. The same drivers will vary their route dependent upon communication received en-route. Radio, rather than advance message signs, provided the primary source of data (Daniels, *et al.*, 1976). Dudek, *et al.* (1971) earlier had found that 42 percent of Texas motorists wanted information about their routes *before* leaving home, and 92 percent before entering the freeway.

Although those drivers who tended to be flexible with their routing relied on radio, both Daniels and Dudek found that most other drivers, even though they listened to radio for traffic reports, took no action. Usually the reason given was that information was out of date or not accurate. Perhaps the most important cause lies with the failure of responders to provide prompt and usable information to the media. "Providing timely, accurate information in a usable, understandable form is a key in getting that information passed on to the public" (p. 66) (Reiss and Dunn, 1991).

COSTS OF DELAY RESULTING FROM AN INCIDENT

Much work has been done establishing costs of delay occurring on urban expressways as the result of an incident. Less is known about delay occurring on urban arterial roads which was the focus of this study. One of the difficulties in establishing delay costs derives from the many opportunities to use alternate routes. In a grid system, such as Chicago, arterials, collectors, and residential streets provide ample choices. However, rerouting is, in part, dependent upon familiarity with the surrounding network, estimates of potential delay versus the added time to negotiate an alternate route, and the availability of alternate routes.

The traditional volume-time relationship is shown as Figure 1, where cumulative volume is measured on the Y axis, and time on the X axis. In free-flowing conditions, the cumulative volume increases over time along the curve OE. When an incident occurs, the segments ABC mark the new volume-time relationship and the difference from the curve OE represents total delay. Emphasis on incident management has rested on reducing the time the incident affects traffic, thereby moving the delay from ABC to A'B'C'. One means of reducing the time that an incident affects traffic is to ensure that adequate response arrives when it is needed, and that once on scene the efforts are coordinated. Both of these tasks requires good communications.

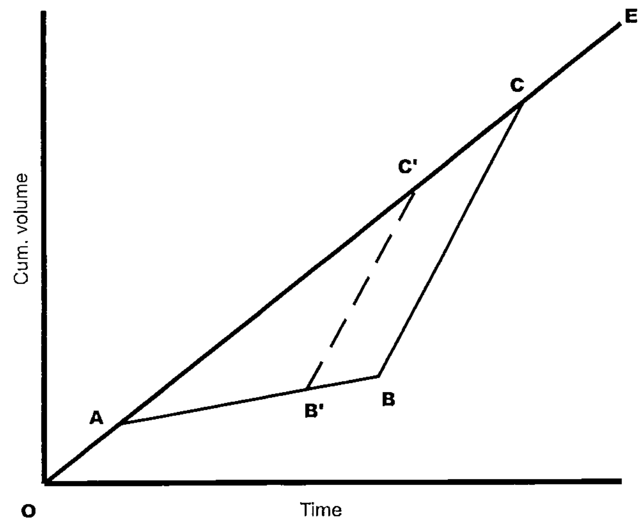

Figure 1 - Traditional Volume-Time Relationship with Delay

An alternate approach has been to reduce demand. For urban expressways, this effort primarily has been limited to the use of HAR and VMS. Its success has been somewhat limited because of the lack of substantial alternate routes. Reducing demand by rerouting flow prior to entry of motorists on expressways has rarely been used (in the 1960's, the Chicago Expressway Surveillance Project attempted to do so through use of VMS placed prior to key entrance ramps). Greater opportunity for demand reduction exists with urban arterial roadways because more alternate routes are available. On the arterial roadway, however, incident management personnel rarely attempt to reduce demand through rerouting of traffic. Alternates, even when available, will not be used in either case unless adequate information is made available to motorists. The effect of reducing demand is shown in Figure 2 where the segments DD'E represent revised demand and the area enclosed by DD'C represents the reduction in delay.

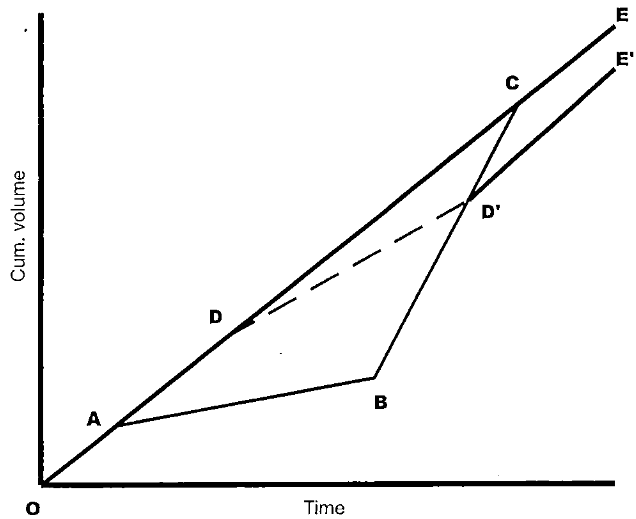

Figure 2 - Volume-Time Curve with Decreased Demand

Combining demand reduction with reduction in on-scene time will result in even greater savings. The remainder of this paper concentrates on how enhanced communications can help improve the on-scene incident management and provide sufficient information to motorists to help provide acceptable rerouting.

