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TRAFFIC MANAGEMENT FOR SPECIAL EVENTS

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Background

This paper describes the conception, development, construction, and early operational experience with a freeway surveillance and control system on Interstate 75 and the downtown portion of Interstate 71, in Cincinnati, Ohio. (See Figure 1.)

The system was conceived early in 1967, as a part of the Cincinnati transportation, economic, and development goals to locate new sports stadiums near the central riverfront area within walking distance of the Central Business District (CBD).

The Cincinnati CBD is adjacent to the Ohio River; I-71 and I-75 use a common bridge east of the 100-year-old Suspension Bridge. The CBD also has virtually no usable street system for major traffic volumes and, while immediately adjacent to the freeway, it was served directly by only one exit and no direct entrances. In general, the transportation system in the CBD is geographically constrained and has continuing problems because of growing demand. Special events in the CBD further exacerbated difficult traffic management problems.

A freeway surveillance and control system was developed to advise motorists of the traffic and parking conditions in the stadium area on occasions of stadium events, and alternate exits to use for downtown parking when stadium parking was filled. Initially, $1,000,000 was appropriated, upon the recommendation of the City Traffic Engineer, for the surveillance and control system and other traffic control requirements.

Description of Facilities

The major CBD transportation facilities are I-75 and I-71 which are briefly described below along with some of the traffic generation characteristics of the Riverfront Stadium.

I-75

I-75, from approximately four miles north of the downtown area to its junction with I-71 on the north side of the Ohio River, is an eight-lane freeway on which the highest weekday ADT was approximately 170,000 vehicles. Peak weekend traffic volumes exceeded 200,000 per day. The Ohio River bridge is a six-lane, two-level bridge, with three lanes in each direction. At the south end of the bridge is an interchange with a lane drop reducing the I-75 and I-71 combined flow to two through lanes in each direction.

The four-lane segment through the interchange has a capacity deficiency that resulted in a daily southbound backup of traffic of from one-half to two miles in length. On a major summer holiday weekend, backups of as long as twenty miles were recorded. Travel-time studies find four-mile backups represent about one-hour passage time.

By 1980, three additional Interstate bridges were completed and along with major repairs to a surface street bridge, Interstate bypass routes are now available around the metropolitan area, which has helped to reduce the ADT to 140,000.

I-71

I-71 is also a major distributor for traffic to and from the downtown CBD and the freeway system. It is a six-lane facility, with acceleration, deceleration, and/or weaving lanes throughout its downtown alignment. Completion of I-71 through Cincinnati occurred in 1974, and the facility at its highest point carries about 90,000 vehicles per day. A significant shift in volumes occurred with the completion of I-71. Operational problems do occur in both directions of I-71 since northbound traffic from the I-75/I-71 bridge must weave across the entire facility to proceed north on I-71, with the reverse movement required in the southbound direction.

Riverfront Stadium

The Cincinnati Riverfront Stadium was completed in 1970. The stadium provides baseball seating of 52,000 and football seating of 56,000, with standing-room crowds for football of over 60,000. The stadium is a circular structure, 800 feet in diameter, which is surrounded by a trapezoidal-shaped three-level parking garage. A plaza roof forms the primary bus and taxicab loading and parking area serving as the major pedestrian access to the stadium. The parking structure has a parking capacity of 3,000 vehicles, and city-owned surface parking at the site provides an additional 2,000 spaces. Other parking facilities within the immediate area of the stadium provide an additional 1,500 to 2,000 spaces.

Surveillance and Control System

Originally only a surveillance and changeable message sign system were planned for I-75 to assist stadium traffic approaching Riverfront Stadium. The system was to advise motorists of traffic congestion and suggest alternate freeway exits, as appropriate, thereby avoiding major freeway breakdowns. Sampling detectors located at strategic points would feed data on traffic flow to a central computer and base station located in the Stadium Traffic Control Room. The computer would select from a limited number of predetermined messages available at each changeable message sign, and transmit control demands.

After careful and extensive review it was decided in 1970 that the surveillance and changeable message sign system should be expanded and redesigned as a surveillance and control system. The expanded system would thus help manage daily peak-period traffic flow. To provide visual surveillance of the roadways, closed-circuit television was also implemented in the expanded system. Transmission from the remote TV cameras is by coaxial cable. The TV system design consists of six cameras and monitors, the installation of which were completed in the fall of 1970.

