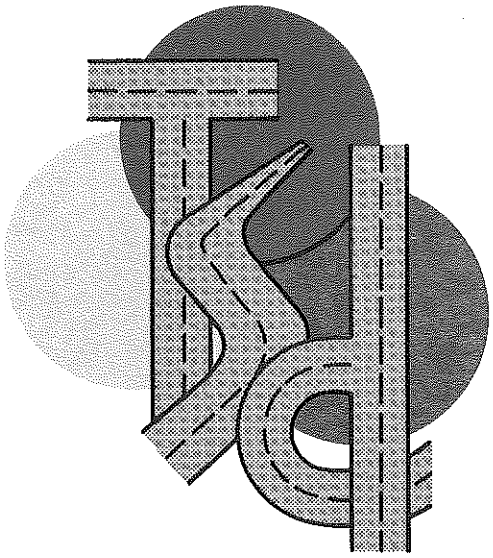
DETROIT FREEWAY

SURVEILLANCE & CONTROL EVALUATION



# TRAFFIC and SAFETY DIVISION

DEPARTMENT OF STATE HIGHWAYS
STATE OF MICHIGAN

MICHIGAN DEPARTMENT OF STATE HIGHWAYS

# DETROIT FREEWAY

# SURVEILLANCE & CONTROL EVALUATION

By

Bruce A. Conradson

Conducted by

Traffic Research Section
Traffic & Safety Division

January, 1969

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# DETROIT FREEWAY SURVEILLANCE & CONTROL EVALUATION

This report was prepared as a direct result of an assignment given by Deputy Director John P. Woodford during meetings held on December 5th and 8th, 1967, at which time the future of the John C. Lodge Television Surveillance and Control project was discussed. It was decided that the Traffic and Safety Division would conduct a final evaluation of all Freeway operations research findings and recommend in detail, and justify on the basis of cost effectiveness and sound engineering judgment, what, if any, elements of the surveillance and control system now being researched should be made operational.

In essence, our recommendations are as follows:

1. Termination of the John C. Lodge Television Surveillance and Control project as an operational unit. Equipment would remain in place for use in research conducted on occasion by the Department and for possible use by outside agencies wishing to contract for the facilities. This would entail little, if any, expense to the Department.
2. Formation of a small fulltime Freeway Operations Group made up of experienced engineers and technicians whose exclusive responsibility will include study and treatment of bottlenecks and general traffic operational problems on the Detroit Metropolitan freeway network.
3. Formation of a Freeway Operations Advisory Committee, made up of one representative each from the city of Detroit, Wayne County, and Department of State Highways, to review major proposals for operational changes developed by the operations group.
4. Programming of sufficient funds beginning in 1969 to allow for the installation and operation of a system of electronic surveillance and entrance ramp control on selected sections of freeway in the Detroit Metropolitan area.

## JUSTIFICATION

### Problem

The rapid and continued growth of traffic demand in the Detroit Metropolitan area has been closely accompanied by increased freeway congestion, accidents, and a general deterioration of the quality of traffic flow. It is true that some relief can be expected upon the completion of the planned freeway network which will tend to better distribute demand.

However, the prime cause of freeway congestion, that is bottlenecks, will still be with us. This is because of the nature of bottlenecks which can be defined as any instance during which vehicular demand exceeds capacity. Therefore, while the completed and balanced freeway network may more nearly provide for sufficient capacity under optimum conditions of weather and traffic flow, any decrease in capacity caused by weather conditions, disabled vehicles, accidents or normal maintenance operations will quickly destroy the demand-capacity relationship required for maintenance of free, non-stop traffic flow.

Unfortunately, this "unusual" freeway condition has been proven to be not the exception but the rule. Extensive records logged in the short 3.2 mile television surveillance area on the Lodge Freeway have shown that lane blocking incidents occur on the average of four times per day and this only includes a fourteen hour period from 6:00 a.m. to 8:00 p.m. Monday through Friday.

Typical One Year Total

For 3.2 Miles of John C. Lodge

| | |
|---|---|
| Maintenance Operations - - - - - - | 1588 occasions |
| Accidents - - - - - - - - - - - - | 493 |
| Stalls - - - - - - - - - - - - - - | 861 |

From this, we can conclude that one or more lanes of the Lodge Freeway within the present 3.2 mile surveillance area will be blocked for an average of about one hour of each day. The Lodge Freeway is not unique in this respect.

Reduction in available capacity is, of course, only one cause for the creation of a bottleneck. Fluctuations in traffic volumes caused by sporting events and holidays can easily cause demand to exceed available capacity even though no on-freeway obstructions are present.

In addition, we have built in a number of geometric bottlenecks throughout the years. Lane reductions, too short weave sections, left-hand exit and entrance ramps, short sections of upgrade which cause truck traffic to slow down are examples of this.

Thus, even with a fully constructed and fully operational freeway system, as now planned, completed, we can safely predict the frequent occurrence of breakdowns in traffic flow.

Considering the huge investment we will have in the freeway facilities when they are completed, it would seem extremely desirable to take steps necessary to assure that each mile of freeway is able to operate at as near its potential as possible. Just as no private enterprise would maintain a plant which is capable of operating at its potential for only 50% of the year, we must assure that the freeways are capable of operating at their full potential.