SUMMARY OF ISSUES AND RECOMMENDATIONS

Issues described in the subsequent sub-sections of this paper were uncovered from on-scene observations, videotaping incidents, and from debriefing those who handled incidents. The recommendations came from previous research, an incident management workshop described earlier, and on-scene testing. Important is that many of the recommendations either are in place at selected agencies or have been tested. The discussion of all issues and recommendations appeared in Raub *et al.* (1996a). The one area which has not been given enough attention and which would benefit from significant additional effort is that of communicating with motorists, and it is this area which may hold the most promise for reducing delay. This important considerations is discussed along with other communications issues.

Notification And Dispatch

Unlike the situation on expressways, learning that an incident has occurred on an arterial roadway usually is not difficult or time consuming. Emergency assistance is accessible by telephone either at a nearby residence or commercial location, or through the increasing use of cellular telephones. Responders do not have to wait until automatic detectors give an indication of congestion without information regarding the nature of what has occurred.

Historically, public safety call takers have lacked a degree of confidence in the information provided by persons other than police officers. This lack of confidence has been manifested by delays while the public safety dispatcher awaits arrival of a police officer on the scene for a "better" report.

Public safety call takers have the responsibility to assess the need for and direct the best initial response. These persons may be the public safety telecommunicator, a supervisor, or someone who is assisting with answering telephones. Other intervening call takers such as tow services, motor clubs, and community relay organizations such as cellular *999 (Star 999) in the Chicago metropolitan region often need to relay information to the public safety telecommunicator. They must extract from the reporters of an incident accurate and comprehensive information about it. The difficulty appears to be a lack of training both for motorists on how to report an incident and for call takers on how to obtain correct information.

1. Provide education and training to the public on how to report incidents. Their notification of incidents needs to be accurate and comprehensive, yet concise. An important body of reporters are those who drive for a living. This list includes truck drivers, delivery, outside sales, real estate, and utility personnel, and tow operators. They also are easier to reach for training. The kinds of questions that should be resolved were shown in Figure 3. Education can take place through a number of channels.

> 1. What has happened.
> 2. What is the exact location.
> 3. How many different units are involved and what are the types.
> 4. How is the roadway blocked.
> 5. How many confirmed injuries have occurred.
> 6. Is there spillage of a potentially dangerous substance; is there fire.
> 7. Can the involved units be moved.

Figure 3 - Questions to Be Answered

a. Produce a brochure which describes how to assist at an incident, both as a bystander or as one involved. This can be distributed by automobile clubs, at registration and driver license renewals, or with vehicle insurance premium notices.

b. Prepare a short videotape based on the brochure which can be distributed to television for public service announcements or shown at various community gatherings.

c. Include instruction in driver education courses on how to report incidents.

d. Provide formal instruction on incident reporting to those frequently on the road such as tow operators, bus drivers, utility personnel, taxi drivers, and sales personnel, e.g. real estate and insurance sales, as part of their initial or recurrent training.

2. Train public-safety and quasi-public-safety (such as the *999) call takers how to gather, assimilate, and summarize information received from the public. One useful tool is a check list of questions such as were shown in Figure 3. These also can become the basis for an expert system to integrate dispatch.

3. Provide greater latitude and authority to call takers and public safety communications personnel to determine level of response and personnel to be notified. For example, once they receive adequate information, the call taker also can direct non-emergency service personnel such as towing and public works to the scene dependent upon need.

4. Train and authorize telecommunicators to be off-scene coordinators and give them more authority to dispatch response which appears to meet the apparent need and at the appropriate time rather than providing a "standard" response to every call.

On-Scene Communications and Command

From the arrival of the first responder, on-scene coordination may be the most important element related to reducing the time that an incident affects traffic. The handling of specific roles at the scene generally is not in question. Police handle those activities which are clearly within their domain; fire works within theirs; tow services handle the vehicles, and on rare occasions the streets department may maintain traffic flow or implement detours. Where problems arise is that no one person maintains an overall view of the scene unless the incident is a fire. Yet, management of an incident, whether it is a traffic stop, vehicular crash, or water main break, should have the same command structure as occurs at a fire. There are two over-riding issues: lack of inter-organization radio communication, and lack of overall command.