Major system components are as follows:

1. The lamp-matrix-type changeable message signs (CMS) are controlled by solid-state electronic circuitry, with messages generated at the base station computer. The CMS use 15-inch-high letters on both four-line and two-line signs; only 12" letters are used on "insert type" changeable message guide signs. Low-voltage 30-volt lamps operating at 15 to 21 volts provide long lamp life. Daytime and nighttime brightness levels are automatically selected on the basis of ambient illumination. The system includes:

   a. Five four-line, 80-column, full-bank lamp-matrix-type CMS.

   b. One two-line, 180-column CMS.

   c. Thirteen one-line, 80-column changeable message inserts for mounting within fixed-message guide signs.

   d. With an 80-column line, the message on a given line is limited to approximately 13 letters, including spacing.

2. A total of 87 detectors provide traffic flow information, i.e., volumes, lane occupancy and speed data. Twelve detectors are of the magnetometer type attached to the undersides of two bridge decks. The remainder are loop detectors cut into the pavement.

3. Field stations, coaxial cable, and the base stations form the communications for the entire system, utilizing a time-sharing multiplex technique.

4. The message generation functions and control system for the sign operation are contained in a Digital Equipment Corporation PDP8F mini-computer, with necessary interfacing between both the field station and the General Automation 18/30 computer, which provides traffic control status selection on an automated basis.

5. The Manual Control panel, video sign message monitors, and teletypewriter input provide for operator control. Manual override of the automated system permits display of special messages when required on any sign or combination of signs. The Status Display Map Panel shows the current traffic status, the message shown on each sign, and detector operation throughout the system.

6. The GA 18/30 master computer for the system has 8K memory. This machine processes and evaluates information from the sampling detectors on volume, speed, and lane occupancy, and automatically controls the sign statuses/messages.

<u>System Operations</u>

This system is designed to provide information to the motorist already on the freeway about traffic conditions and alternate routes. Entrance ramp control or metering is not included in the current project although it will almost certainly be necessary on I-75 in the future.

The system operational mode is based on "traffic status." A traffic status represents a given combination of traffic and/or stadium parking conditions likely to occur. In the automated mode, detector information at strategic points is analyzed by the GA 18/30 computer and used to select the most appropriate status for the current condition.

The basic method of automated message selection is that of group message changes based on the current "status" or traffic condition. A total of 37 statuses are identified in the automated mode. An additional six statuses are available for manual selection, including such special messages as "Accident Ahead", "Reduce Speed", "Congestion Ahead", "Reduce Speed", "System Test, Ignore Signs", and other special-purpose messages. Future provisions will include five additional automatically selectable statuses. The system also has complete manual override provisions, and monitoring personnel in the Stadium Traffic Control Center can manually change either the entire status or any individual sign or signs within the system to meet conditions not covered by the automated selection system.

Following the opening of the Riverfront Stadium in 1970, it became evident that the stadium traffic was not in fact the major problem originally feared. The more frequent usage of the surveillance traffic control system became the daily operation on I-75. Message word selection posed some problems. For example, it was felt the word "Closed" would represent a complete physical closure with no traffic getting through, and that this word might cause loss of confidence in the system if motorists found it possible to move through the area. The word selected for general usage was "Blocked".

When the system became operational, it immediately became evident this word was also unsatisfactory, because it caused sudden and erratic maneuvers by drivers who thought they were facing an immediate emergency situation. Instead, the words "Congestion" and "Congested" were used. These words overcame many of the problems of sudden and erratic responses created by the word "Blocked". Other improved messages were also developed, with the words "Delay Ahead" as the key message, and estimated delay times, and a positive instruction such as "Use Alternate I-75".

The closed-circuit television (CCTV) system permitted effective operation of a manually changeable signing system for more than four years before the electronic surveillance system became operational. We are convinced that closed-circuit television is an invaluable, if not essential, element in optimum operation of any major surveillance and control system involving a relatively compact geographical area or areas. Capabilities and/or advantages of CCTV not now duplicated in any other way include:

1. Backup for other modes of surveillance. At the present time, CCTV technology must be considered more reliable, from maintenance and

performance standpoints, than detector output communication and analysis.

2. CCTV provides information on causes of backup, congestion, or stoppage of traffic, as well as their existence; and, unless detector spacing is extremely close, CCTV provides a more precise and rapid evaluation of the exact extent of the problem.

3. CCTV permits emergency services to be summoned almost instantly when accidents, breakdowns, or other emergencies occur within the area of coverage.