## PAST EFFORTS

There are several accepted tools and practices already available to us to help us to accomplish the goal of improved freeway utility.

### Regulatory

For instance, we would not think of performing routine maintenance operations during periods of peak flow. Local agencies have passed ordinances which require truck and other slow vehicles to stay in the right hand lane, thus reserving remaining lanes for higher speed traffic. An ordinance has been passed which prohibits the use of the walled section of the John Lodge Freeway to carriers of flammable material, thus guarding against the possibility of a catastrophe.

Surveillance

The Wayne County Road Commission has three wreckers on patrol duty whose mission it is to locate and remove disabled vehicles. The City of Detroit, until recently, had a number of cars and officers assigned to freeway patrol duty whose mission was not only to enforce the law but who located and facilitated the early removal of blockages. This police freeway patrol activity has recently been severely cut back because of manpower shortages and a greater emphasis on policing of crime and civil disturbances.

Informational

Detroit Traffic Central was set up to act as a collection center and a disseminator of information relating to freeway conditions. This information is now disseminated through commercial radio stations in the form of short advisory broadcasts.

All of this official and unofficial effort has, and is being put forth in an attempt to optimize the efficient and safe flow of freeway traffic in the Detroit Metropolitan area.

## NEW DEVELOPMENTS

While these efforts have produced a certain degree of success, additional measures are needed to assure our freeway system will operate up to its capabilities. Two relatively new approaches aimed at achieving this have been proven to be effective. One approach is directed toward quick detection and removal of "on freeway" incidents, thus restoring capacity to its maximum. The other approach is directed toward limiting freeway demand so that it remains at, or just below, available capacity.

Electronic Detection System

The first approach, quick detection of flow reducing incidents, can be achieved by the installation of a system of detectors capable of measuring the quality of traffic flow such as volume, speed, density, and occupancy. When these parameters approach certain values or show certain fluctuations,

it can be determined that some type of incident has occurred and we may then dispatch aid, either the police freeway patrol or perhaps in the form of some type of all purpose vehicle. The Illinois State Highway Department has a fleet of 40 such vehicles assigned to locate and remove obstructions to flow on Chicago area expressways. They now have plans to expand this fleet in the near future.

As we pointed out earlier, detection of capacity reducing incidents is only half the answer. In order to take full advantage of our detection capabilities, we must develop the capability to respond, to limit demand whenever and wherever necessary.

Ramp Metering

The most promising tool we now have to affect demand is entrance ramp metering. Study techniques and instrumentation are now available to allow us to proceed with implementation of a ramp metering system. Briefly, the concept of entrance ramp metering is an attempt to limit the rate of demand on a freeway to keep it at or just below the capacity. A flexible ramp metering system allows us to vary the demand to compensate for not only fluctuations in demand, but to also compensate for fluctuations in capacity caused by weather, incidents, or geometric bottlenecks. Metering has a tendency to discourage the short length trip to the advantage of the long length trip. By its nature, it requires vehicles to enter the freeway flow one at a time, thus reducing the potential adverse effects of merging. We have long recognized that the interaction between merging ramp traffic and through traffic can cause abrupt reductions in speed, which in turn develops shock waves up stream of the merging area resulting in a reduction in freeway capacity and producing congestion and breakdown. Once breakdown occurs during a period of peak flow, it is now virtually impossible to return to smooth continuous flow until volumes drop. However, with a flexible system of adjusting demand in operation, we will have the ability to reduce flow into the congested area and should very often be able to again return the freeway to a steady flow condition.

## FREEWAY OPERATIONS GROUP

At this time there appears to be a real need for increasing, concentrating and emphasizing our efforts to improve conditions on our urban freeways, particularly in the Detroit area. There are a number of ways to implement a program of continuing freeway study, surveillance and control. The approach recently adopted by the California Division of Highways seems particularly well suited to the job to be accomplished here in Michigan. They have formed a "freeway operations group" whose objective it is to improve traffic flow on the Los Angeles area freeway system. This is not to say that no activity of this nature was in progress before formation of this new group. It merely means they have felt the need to center and emphasize their efforts by making a separate activity responsible for coordinating the attack on metropolitan freeway congestion and safety problems.

The size of such a group here in Michigan need not be large in order for it to produce meaningful improvements. Perhaps a four-to-five man team of engineers and technicians would form a good basis for such a program. Their activities might be separated into essentially three phases: (1) A surveillance or inventory phase, (2) a planning or improvement phase, and (3) an operational phase.

To briefly elaborate, phase one would include conducting a comprehensive inventory to determine the location of problem sections, bottlenecks, and the extent and duration of congestion due to them, and then assigning a priority ranking for treatment.

Phase two, Planning and improvement, would be to subject each problem section to more intensive study in order to determine the exact causes contributing to the problem and to develop recommendations for improvement.

Possible improvements might be relatively easy and inexpensive geometric solutions such as those recently formulated for improving traffic operations on the Lodge Freeway in the vicinity of the Davison interchange. (A detailed description of these improvements is contained in Appendix A.)

The proposed closure of the John R. entrance ramp to the westbound Ford Freeway is another current example of an "instant" improvement. The problem here involves the short distance available for weaving to facilitate movement onto the northbound and southbound Lodge.

