EVALUATION OF A DYNAMIC FREEWAY RAMP ENTRY GUIDANCE SYSTEM

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OPTIMIZING FREEWAY CORRIDOR OPERATIONS
THROUGH TRAFFIC SURVEILLANCE,
COMMUNICATION AND CONTROL

Final Report

Task 3

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SUMMARY OF FINDINGS

In order to optimize freeway corridor operations where the presence of ramp metering creates queueing delay as a result of entrance ramp demand patterns not conforming with available capacity along a freeway, a series of eight ramp queue condition information signs were installed for each of the northbound entrance ramps serving the freeway under surveillance control. The signs are placed along an alternate surface street route paralleling the northbound John C. Lodge Freeway in Detroit and were in operation during the afternoon peak period. Wherever possible the alternate route consists of the frontage road to the Freeway, but where the frontage road is not continuous between ramps a nearby surface street is employed. In those cases where the alternate route is several blocks away from the Freeway, signs are placed in advance of the intersection of the cross street from which the particular entrance ramp extends.

Each sign displays queue conditions for three succeeding entrance ramps such that the driver can either select the nearest entrance ramp for entry or continue along the alternate route. The signs are larger in size and contain larger lettering than comparable signs installed by the Texas Transportation Institute along a portion of the alternate

route in 1968. The signs are internally illuminated and always present a positive routing indication to the driver. Symbolically, the color green indicates lack of congestion at an entrance ramp and on each sign the nearest such ramp is indicated by the flashing green message, "ENTER." Congested ramp names are displayed in red but the alternate route is always green. Should all ramps be congested the alternate route arrow beyond the farthest downstream ramp is flashed in green.

The signs installed by The University of Michigan are both visible and legible at greater distances than the signs designed by the Texas Transportation Institute and for a group of test subjects were slightly better understood than were the TTI signs. Once the signs were understood, the test subjects experienced little difficulty in making the necessary turning movements, so it is concluded that sign placement and legibility distance is adequate. Drivers unfamiliar or confused by the signs could very well experience difficulty since along the alternate route drivers must contend with other traffic. A questionnaire survey of public response showed that 68% of the respondents understood the signs on paper. An extensive public relations effort involving television, radio and newspaper media and the handing out of an explanatory leaflet to ramp users the day before the signs were made operational reached about half of the ramp users the day of the questionnaire a month later. This demonstrated the desirability for such innovative new traffic engineering devices to be relatively self-explanatory to ensure driver understanding and obedience.

According to the questionnaire, 41% of the ramp users claim to use the signs. This is contrasted with the experience with similar but more symbolic signs used in Chicago where sign usage was 24%. This was attributed to the positive routing information presented on the University of Michigan signs. License plate studies of ramp diversion as related to sign message state were also conducted, although the results were inconsistent. In general, the amount of diversion is not as great as claimed by drivers on the questionnaire. However, diversion was present and in the month following the installation of the signs, demand shifts to downstream ramps were noted. Drivers displayed a reluctance to enter when the sign displays were predominantly red, and according to questionnaire results, 27% of the respondents would not use the Freeway at all when confronted by an all-red display. A comparison of 1969 origin-destination material with data from 1967 indicated a decrease in the proportions of shorter trips, although some of this can doubtless be attributed to the installation of ramp metering after the 1967 origin-destination study.

It was concluded that evaluation of these signs was impaired by the limited nature of the study. Budgetary limitations confined the study to one alternate route, and for those ramps not on the service drive, as few as six percent of ramp users actually passed a sign (i.e., were proceeding northbound along the alternate route). This limited the effectiveness of these signs in promoting significant diversion from these ramps. Furthermore, sign usage decreased with frequency of ramp use. This was interpreted to be an adverse reaction to the signs by daily users who evidently experimented with the alternate route and found it unsatisfactory. Only minor traffic engineering improvements were made along the alternate route and the signal network did not favor diverted freeway users so some drivers may have found the route unappealing. Also, since there was no provision for handling demand surges at downstream ramps resulting from diversion, it is possible that some diverted drivers did not find uncongested conditions as promised by the signs.