Although police can talk with police, and fire with fire, they often do not share communications channels. Rarely can anyone on the scene talk by radio with responders such as tow operators, streets departments, or other emergency services agencies. This lack of radio communication means that specific instructions for response, need for traffic assistance, or highway closure may be delayed until the requests are relayed through appropriate telecommunications links or even in person. In the Chicago metropolitan area which was the source for information gathered during the study, fire agencies have a common channel because of their mutual aid agreements. Police can communicate through a state-wide emergency police channel, but it is controlled by the Illinois State Police and generally used only for emergencies such as "officer needs assistance." Additionally, individual communities equip their vehicles with community fire and police channels, and may even share a radio channel with one or more bordering communities. In general, however, most agencies can communicate only to a few others.

A second issue is one of limited, unified command at the scene of an incident. Each responder takes his appropriate action without clear knowledge of either the outcome of that work on clearing the incident or its effect on traffic. For example, at a crash with injuries the police arrive at the scene and may or may not block lanes or reroute traffic. They take whatever steps they can to apply immediate aid, but with the arrival of emergency medical services (EMS) personnel relegate at-scene command to the EMS personnel. Yet, these later arriving personnel are concerned solely with the injured persons, and their approach to the work often is for their efficiency without regard to any negative effect on traffic.

Lack of communications becomes more apparent when police deal with tow operators. First, police only have an estimated time of arrival (ETA) of the tow. Generally, they cannot direct the tow operator on how to approach the scene in the most expeditious manner. When the tow truck arrives, the police often defer to the operator without considering how the tow operator's work will affect traffic. Where multiple vehicles are involved in a collision, without direction otherwise, the tow operator will remove the first vehicle leaving the second in place for a later arriving service instead of clearing the road before leaving with the tow.

Another problem lies with communicating with motorists involved in an incident. Often, the emergency medical services personnel are attempting to determine the extent of injuries and does not speak the language of those involved. The result can increase the time needed to remove injured and otherwise return the scene to normal.

Through the use of cellular telephones and electronic bridges, various agencies can develop adequate methods of communicating with each other. The State of Illinois, for example, has a common 800 megahertz channel set aside for interagency communications. However, most agencies do not know of its existence, or where it is known, rarely use it. On-scene communications ultimately means that the on-scene commander should be able to direct other responders promptly without having to find and talk personally with those who are doing various tasks.

On-scene command always should take place, even if only one person is responsible for handling the incident. The police officer generally is the first responder, and should receive training which provides him a basis for making decisions about how work at the scene will affect management of the incident *including* traffic control.

While the first arriving officer may be the on-scene commander by default, when more than one responder is required, command responsibility could shift to other responders who have been trained, and have appropriate knowledge and experience. Each agency needs to examine its personnel resources and training programs to establish a complement of personnel who can assume command of the scene.

Until such time as the nature of incident moves from police oriented to one which is the sole responsibility of another agency, whether it is fire or streets department, the police should maintain responsibility for overall coordination. When the responsibility for command changes, it should be done explicitly so that each party knows who has assumed the responsibilities. This formal exchange of responsibilities is critical when the incident is such extent that it requires a large number of resources on the scene and is resulting in significant rerouting of traffic.

1. When an incident is expected to last beyond some predetermined time, police management or a supervisor may need to assume command. This step is especially important at the scene of a crash where the first responder may have responsibility for gathering crash data.

2. Train police officers and supervisors to manage a scene. The training needs to include traffic control and diversion.

3. Prepare policy which sets out responsibilities of the coordinating officer and defines when a police supervisor will assume those responsibilities.

4. Police and fire supervisors should observe and evaluate the response to some minimum number of events each year in order to assess performance of their personnel. From these evaluations, they develop recommendations for changes in procedures and for training. Supervisors should meet with staff periodically to review observed incidents and recommend improved practices. Interagency debriefings also play an important role in this review of incident management.

5. Provide emergency responders with a card in several of the more commonly used non-English languages which contains common phrases related to need, e.g. "I am out of gas," used by them when servicing involved motorists.

Traffic Control

Traffic control is not the primary concern of most responders with the exception of agencies responsible for the roadways, e.g. streets departments, and often traffic operations are not considered at all. A common outcome is that traffic is delayed unnecessarily or rerouted insufficiently. With the mishandling comes costs of increased fuel usage, pollution, and lost time. The incident also may generate secondary collisions which result in injury, property damage, and additional responder costs (Raub, 1997).

Traffic movement around an incident often is not considered. However, improperly handled traffic can increase the danger to those handling the incident, as well as increase the likelihood of secondary crashes involving motorists affected by the primary incident.