One wonders how many additional so-called "instant" improvements are waiting to be found on the Detroit Metropolitan Freeway network. It is quite possible, and even likely, that additional recommendations to alter certain geometric bottlenecks would originate within such a study group. As can be seen, these improvements need not be expensive.

During this second phase, intensive study of certain bottlenecks will tend to indicate that the ability to alter and adjust upstream demand promises certain benefits. It is at this point that the third phase begins.

Phase three, Operations, would entail selection of which of these problem spots to include in a several mile section of electronic surveillance and entrance ramp control. The selection will be partially influenced by ranking on the priority list complied during the inventory phase, and partially on susceptibility to improvement by altering demand.

A ramp metering system cannot be placed in operation without a certain amount of preliminary study of traffic flow within a corridor. Experience gained in Chicago tends to indicate that the same degree of success may not always be achieved on all sections of freeway placed under entrance ramp control. Therefore, it is imperative that a thorough preliminary study be conducted before controls are applied. It is more likely than not that certain areas, while being very capable of benefiting by early detection of capacity reducing incidents, are not well suited to entrance ramp control. This may be due to a number of reasons such as limited storage space on the entrance ramps, or a lack of available capacity on alternate surface streets. These alternate routes must be included in any preliminary study so that potential trouble spots can be foreseen and

provisions such as revising of signal timing, possible turn prohibitions, peak period parking removals, and other improvements can be accomplished before entrance ramp metering is put into effect. If congestion and delay on the surface streets within the freeway corridor exceeds the savings on the freeway itself, the metering operation may have to be altered or even discontinued. Thus it should be clearly understood that the concept of altering entrance ramp demand by means of metering must be used with discretion and should not be considered a cure-all for improving conditions on the freeway.

After such a candidate section has been isolated, work can begin on the surveillance aspects of the operations phase. A system of detectors will be placed at intervals along the freeway and on all entrance and exit ramps. Data gathered by this system of detectors will be carried by leased telephone line to a control center where it will be monitored by a small digital computer. A short period of monitoring will be required to establish a data base, or norm. During this period of limited operation, necessary studies would be conducted by this same small staff of engineers and technicians. Collection of the data will serve two purposes. First, we will soon become familiar with all characteristics of traffic within the study area at all times of the day. Using this data as a sort of benchmark, we will quickly be able to detect the effects of any incident affecting capacity such as a stalled vehicle or accident. Initially the detection system can be monitored by one technician perhaps only during peak periods who will initiate police response when necessary. This pure surveillance aspect can produce benefits by itself as early detection and removal of blockages greatly reduce their snowballing effect on traffic. The second use that would be made of this collected data would be to develop flexible entrance ramp control logics or stratagies. That is, we will develop certain "plans of attack" or metering schemes for certain reoccuring types of congestion.

The application of existing and newly developed tools of traffic control might be considered a fourth phase. Examples of this might include use of plastic pavement markings, engineering of temporary controls in maintainance and construction areas, development of new freeway working hour restrictions, making miscellaneous sign changes, refinement of entrance ramp metering logics, and use of television surveillance at selected spot locations.

## BENEFITS

In evaluating the economy of any system of freeway surveillance and control, the rate of return will not be a measure of direct monetary return, but rather the return will be in terms of road user benefits such as reductions in travel time and an increase in safety.

The Illinois State Highway Department is only one of several agencies who have been conducting extensive research into the possible techniques and benefits of freeway surveillance and control. However, they are to our knowledge, the only agency which is now largely phasing out this research and placing their emphasis on practical application. They have well documented the benefits of surveillance and control in reducing accidents and congestion and are now proceeding with the extension of a system of freeway surveillance and control to 100 miles of freeway in the Chicago Metropolitan area.

Extensive before and after studies conducted as a result of treating one bottleneck area on the outbound Eisenhower Freeway in Chicago revealed several operational improvements.

(1) The period of congestion was not completely eliminated, but was reduced from 75 minutes to 30 minutes.

(2) Individual travel times through the short study area were reduced by about 20%.

(3) Comprehensive accident data for the eighteen month period following commencement of the entrance ramp control system showed a 14.4% reduction within the control area as opposed to a 3% increase on all other portions of the Eisenhower Expressway.

It was interesting to note that main accident reductions took place in sections upstream of the control section thus reflecting the elimination of congestion backup into these areas.

An accident reduction on Houston's Gulf Freeway was well documented in a one-year before and after study. In a 5.2 mile section, inbound only, and only for the one hour A.M. peak period, 7-8 A.M., accidents went from 77 before to 44 after installation of a ramp metering system.

Travel Time Savings

The Texas Transportation Institute which has recently completed their evaluation of a similar system of electronic surveillance and entrance ramp control on the John Lodge Freeway in Detroit has reached the following conclusions relating to the cost of such a system to the benefits to be derived. They have found that it costs about 18¢ to save one vehicle hour of travel time. Current values assigned to the worth of one such vehicle hour range from a low of $1.55 to a high of $3.00. This would result in a minimum benefit cost ratio of ten to one.

Monitary Savings Through Accident Reduction

Approximately 170 accidents per mile take place annually on Detroit area freeways at a cost of approximately $400,000 per mile per year. (Using National Safety Council Accident Cost Data). Assuming a 15% reduction in accidents could be achieved (which would not seem unrealistic judging from reports from Chicago and Houston), we can apply current cost values assigned to fatalities, personal injuries, and property damage accidents and arrive at a dollar savings of $60,000 per mile per year.