Other studies of driver attitudes have found that the information most desired by freeway users is specific information on such unexpected congestion as caused by accidents and drivers would be most willing to divert to an alternate route to avoid such congestion. In this study, the ramp metering program serves to optimize on-freeway operations and thus the driver queued at an entrance ramp or diverted along the alternate route receives no surveillance benefit until he enters the freeway. The signs can direct the way to a ramp with less queue delay, but the time savings may be lost in increased surface street time. In this study it appeared that a majority of drivers are unwilling to follow the alternate route for great distances.

A cost-effectiveness study was performed on the demand changes presumed to be induced by the signs and the marginal cost/effectiveness ratio for the signs amortized over a ten-year period is estimated at six cents per vehicle-hour saved. The benefits in improved freeway operations offset the disadvantages of increased surface street travel time for diverted motorists.

PART ONE

CHAPTER ONE

INTRODUCTION AND RESEARCH APPROACH

INTRODUCTION

This report presents information on the planning, design, operation and evaluation of the effectiveness of a set of dynamic ramp queue condition information signs placed along an alternate surface street route paralleling a 6.1 mile section of the northbound John C. Lodge Freeway in Detroit, Michigan. These signs indicate the state of congestion at the nearest entrance ramp and the next two following ramps along the alternate route in order to facilitate the entry of drivers to the Freeway. The basic premise of the study was that there existed unused capacity at existing levels of service on the northbound surface streets in the Lodge Freeway Corridor during the evening peak period which would allow some diversion of freeway traffic originating in the corridor. The queueing congestion at the ramps was principally the result of ramp metering operations initiated at eight entrance ramps in 1967 (62). Since ramp metering generally reflected congestion on the Freeway, the ramp condition information signs were also intended to redistribute traffic entering the Freeway Corridor to those portions of the Freeway with available capacity as indicated by the lack of ramp congestion.

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*Numbers refer to references at the end of Part One of this report.

This report is one of a series of related studies conducted by the Highway Safety Research Institute of The University of Michigan with the objective of optimizing traffic operations in the John C. Lodge Freeway Corridor by means of traffic surveillance, communication and control (13, 46, 54). (The research sponsor's project statement is presented in Appendix E.) Surveillance efforts in the Lodge Corridor began in 1955, were later formalized into the National Proving Ground for Freeway Surveillance Control and Electronic Traffic Aids, and in 1967 were incorporated into the National Cooperative Highway Research Program of the Highway Research Board (12, 18, 62). The 1967 and 1968 research program was conducted by the Texas Transportation Institute (TTI) during which time ramp metering was implemented and preliminary steps were taken to incorporate the adjacent surface street network into the surveillance system (62). The University of Michigan succeeded TTI as the research contractor in 1969.

The section of the Lodge Freeway Corridor under study extends northwesterly from West Grand Boulevard to Meyers Road (as shown in Figure 1) and includes major arterials within approximately 0.5 mile of the Freeway. Surveillance control is supervised by an IBM 1800 digital computer with an input and output interface for field communication. This