The agency with the most knowledge about handling traffic and usually has adequate equipment to assist with rerouting or preparing detours is the streets department. Yet, this department rarely is called except for longer term activities which may be within their expertise, e.g. a water-main break.

"Gapers" present a serious threat to responders and other motorists because of their inattention to the task of driving.

The summarized recommendations presented below mostly reflect common sense and are relatively easy to implement. Key to making them work is both planning, and interagency agreements spelling out responsibilities.

1. Personnel on the scene should be providing traffic direction and rerouting. Where time permits, the streets department should be notified and provide traffic control.

2. Streets department (or equivalent departments of transportation) personnel should be part of scene management resources; their services to be available under specified conditions, e.g. street closure lasting more than one hour.

3. A detour should be considered when an entire roadway must be closed for more than 30 minutes, or when use of opposing traffic lanes is not feasible because of median barriers or heavy traffic use.

4. Use trained personnel to keep vehicles moving.

    a. Educate police officers on how an incident can affect traffic and provide methods by which they can help minimize the effects.

    b. Train police and fire personnel in traffic control with emphasis placed on moving traffic by or around incidents with the least risk, delay, and confusion for the motorists.

Communicating with Motorists

Motorists frequently are unaware of an incident until they are caught in the resulting congestion. They have not learned of the incident in a timely manner and have not had an opportunity to select an alternate route. Unlike expressways where limited alternate routes exist, motorists on the urban arterial roadways may have ample choices. The other routes can move affected traffic provided that motorists know that an alternate exists and are in a position to use it. Once the motorist reaches the scene of the incident, choices may have been eliminated. If the delay appears significant, the motorist may attempt maneuvers, either turning into residential streets which may or may not have an exit, or turning across traffic flowing in the opposite direction. Both represent potentially dangerous options.

The task of notifying motorists on expressways may be handled by an emergency management center or other traffic control commands established and staffed for the purposes of reducing congestion and delay from incidents. For the urban surface street, the task will fall on the persons responsible for dispatching the responders.

Motorists often do not receive timely information about situations which are affecting traffic. This problem occurs less frequently on urban expressways because of the attention given both the detecting incidents and notifying drivers through the use of VMS, HAR, and the broadcast media. The same attention has not be given to the urban arterial roadway. Dispatchers and others responsible for dispatching and communicating with responders are not trained nor have the authority to notify broadcast media.

Even when information about the incident is known and broadcast, it rarely specifies a duration or alternate routing. As a result, by the time the motorist arrives at the scene of an "incident," it may have been cleared and traffic returned to normal. The motorist begins to lack confidence in the reports.

There is a need to get information to motorists which will assist them in making adequate choices for their driving. Choices provided include both that of appropriate routes to take and times to depart.

1. Increase the number of VMS locations. Too often, signs are posted only at limited locations, and some may give information without providing an opportunity for the driver to make alternate choices. On the 401, Toronto may have one of the more comprehensive installation of VMS that provide ample opportunities for drivers to chose alternate routing.

2. While more expensive than using the broadcast media, the availability of highway advisory radio (HAR) provides an opportunity both to localize the broadcast of a message (because they operate at low power), and to repeat it frequently.

3. Messages that go out over the air need to address, at a minimum:
   a. location of the incident,
   b. type,
   c. time of occurrence, and
   d. expected duration.

4. Dispatchers and other personnel located remotely from the scene need authority and procedures to notify broadcast media, especially when any incident is going to last for more than 30 minutes and affects significant amounts of traffic.

5. Provide electronic devices prior to the scene that direct motorists into new traffic patterns long before they arrive and are trying to combine maneuvers with the inevitable gaping at the scene. Personnel from streets agencies can be most helpful in this regard in that they usually are trained in traffic management and frequently have the equipment to reroute motorists, e.g. cones and directional signs and arrows.

CLOSURE

Throughout this paper, the emphasis has been on communication, both among responders (and with their dispatching headquarters) and motorists. While responders are well trained in their specialities, generally managing to have the proper equipment on the scene, and ultimately clear the incident, the area of communications is forgotten. Yet, it remains a key to decreasing the time that an incident remains active (on-scene command and communications among responders). Reducing the time that capacity is restricted will reduce delays. This result especially is true in metropolitan areas where roads carry high volumes of traffic. However, communication also needs to be directed toward reducing traffic demand at the scene. In this latter case, delay can be reduced through a combination of providing alternate paths for travel and in motorists delaying their trips. Surveys of motorists in Chicago and Houston, Texas have shown that motorists will alter their travel path and travel time if they receive timely and accurate information about travel conditions. With the combination of both improved scene management through enhanced communication among responders, and communication with motorists, significant reductions in delay can be achieved.

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