## COSTS

We have made the following estimate of the cost of installation of a system of electronic surveillance and entrance ramp metering. Bear in mind that some sections of roadway can benefit by addition of the electronic detection system alone, while others are well suited to the full treatment.

Thus it is not contemplated that every mile of urban freeway in the Detroit Metropolitan area will be placed under both surveillance and control.

Our best estimate of these costs follow:

Electronic Detection System

| | |
|---|---|
| Installation | $10,000 per directional mile |
| Operation (annual) | $ 1,200 per directional mile |
| (Including the leased line and electrical energy) | |

Entrance Ramp Control

| | |
|---|---|
| Installation | $12,500 per directional mile |
| Operation (annual) | $ 1,300 per directional mile |
| (Including leased line and electrical energy) | |

Salaries (based on a five-man operation group)

| | |
|---|---|
| Engineer IV | $15,000 |
| Engineer III | $12,000 |
| Programmer | $10,000 |
| Technician | $ 8,000 |
| Technician | $ 7,000 |
| | $52,000 |

Computer

Annual lease fee of $50,000
(This size computer should have the capacity to handle the entire existing Detroit Area Freeway system.)

Office Space

1000 square feet at $5/sq. ft. $ 5,000 annually
(A more detailed estimate of annual costs based on some basic assumptions appears in Appendix B)

## ORGANIZATION

We recommend the freeway operations group initially report to the Traffic Research Engineer in Lansing. Ultimately, it may be desirable to include the group as a unit of the Traffic Operations Section, or as an office reporting to the Assistant Traffic and Safety Engineer as is now the case with other out-state traffic offices.

It has been recommended earlier in this report that Wayne County and the City of Detroit be given an opportunity to participate in the form of becoming part of a Freeway Operations Advisory Committee. We also recommend

they be given the opportunity to participate by contributing manpower to the Freeway Operations Group and in addition by making financial contribution toward the installation and operation costs of any hardware that is needed.

Another source of financial assistance will be the Bureau of Public Roads which has gone on record as being willing to participate in the usual proportions toward the installation costs of any proposed electronic surveillance and ramp metering system.

## SUMMATION

The motorist continues to demand help on the freeway system. We must do everything within our power to increase his safety and to reduce his delay and aggravation to an acceptable minimum. We believe adoption of these proposals will allow us to better meet our responsibilities along these lines.

## APPENDIX A

### Proposed Operational Improvements to John C. Lodge Freeway @ Davison Freeway

Presently the northbound left-hand exit ramp has no deceleration lane and is somewhat hidden by a horizontal curve and a structure. This configuration has resulted in a number of rear-end collisions and erratic vehicle maneuvering in the vicinity of the off ramp. Experience gained on the Lodge Freeway Television Surveillance Project has shown that this type of erratic behavior on the part of a single motorist can trigger an abrupt slow-down, which during periods of heavy flow often precipitates a breakdown. Plans are now in progress to realign the northbound freeway lanes, utilizing an abandoned bus turn-out lane. The extra space thus gained will be available for use as a deceleration lane. It has been estimated that this improvement can be accomplished at a cost of $20,000.

Another example of this nature is the recent plan developed to alter the operation of the westbound Davison to southbound Lodge left entrance ramp. This left entrance ramp carries a relatively heavy volume of commercial vehicles which account for up to 20% of all ramp traffic during the morning hours. City of Detroit ordinances require that these commercial vehicles stay in the right-hand freeway lane except where left-side entrances or exits are provided. It is this requirement, and the natural tendency of the truck driver to get to and remain in the right-hand lane that is one of our primary sources of trouble here. Consequently, the southbound Lodge presently backs up from the Davison interchange daily during at least a two hour period in the morning. Truck drivers enter the Lodge in the left-hand high speed lane and attempt to weave to the right-hand freeway lane as soon as possible. It is with this weave situation that it is proposed to take

corrective action. The proposal under consideration involves the prohibition of commercial vehicles from the left-entrance ramp and their utilization of an alternate route. These vehicles will be directed to a U-turn crossover west of the interchange, thence onto the eastbound Divison-to-southbound Lodge right-entrance ramp. A cost estimate of $5,400 has been made for this correction which will be for work to improve the U-turn facility.

## APPENDIX B

### Projected Yearly Expenditures

We will make the following basic assumptions:

1. 100% of the present 50 mile Detroit Area freeway network will ultimately be placed under electronic surveillance.
2. 50% of this same network will be placed under entrance ramp control.
3. An ambitious 5 year program is required to accomplish this work.
4. The first year will be used primarily in phases one and two, inventory and planning.