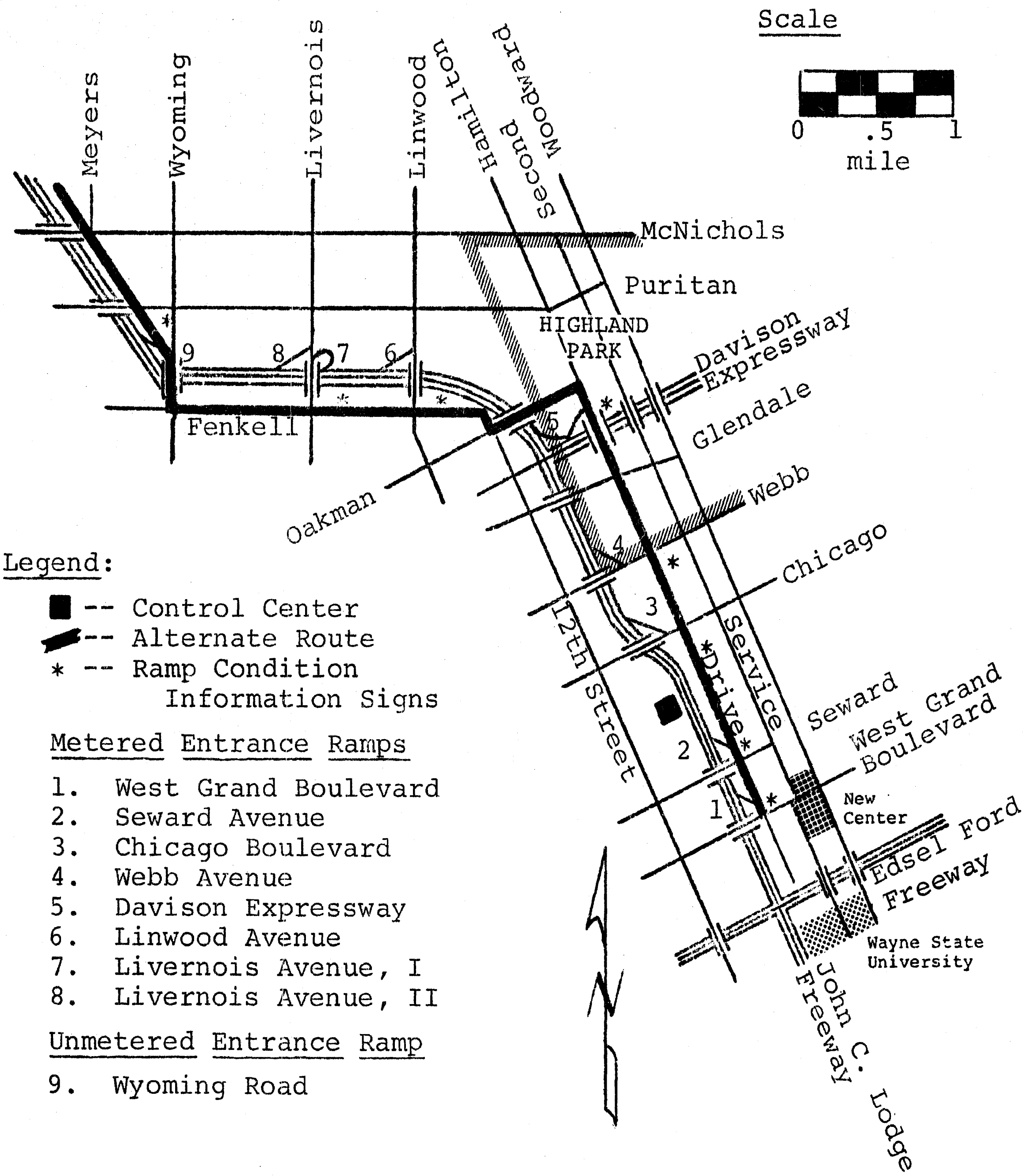


FIGURE 1

NORTHBOUND JOHN C. LODGE FREEWAY CORRIDOR
SHOWING ALTERNATE ROUTE AND LOCATION
OF RAMP CONDITION INFORMATION SIGNS

equipment is located in the Control Center at the Herman Kiefer Hospital which is adjacent to the Lodge Freeway. Field equipment utilized consists of 48 vehicle presence detectors located at nine stations along the northbound Freeway in addition to those on the nine entrance ramps and ten exit ramps within the study area. The detectors are connected with the central computer by means of leased telephone cables and lines. The Freeway is thus a closed loop system where the entrance and exit of each vehicle to the 6.1-mile research section is monitored.