4. CCTV permits the confirmation of the sign messages that are displayed in the field. Since field message verification was not incorporated into the original electronics at the Control Center, the ability to verify these messages by CCTV is often used by operators in the Control Center.

5. CCTV does have its limitations, also, and probably would not alone provide adequate surveillance capabilities for most systems. Limitations include coverage area and nighttime resolution of cameras and monitors. Most importantly, CCTV does require trained personnel to observe the monitors, make decisions, and take corrective action. CCTV provides no capacity for automated operation.

The initial complement of personnel assigned to the Stadium Traffic Control Center consisted of two persons, a supervisor and programming specialist during the morning rush hour, one person during the afternoon rush hours, with an additional field observer for stadium events. Initial operator training includes 16 hours of instruction plus "hands on" systems use under daily operating conditions. Subsequent training is oriented to maintenance considerations and requirements, which is attended primarily by the City's electronic maintenance personnel and electrical engineering personnel. This session involves a total of 32 hours of instruction, including several field trips.

The operating procedures for the system are not difficult, and in order to distribute the work load, many additional operators have been trained. Most of the present engineering and senior subprofessional personnel in the division now serve as operators. One engineer is assigned responsibility for programming changes in the system, and for coordinating the efforts of the maintenance contractor.

System Effectiveness

The system has successfully operated in the automatic mode and it has also been found successful in various types of operations.

The changeable message sign system has operated effectively and has been accepted by the public, especially when used in conjunction with the I-75 peak-hour traffic diversions.

Typically, p.m. capacity restrictions occur on I-75 southbound at the I-71 junction and bridge over the Ohio River into Kentucky. The need for traffic diversions utilizing parallel city streets and/or other Ohio River bridges occurs frequently, but particularly on Friday afternoons and pre-holiday periods. Overall speed is estimated at 15-20 miles per hour, with alternate routes saving 19 to 48 minutes.

Stadium and Riverfront Coliseum traffic operations have been successful. Traffic crowding within the vicinity has been avoided because of the use of the CMS once the stadium parking facilities are filled. Few major traffic delays have been experienced and the parking lots normally empty within 30-35 minutes after events have concluded.

The CMS are frequently used to alert motorists and assist with maintenance operations in the sections of I-75 and I-71 which are instrumented by the surveillance and control system. Standard messages and status are on a special tape, with manual selection.

The CMS have also been very useful during special events in downtown Cincinnati. Street festivals, parades, footraces, and other special events require closure of certain major downtown streets. The CMS are used to alert freeway traffic of street closings due to the special events.

The system has also been effective in assisting with freeway incidents. For example, southbound I-75 about one mile south of the Ohio River starts a long upgrade on a very tight alignment, which is the site of frequent incidents. In response to telephone requests from Kentucky officials, manually programmed messages are frequently displayed on the CMS to help alleviate the incident problems. The CMS have also been helpful on this upgrade during severe ice and snow conditions.

System Deficiencies

The Cincinnati system was one of the earliest of its type, and electronics and communications technology have advanced dramatically in the intervening 15 years. A surveillance system installed today would avoid most or all of the problems experienced in Cincinnati.

The following summarizes some of the major deficiencies found.

- As with many systems, severe electrical storms created grounding and lighting protection problems. These have now been solved.

- The CMS did not have easy access for maintenance of electronics. Typically electronics were located in the signs over the freeway lanes and no catwalks were available. Ready accessibility to the electronics is mandatory.

- Good Control Center verification of the messages on the CMS has not always been quickly obtainable. Partial verification of CMS when within viewing range by CCTV has been used. Unfortunately, too many messages cannot be verified without use of field observers.

- Initially considerable problems were encountered with the detectors but these problems have been solved.

- As of 1985, the General Automation 18/30 Master Computer is becoming an obsolete model with some reliability problems. The PDP8F sign message generation and control mini-computer is still quite reliable.

Summary

The I-75 traffic surveillance and control system has operated successfully in the automatic mode for several years. The system demonstrates the value of the use of "real time" on-freeway congestion and incident detection and control through automatic traffic diversion to exit ramps and alternate routes by the use of changeable message signs.

The electronic technology and hardware comprising the system provides a "building block" approach for future actions without fundamental changes in the Central Control Station, or either of the computers. It will be possible to expand the system to operate additional changeable message signs further north on I-75, and also on I-71. Some entrance ramps on the Cincinnati freeway system must be controlled or metered in the future to assure good freeway system operation.