#### 1st Year

| | |
|---|---|
| Salary | $52,000 |
| Office Space | 5,000 |
| | $57,000 |

#### 2nd Year

| | |
|---|---|
| Salary | $54,000 |
| Office Space | 5,000 |
| Computer | 50,000 |
| Capital Costs | 406,250 |
| Leased line & electrical energy | 46,250 |
| Maintenance | 5,000 |
| | $566,500 |

#### 3rd Year

| | |
|---|---|
| Salary | $56,000 |
| Office Space | 5,000 |
| Computer | 50,000 |
| Capital Costs | 406,250 |
| Leased line & electrical energy | 92,500 |
| Maintenance | 10,000 |
| | $619,750 |

4th Year

| | |
|---|---|
| Salary | $58,000 |
| Office Space | 5,000 |
| Computer | 50,000 |
| Capital Costs | 406,250 |
| Leased line & electrical energy | 138,750 |
| Maintenance | 15,000 |
| | $673,000 |

5th Year

| | |
|---|---|
| Salary | $60,000 |
| Office Space | 5,000 |
| Computer | 50,000 |
| Capital Costs | 406,250 |
| Leased line & electrical energy | 185,000 |
| Maintenance | 20,000 |
| | $726,250 |

6th Year (typical of continuing operation)

| | |
|---|---|
| Salary | $62,000 |
| Office Space | 5,000 |
| Computer | 50,000 |
| Leased line & electrical energy | 185,000 |
| Maintenance | 25,000 |
| | $327,000 |

## APPENDIX C

This section consists of letters from persons across the nation who have either an interest in, or a responsibility for, freeway operations.

The re-occurring theme expressed by these men is their sincere and sometimes outspoken belief in the need for developing a capability for early detection of changes in freeway operation and then to be able to respond to return the operation to normal.

# City of Detroit

JEROME P. CAVANAGH, *Mayor*
DEPARTMENT OF STREETS AND TRAFFIC
WATER BOARD BUILDING
DETROIT, MICHIGAN 48226

963-5303

ALGER F. MALO
*Director*
HOLDEN M. LEROY
*Assistant Director*

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| | OFFICE MGR. | | RESEARCH |
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| | FILES | | DTE |

July 11, 1968

Mr. H. H. Cooper
Engineer of Traffic & Safety
Department of State Highways
Stevens T. Mason Building
Lansing, Michigan 48926

Dear Mr. Cooper

The following comments concerning the need for a surveillance and control system on our freeway network are in response to your recent letter.

We believe that expenditures for surveillance and control systems are becoming as necessary to today's urban freeway operation as many other continuing costs, such as road or bridge maintenance. The operational expenditures needed to insure that optimum use is being made of today's facilities can be easily justified when the tremendous investment in existing freeways and the ever-increasing economic and sociological factors affecting the construction of new ones are considered.

We do not believe that the results of recent studies evaluating the existing system on the John C. Lodge Freeway should be used without recognizing the study limitations. These limitations include the use of very small data samples, the use of information from earlier studies which may no longer reflect today's conditions, the effect of the limited coverage provided by the present surveillance and control system on its efficiency and the failure to include many of the benefits resulting from the system. These additional benefits include improved safety, improved communication, service to maintenance forces, service to police and fire agencies and the value of the knowledge gained from observing vehicular operation.

We believe that any future system should include visual surveillance capabilities, if not over the entire freeway system, at least in turbulent areas and in congested areas where lane

blockage is especially critical; some means should be included to control freeway access and reroute traffic; there should be an on-freeway communication system either through the use of changeable message signs, direct radio contact or a combination of both; there should be included a tie-in to off-freeway communication systems such as we presently have through the Police Traffic Central or the Citizen's Band Radio Project. Above all, we believe that research should continue to develop and test new systems and the operating agencies should be careful not to commit themselves to any system which cannot be modified to include new developments of proven effectiveness.

We hope our comments will be useful to you in planning your future action. We also hope you agree that there is great value to be derived from surveillance and control systems on urban freeways.

Very truly yours

Director

RONALD REAGAN, Governor

STATE OF CALIFORNIA—TRANSPORTATION AGENCY

DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS
P. O. BOX 1499, SACRAMENTO

July 9, 1968

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| | OFFICE MGR. | | RESEARCH |
| | SECRETARY | | Surveillance |
| | FILES | | DTE |

Mr. Henrik E. Stafseth, Director
Department of State Highways
Stevens T. Mason Bldg.
Lansing, Michigan 48926

Dear Mr. Stafseth:

This is in response to a letter dated June 25 from Mr. H. H. Cooper requesting our view regarding the need for and the worth of a surveillance and control system on metropolitan freeway networks.

The California Division of Highways has activated a Freeway Operations Department in the Los Angeles District whose functions are very similar to the corresponding unit of the Illinois Division of Highways that operates the Eisenhower Expressway.

It is planned to expand these functions in an orderly manner depending on how fast personnel can be trained in the unique science.

We believe that the concept of freeway traffic surveillance and control is very promising, based on experience on short sections of freeway in Houston, Chicago, Detroit and Los Angeles. Although the techniques vary, the principle is the same in all of these places. The principle is to control the rate at which vehicles can enter the freeway, by stop-and-go signals on the entrance ramps, so that the capacity of the freeway downstream of the entrance is not exceeded. The capacity is not increased above what it would be without control.

The result is not only a smooth-running freeway, and a substantial reduction in peak-period accidents, but the aggregate delay to all traffic in the corridor is reduced. This is best proven by the fact that in Chicago, Houston, and Los Angeles there have been positive and

significant reductions in length of peak period congestion -- i.e., the back-up of waiting vehicles at the controlled ramps drops off to zero (because the freeway achieves free flow) at an earlier time of day than it did under the uncontrolled condition.