The locations of the eight metered ramps are depicted in Figure 1. The northernmost entrance ramp in the corridor, at Wyoming Avenue, was not metered as congestion seldom extended this far north. In September 1968, TTI installed four ramp condition information signs along the Lodge Service Drive between West Grand Boulevard and Chicago Avenue and on Hamilton Avenue in advance of Webb Avenue (shown by the four southernmost asterisks in Figure 1). The Service Drive extended becomes Hamilton Avenue at Chicago as the Freeway alignment moves several blocks to the west. It was expected that total travel time in the corridor would be reduced if the Freeway were made to accommodate a greater proportion of the corridor travel at optimal performance levels (18). The function of the ramp metering system was to maintain Freeway usage at a high level of service by storing excess demand at the entrance ramps. The function of the ramp information signs was to divert drivers away from the more congested ramps to alternate routes and also to encourage those drivers choosing to use the Freeway to enter farther downstream at ramps indicated by the signs to be uncongested. In their evaluation of the four signs shortly after they were installed, TTI did find a daily travel time savings of 163 vehicle-hours attributable to the signs (18).

Continuing this research in 1969, The University of Michigan expanded the ramp condition information sign system to include all nine entrance ramps in the corridor. The establishment of an alternate surface street route linking these ramps was complicated by the lack of a continuous frontage road, the westward shift of several miles taken by the Freeway before resuming its northwestern alignment and the changing major street patterns within the area. In particular, north of the Davison Expressway the Lodge Freeway deviates away from the natural alternative routes of Hamilton, Second and Woodward Avenues. The driver seeking to enter the Freeway must be strongly motivated not to enter at or before this point, and instead follow other streets and lose sight of the Freeway.

Inspection of the Lodge Corridor origin-destination study conducted by the National Proving Ground staff in 1965 showed that the concept of an alternate route to the Freeway was well established in the southern half of the corridor below the Davison Expressway (45). The primary traffic generator in this area is the "New Center" complex surrounding the headquarters of the General Motors Corporation located on West Grand Boulevard west of Woodward Avenue (Figure 1). Table 1 gives both the proportion of this afternoon peak period traffic at the four ramps adjacent to or downstream of the New Center area and the relative importance of this traffic on these ramps.

TABLE 1

1965 NEW CENTER TRAFFIC ENTRANCE RAMP USAGE

LODGE ENTRANCE RAMP	PERCENT OF NEW CENTER TRAFFIC ENTERING AT RAMP	PERCENT OF RAMP TRAFFIC ORIGINATING IN THE NEW CENTER AREA
West Grand Boulevard	63.6%	64.3%
Seward Avenue	28.7%	54.0%
Chicago Avenue	5.4%	17.1%
Webb Avenue	2.3%	12.9%
TOTAL	100%	

The entrance ramps at West Grand Boulevard and Seward Avenue directly service the New Center area, but it is seen that significant proportions of Chicago and Webb ramp traffic also come from there. In 1965 it was concluded that those drivers diverting to the Chicago and Webb ramps were avoiding freeway congestion in the vicinity of the Ford Freeway Interchange and taking advantage of good conditions on Hamilton and Second Avenues (45). At the West Grand Boulevard and Seward Avenue ramps traffic from the New Center area increased steadily after 3:00 p.m. until the peak hour from 5:00 to 6:00 p.m., but there were no diversions to Chicago and Webb from the New Center until 5:00 p.m., an occurrence which substantiated the diversion theory.

In all likelihood the diversion increased with the TTI implementation of ramp metering in 1967 as a result of increased ramp congestion at the busier West Grand Boulevard and Seward entrance ramps (62). Increased ramp delay added a new component to individual travel times that inevitably would make increased surface street travel more appealing to some drivers.

The TTI ramp condition information signs installed in late 1968 served only these four ramps where diversion patterns had already been established. By extending the alternate route system an additional 3.3 miles to Wyoming

Road a stronger test of the feasibility of a driver information system and the willingness of drivers to follow an alternate route was established. Heathington, et al., questioned 732 drivers residing in the Chicago metropolitan area on their preferences for improvements to be made to the existing highway system other than construction of additional highways (39). From among a list of nine improvements the third most popular selection was the use of dynamic signs indicating freeway traffic conditions for drivers seeking to enter freeways. Some 64% of the respondents expressed interest in such information with the implication being that they would stay off a freeway known to be congested at the point at which they wished to enter. The availability of the test site in Detroit provided an opportunity to determine if this expression of driver intentions corresponded to actual traffic behavior.