Most of the traffic congestion problems reported in our area are resulting from accidents, stalled vehicles, fire and other emergency equipment responses, and other incidents, rather than being caused by actual capacity deficiencies in the roadway system. If we are to provide safe and convenient peak-hour operation on our street and highway systems, our greatest future opportunities will be in more quickly detecting incidents of the types just mentioned, dispatching assistance to clear those problems, and communicating more effectively with motorists how to avoid them.

ORGANIZATIONAL PLANNING FOR TRAFFIC MANAGEMENT ACTIVITIES

D. H. Roper, California Department of Transportation

Every day, the flow of traffic on our freeways and streets is slowed as the result of incidents -- everything from vehicle stalls, flat tires, spilled loads, accidents, major events with large crowds, to maintenance and construction activities. And every day, the resulting congestion and additional accidents are costing the traveling public millions of dollars. During one calendar year in the Los Angeles region, there were 220 incidents that cause major blockages of freeway lanes. Delays and secondary accidents are costing Los Angeles freeway drivers a staggering $60 million each year! Clearly, it's a problem that demands attention.

Yet, in many areas, little or nothing is being done to deal with the problem. In fact, there seems to be an attitude that this is just one of those things that must be accepted and about which little can be done. Such is not the case -- plenty can be done.

Analysis of delays caused by accidents or other lane blockages in Los Angeles revealed the critical nature of the time required to remove the obstruction and restore full roadway capacity. During off-peak hours, each additional minute taken to correct the problem extends the duration of congestion by four or five minutes. In peak periods, this factor often soars to fifty to one, or more.

Clearly, any program to deal with the problem should focus on cutting this total time -- the time to detect that a problem has occurred, the time to move forces into the field to deal with the problem, the time to make decisions and implement diversion routes, the time to clear obstructions and restore capacity, the time to make necessary repairs to the roadway, and the time to dissipate congestion and return traffic flows to normal.

An effective program to manage incidents costs money: personnel costs, training costs, and equipment costs. But you can expect the resulting savings in delays and in related secondary accidents will far exceed those costs. Based on over ten years' experience in the Los Angeles District, Caltrans has seen a 5:1 or 6:1 benefit/cost ratio. Last year, Caltrans' cost for the response team program was about $85,000; of that amount, over $30,000 has been recovered from those parties who caused the accidents. During the same period, savings to the public resulting from reduced delays totalled over $550,000. The resultant benefit/cost ratio was about 10:1.

An incident management program cannot be truly successful unless there is a cooperative, coordinated attitude on the part of each of the agencies involved. The working relationship between the traffic engineering, maintenance, and enforcement organizations is particularly critical. All have a legitimate responsibility and authority at an accident scene; all have resources to help correct the situation and get traffic flowing normally again. Local agencies need to be included, too -- detoured traffic will frequently be operating on city streets. A host of other authorities also will be involved: fire departments, tow truck services, ambulance services, etc. The key is to meet together before an emergency and to plan how each agency can coordinate its necessary work with that of the other members of the team, all working toward a common goal. And keep in mind, from a traffic flow point of view, the goal is to get traffic back to normal as quickly as possible.

Invariably, with this kind of informal multidisciplinary team, the question will come up: "Who's in charge?" In Los Angeles, our answer is that no one agency is in charge; consensus decisions are made by the team. This may fly in the face of some organizational theorists, but in the real world, it works well.

The Caltrans' incident response teams in Los Angeles are comprised of about two dozen volunteers, all with a traffic engineering background and all of whom have other regularly assigned duties in the Traffic Operations functions. Teams operate similarly to a volunteer fire department -- members take equipment (vehicles, sign trucks, signs, flares) home with them, are on call 24 hours a day, and go into action whenever an incident blocks two or more freeway lanes for two or more hours. Team personnel, along with police, maintenance, and other emergency personnel meet at the incident site and actively manage the situations. Providing help for the injured, clearing the wreckage, repairing damaged facilities, detouring traffic, and keeping the public informed of the situation are all carried out in a coordinated manner.

In metropolitan areas freeways are becoming more clogged with traffic. In turn, lane-blocking incidents are increasing and delays and secondary accidents are becoming increasingly critical. The consequences of these problems can be reduced significantly using proven incident management techniques. So to do anything less is to simply surrender to the problems.