In addition to the reduction in delay, the freeway users are getting a real "seat-of-the-pants" improvement in journey speeds -- from stop-and-go driving to 30 or 40 mph in the worst part of the peak period, and to 50-60 mph in the part of the "peak period" that no longer has any congestion. From the point of view of the highway administrator, this may be the most important result of all. It furnishes an answer to the loose statements being made around the country that "freeways will never work," which if they are made often enough and receive enough credence, could result in a severe reduction in the rate of constructing new freeways.

The reason why ramp control works is that it increases throughput in the corridor. It does not increase capacity of the freeway, but by diverting or storing traffic that wants to come in "at the head of the line," it allows more traffic to use the freeway upstream of that point.

Overall Potential of Freeway Surveillance and Control.

An urban area generates travel which can be measured in vehicle-miles. Because of the necessity for people to do business with one another, the rate of demand varies, peaking in the morning and evening. The rate can be expressed in vehicle-miles per minute. We have called this throughput, in the preceding explanation of why the ramp control projects work. Delay is caused whenever the actual throughput of the road network is less than the demand. The same number of vehicle-miles will be generated, but if the road throughput is insufficient, it will take a longer period of time to service them; in other words, people will be delayed, and the delay is manifested in congestion. There are other causes of delay, too, but this one -- demand exceeding capacity -- is the most important one and is the kind we are talking about in what immediately follows.

The only way to reduce this kind of delay is to increase throughput. It will have been noted that the freeway ramp control projects do increase system throughput, but this increase is in the same order of magnitude as a ramp volume. It is an order of magnitude less than the increase in throughput that would be achieved by construction of a new freeway.

Because of the relatively low cost of ramp control, it is likely that the unit cost of reducing delay or of increasing throughput that can be achieved by ramp control where it is practical would be considerably less than the unit cost of throughput obtainable by new freeway construction. But in view of the inevitable increase in travel (vehicle-miles) which will occur during the next twenty years, it is a mistake to hold out the promise that electronic control devices can be substituted for increased road capacity. It is very unfortunate that technical persons who have access to the facts have made public statements which carry this implication. Such statements are often motivated by the groundless fear that new highway facilities to provide for the inevitable new travel will consume so much urban area that there will be no room left for anything else. It would be better for highway-oriented people to cite something that is a fact: the most extensive urban freeway network in the world (Los Angeles) carries 40% of the travel in that urban area and only occupies 1% of the space.

Probably the most important result of ramp control will be to control the demand rate. Demand has a tendency to rise to meet capacity and theoretically is infinite, in a mathematical sense. For example, if one relatively minor shop with 50 employees closes at 5:00 p.m. (or at 4:30), there will be a demand for 50 vehicles to exit from the parking lot at an instant, which is zero time, and 50 divided by zero is infinity. In order to eliminate delay, it would be necessary to provide infinite capacity. The same thing happens to freeways, and it will therefore probably be impossible to eliminate delay regardless of how wide they are made.

Ramp control, by creating small amounts of delay before the cars enter the freeway, can result in leveling out the demand over a longer period of time, and provide a more predictable level of service for everyone.

I am enclosing a copy of a report on "An Operational and Experimental Freeway Surveillance and Control System for Los Angeles" which was prepared by our Los Angeles District. I have authorized the District to proceed with design of the system described.

Sincerely,

J. A. LEGARRA
State Highway Engineer

Enclosure

By
Deputy State Highway Engineer

STATE OF ILLINOIS
DEPARTMENT OF PUBLIC WORKS AND BUILDINGS
FRANCIS S. LORENZ, DIRECTOR

VIRDEN E. STAFF
CHIEF HIGHWAY ENGINEER

DIVISION OF HIGHWAYS
OFFICE OF THE DISTRICT ENGINEER
~~ROOM 807~~
~~300 NORTH STATE STREET~~
~~CHICAGO 60610~~

IN YOUR REPLY PLEASE
REFER TO FILE:

230 Madison Street
Oak Park, Illinois 60302
July 1, 1968

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REC'D JUL - 3 1968 TRAFFIC DIVISION

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Mr. H. H. Cooper
Engineer of Traffic and Safety
Department of State Highways
Stevens T Mason Building
Lansing, Michigan 48926

Dear Mr. Cooper:

Thank you for your letter of June 10, 1968, and the copy of Mr. Conradson's report. We feel that the following two comments are appropriate:

1. The Chicago Project will continue its research program, but the expanded surveillance and control system will provide a much wider scope.

2. Inasmuch as the existing system consists of only ten directional miles of surveillance, the operations are not continuously monitored by observers outside of peak periods. The detection of congestion at any surveillance station, however, triggers an audible alarm in the office, thereby summoning an observer when needed without tying up manpower during trouble-free periods.

We are glad to be of help to the Michigan Department of State Highways. I have enclosed a short letter concerning the worth of freeway surveillance and control systems, as per your request.

Very truly yours,

Patrick.