ESTABLISHMENT OF AN ALTERNATE ROUTE TO THE FREEWAY

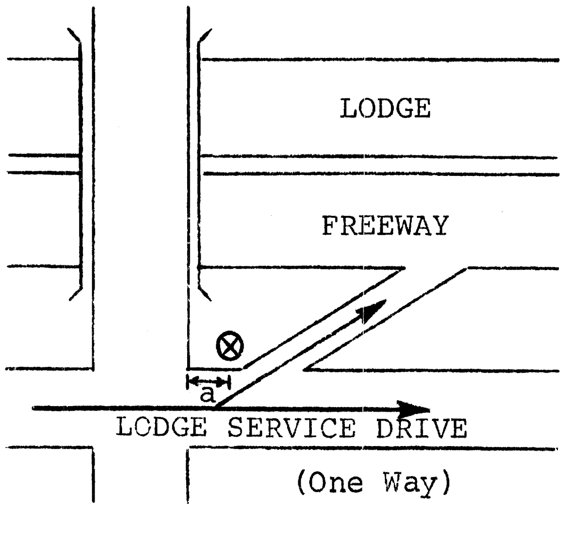
The alternate route to the Freeway between West Grand Boulevard and Wyoming Avenue is indicated in Figure 1. It generally follows the frontage road or service drive where available, or the nearest parallel street where there is no frontage road. All of the nearby arterials that parallel the Freeway were considered, but it was decided that Freeway users would be more inclined to follow the route in nearest proximity to the Freeway. The frontage road extending from West Grand Boulevard terminates at Chicago Boulevard where it becomes Hamilton Avenue. The Freeway parallels Hamilton Avenue a few blocks to the west until it veers further west some blocks north of the Davison Expressway. From this point there is no natural alternate route, so Oakman Boulevard, a collector facility and a portion of 12th Street was included to link Hamilton Avenue with Fenkell Avenue, the latter a narrow arterial paralleling the east-west alignment of the Lodge Freeway a few blocks to the south. At Wyoming Road the alternate route proceeds to the north on Wyoming until the frontage road is intersected just north of the Freeway.

The ramp condition information signs are located so that they provide information on seven of the eight metered ramps (Figure 1). The eighth metered ramp, Livernois

Avenue, II, serves southbound Livernois traffic only and is not directly accessible from the south. The Wyoming Road entrance ramp is not metered and the corresponding ramp sign is placed on the frontage road. Peak period congestion north of this ramp is rare.

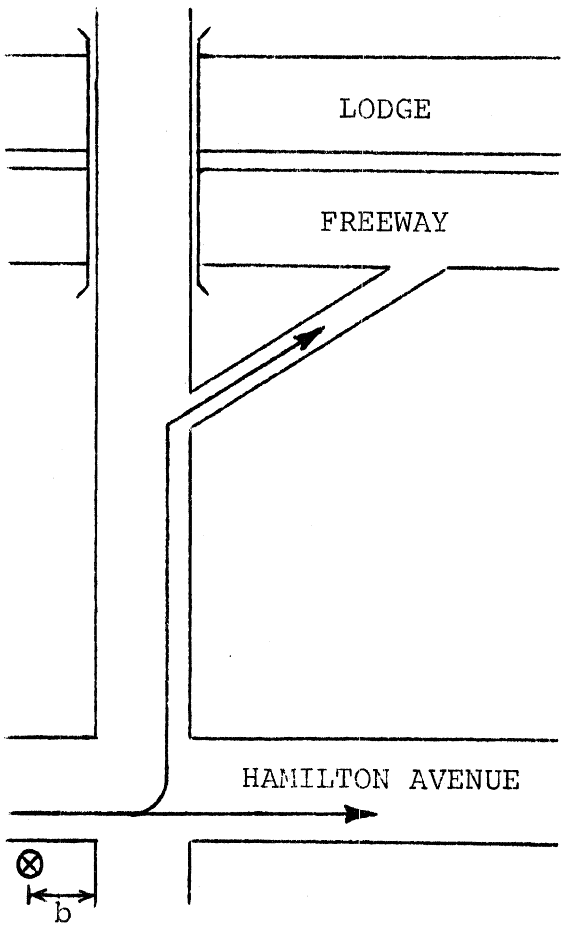
As shown in the top portion of Figure 2, three entrance ramps, West Grand Boulevard, Seward Avenue and Wyoming Road are directly accessible from the frontage road. For three other entrance ramps, Chicago, Webb and Davison, a left turn is made from the alternate route to a cross street and then a right turn is made to the ramp as shown in the bottom of Figure 2. For the remaining two entrance ramps, a right turn is made from the alternate route to a cross street and a turn, one left (Linwood) and one right (Livernois, I), is made from the cross street. These maneuvers are illustrated in Figure 3.