Patrick J. Athol
Supervisor
Expressway Surveillance
Project

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TRAFFIC AND SAFETY DIVISION

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STATE OF ILLINOIS
DEPARTMENT OF PUBLIC WORKS AND BUILDINGS
FRANCIS S. LORENZ, DIRECTOR
DIVISION OF HIGHWAYS
OFFICE OF THE DISTRICT ENGINEER
~~ROOM 807~~
~~300 NORTH STATE STREET~~
~~CHICAGO 60610~~

VIRDEN E. STAFF
CHIEF HIGHWAY ENGINEER

IN YOUR REPLY PLEASE
REFER TO FILE:

230 Madison Street
Oak Park, Illinois 60302
July 1, 1968

Mr. H. H. Cooper
Engineer of Traffic and Safety
Department of State Highways
Stevens T . Mason Building
Lansing, Michigan 48926

Dear Mr. Cooper:

Concerning the worth of freeway surveillance and control systems, I can point to the fact that the Illinois Division of Highways is committed to expansion of our existing system over most of the Chicago area freeway network.

In addition, provisions for surveillance and control will be made on all new urban freeway sections in the Chicago area.

Our research has demonstrated the operational effects of surveillance and control. Practical application will pass these level of service benefits on to the motoring public.

Very truly yours,

Patrick J. Athol

Patrick J. Athol
Supervisor
Expressway Surveillance
Project

Ford Motor Company

THE AMERICAN ROAD
DEARBORN, MICHIGAN

July 17, 1968

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Mr. H. H. Cooper
Engineer of Traffic and Safety
Department of State Highways
S. T. Mason Building
Lansing, Michigan 48926

Dear Harold:

Your letter of June 25 concerning your final report on the possible future courses of action regarding the traffic surveillance system has been received.

In my opinion, the need for surveillance, communication and control of the freeway system is of paramount importance in order to obtain the maximum benefit in terms of efficiency and safety of all existing urban freeways and arterial streets. Although television surveillance may be too expensive in some locations, it's obvious advantages for high density, high accident potential areas such as the Lodge Expressway demand its use.

Attached is a paper which I presented at the 1968 SAE Automotive Engineering Congress describing my views in detail regarding the need for four basic methods of traffic surveillance including: (1) a vehicle in the traffic stream, (2) ground surveillance, (3) aerial surveillance, and (4) satellite surveillance. The satellite could also be used as a communication link and provide real-time information nationwide on an economic basis.

I will be pleased if you will include my comments and the attached paper in the Highway Department's final report.

Sincerely,

F. Platt

Fletcher N. Platt

Attachment

Traffic Safety Association of Detroit

Established in 1941 by Detroit Business and Industry as a Non-Profit Educational Organization

1902 BUHL BUILDING, DETROIT 48226
PHONE: 962-3202 AREA CODE 313

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REC'D JUL 16 1968 TRAFFIC DIVISION

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July 15, 1968

Mr. Harold H. Cooper
Engineer of Traffic and Safety
Department of State Highways
Stevens T. Mason Building
Lansing, Michigan 48926

Dear Harold:

First, please excuse the delay in answering your letter of the 25th. I have been out of the office. Secondly, thank you for permitting us an opportunity to express our opinions regarding freeway traffic operations, surveillance and control systems.

The TSA naturally is for any sound program to promote safety. We have always believed that efficient traffic is safe traffic -- certainly safer than inefficient and uncontrolled traffic.

Considering the projected traffic volumes of the future as well as projected increased accident rates from "over-populated" highways, it would appear that the cost of traffic engineering operations to maximize and optimize capacity and safety of roadways would be cheaper than constructing additional roadways to handle these and other problems.

We would very much be for expanded television camera surveillance -- not as sophisticated as the present system, perhaps -- but a system which could survey the entire urban freeway network.

In comparing the cameras versus the police patrol vehicles, the cameras have the advantage of being able to constantly monitor any given sector continously while patrol cars can report only the situation as it is as they go by and as it is in their immediate area. Cameras provide both a better overview and long-range view. Cameras are more accurate in assessing the total picture.

- more -

Police are still required for enforcement purposes and to provide direct assistance or to provide traffic control at an accident. When such occurs, the police have found the red "X" signals and speed signals to be very helpful in clearing lanes and slowing traffic. So successful, in fact, that they now have a freeway patrol car equipped with a large red "X" which can be displayed and lighted by the officer from inside the car. As he approaches a scene he raises and lights the "X". Motorists today are attuned to stop or leave the lane in which an "X" is displayed. The red "X" offers protection for the officer as well as guidance and instruction for the motorist.

A case in point occured last week when the Lodge became flooded at the northern end. The police requested that the red "X's" be turned on and the flashing arrows activated to clear the freeway. They were turned on for a 45-minute period -- possibly saving lives, injuries or damage from being caught in the flooded sections where it was deep enough to float some cars. It also prevented a massive traffic jam. The Lodge was totally cleared in a matter of minutes. Had the same system been in operation in other or all sections, much of the damage and congestion could have been avoided. These are operational measures which depend upon close co-operation between traffic engineers and police -- something which over the last few years has been developed to a fine degreee between the TV Control section and the Detroit Police Motor Traffic Bureau.

Ramp metering and/or ramp closure for better programming and control of traffic was proven several years ago on the Lodge. It is a concept which must be further developed to optimize freeway traffic. The current program suffers very much from, as a former member of the Department of Streets and Traffic refers to, as "Mickey Mouse" hardware. The over-all concept is good but the present equipment is inadequate to even measure what good it can do, let alone provide much relief. Experimental programs are not the answer. What we need is a program to effectuate better programming of traffic not just provide data for a graduate student's research paper.