Because five of the eight signs are not at the ramp entrance itself, it is possible for much traffic to enter the Freeway without passing a sign, and the signs will have no influence on the route choices of many motorists who are intending to enter the Freeway. To overcome this, several additional signs would have to be erected on the cross streets with access to the Freeway ramps. In the event of congestion, these signs could direct motorists to the chosen alternate route or to another alternate route on which further signs



RAMP INFORMATION SIGN LOCATION AT WEST GRAND BOULEVARD, SEWARD AND WYOMING ENTRANCE RAMPS

	Distance "a" to Intersection
West Grand Boulevard	110'
Seward	70'
Wyoming	70'



RAMP INFORMATION SIGN LOCATION FOR CHICAGO, WEBB AND DAVISON ENTRANCE RAMPS

	Distance "b" to Intersection
Chicago	320'
Webb	140'
Davison	140'

⊗ -Location of Ramp Information Signs

Not drawn to scale

FIGURE 2

RAMP INFORMATION SIGN LOCATIONS AND VEHICLE ROUTES TO FREEWAY

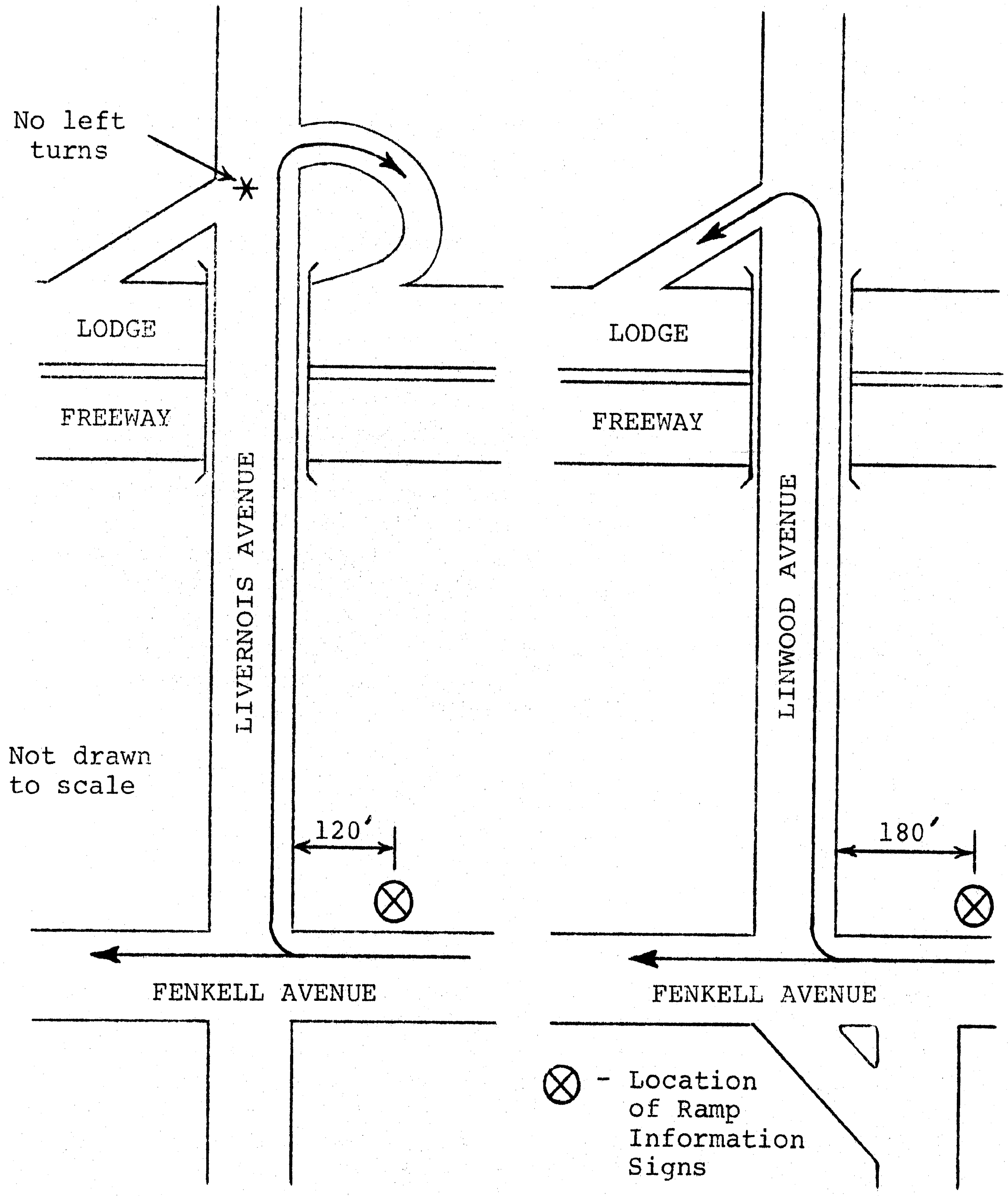


FIGURE 3

RAMP INFORMATION SIGN LOCATIONS
AND VEHICLE ROUTES TO FREEWAY

would be required. The present study, however, is concerned only with the effectiveness of the signs in reducing ramp demand in terms of the volumes actually passing the signs.

It should be noted that during both peak and off-peak periods, each motorist is guided by only one sign at any choice point. Normal good practice for guide signs makes use of confirmation signs to assist motorists in finding their desired path. This would have necessitated, however, at least two signs for the five entrance ramps accessible from a cross street. As the additional funds were not available, the one sign was placed at a reasonable distance before any turning or entering action would be required. Further, it was believed that because of the greater visual impact of the internally illuminated sign, reassurance signs were not needed. Also, the majority of motorists in the Corridor are regular users who would soon become familiar with the ramp signs.