A systems approach to the freeway operations involves not only computerized information and modern facilities such as camera surveillance and operational controls but close co-ordination between the enforcement agencies, the engineers and the communications media both official and commercial. Such a system in Detroit lacks only the expansion of the engineering equipment and operational program.

On a sheer cost-effectiveness basis, the Detroit area freeways must have better operational programming and systems in order to get maximum volumes and safety out of the network. To abandon what is there now would be foolhardy, not to expand it would result in stagnating the present bottlenecking overload and prevent achieving total capacity.

There is one other factor actually disassociated with normal operations, but in these days one of great consideration -- during times of civil disturbance camera surveillance provides the only "patrol" on the freeway to assist and safeguard motorists, and it also (as it provided last July) can be used to spot adjoining surface street "trouble." True, this is not a highway function per se, but could be considered in the same light as a natural disaster which requires extra measures.

In closing, I think it should be pointed out that the regular "customers" of the Lodge have come to expect the TV Control sign and signal operation and feel a protection from the camera surveillance. Last year during some of the so-called research operations when the controls were shut down, the police reported a confused state of traffic. Expansion of the program would do much to build driver confidence in freeway systems.

Thank you for giving us the opportunity to speak out.

Cordially,

W. Howard Cox
Assistant Managing Director

WHC:cd

STATE OF MICHIGAN

GEORGE ROMNEY, GOVERNOR

DEPARTMENT OF STATE HIGHWAYS

STEVENS T. MASON BLDG. LANSING, MICHIGAN 48926

HENRIK E. STAFSETH, Acting Director

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July 15, 1968

Mr. Harold H. Cooper
Engineer of Traffic & Safety
Michigan Department of State Highways
Lansing, Michigan 48926

Dear Mr. Cooper:

It is very evident to me that constant surveillance of the present and future freeway system is of utmost importance. Whenever possible, use of the television system is made in maintenance activities. We have also incorporated the lane control devices on all lane closures of an extended nature.

I appreciate the fact of the high cost of installation and maintenance of such a system, but the savings experienced by the people traveling through the area is surely something to be taken into consideration.

I personally feel that a system that would make use of many devices presently at our command is necessary. This would be a combination of television, ramp metering, loop detectors and lane control devices, all of these devices connected to a central station manned during the periods of peak traffic and maintenance operations.

Surely with the millions spent for construction of these facilities, a small percentage of this should not be too high to insure the most practical use of them.

Very truly yours,

Robert G. Perry
District Maintenance Engineer

RGP:em

EUGENE REUTER
*First Deputy Commissioner and Superintendent*

ROBERT A. LOTHIAN
*Second Deputy Commissioner*

WILLIAM H. POLKINGHORN
*Third Deputy Commissioner and Director of Traffic*

# City of Detroit

## DEPARTMENT OF POLICE

DETROIT, MICHIGAN 48231

RAY GIRARDIN
*Commissioner*

**Motor Traffic Bureau**

PAUL SHERIDAN
*Deputy Superintendent*

WILLIAM E. ICENHOWER
*Chief Inspector*

VINCENT W. PIERSANTE
*Chief of Detectives*

ROSEMARY H. KLUG
*Fourth Deputy Commissioner Chief of Women's Division*

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July 16, 1968

Mr. H. H. Cooper
Department of State Highways
Stevens T. Mason Bldg.
Lansing, Michigan 48926

Dear Mr. Cooper,

Your letter of 6/25/68 to Inspector Ricard regarding surveillance and control of traffic on the freeway system in Detroit has been referred to me for reply.

Complete coverage of the freeway system by television, if used, in conjunction with entrance ramp controls would be the ideal. However, to be more useful, this should be closely associated with the Police Traffic Control Center so that the freeway patrol cars, and the Wayne County Tow Trucks, can be used to the best advantage.

Another useful tool would be greater use of red 'x's and green arrows as lane markers, activated by a central control point - preferably TV headquarters. Along this same line, overhead information signs, such as: "Accident", "Repairs", "Flooding", would, I believe, greatly assist the motorist in avoiding long delays due to blockages of the freeway.

Yours truly,

Albert Saffold

Lieut. Albert Saffold
Motor Traffic Bureau

AS/rd

RESEARCH LABORATORIES

GENERAL MOTORS CORPORATION

July 18, 1968

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Mr. H. H. Cooper
Engineer of Traffic and Safety
Department of State Highways
State of Michigan
Stevens T. Mason Building
Lansing, Michigan 48926

Dear Mr. Cooper:

We appreciate very much your kind invitation to express our views on the means of surveillance and control for the Detroit Metropolitan area freeway network. Since your letter arrived I have been out of town so much that I have not had an opportunity to get together with our fellows and give it the serious consideration which it well deserves.

I just want to let you know that we are now working on it and you will hear from us in the near future.

Sincerely,

A. F. Underwood

A. F. Underwood, Manager
Research Laboratories

cc: E. F. Weller
W. M. Spreitzer

GENERAL MOTORS TECHNICAL CENTER
12 MILE AND MOUND ROADS WARREN, MICHIGAN 48090