There should be a saving of total travel time both for motorists using the Freeway and motorists diverted to the alternate route. If excessive congestion at the ramp entrances can be eliminated, there should also be less congestion for motorists passing the ramps with no intention of entering the Freeway.

The criterion of ramp congestion was generally based on the value of occupancy at a queue detector placed at the head of the ramp. Occupancy is the percentage of time vehicles are under the queue detector during a one-minute period of measurement. Since there is no queue detector at the Wyoming ramp, a rapid increase in occupancy at the count detector at the foot of the ramp was used to indicate congestion at that ramp. For the other ramps, a critical value of occupancy was chosen which, if exceeded for two successive minutes, would indicate congestion in the form of excessively long ramp queues threatening to affect surface street movement. Critical values of 20%, corresponding to a queue length of at least 20 vehicles, were adopted for all metered ramps except for the Davison Expressway ramp where a value of 35% (40 vehicle queue) was selected because of the longer ramp.

These values were chosen after observation of the queueing behavior at the ramps. For every metered ramp, it was noted that occupancy values for queues shorter than the critical value were relatively low and virtually independent of queue length. For a queue extending back to and beyond the queue detector, however, the occupancy values rose rapidly with increasing queue length. As the queue extends beyond the detector, the value of occupancy continues to increase, eventually approaching that found in full congested flow.

Several traffic engineering improvements were made on the streets comprising the alternate route by the City of Detroit Department of Streets and Traffic, the City of Highland Park and the Wayne County Road Commission. The most important change was the addition of a leading left-turn phase on Hamilton Avenue at Oakman Boulevard to assist motorists in continuing on the alternate route from that point. Parking restrictions were increased on Fenkell Avenue which has only two westbound lanes. Static guide signs bearing the legend "TO NORTHBOUND JOHN C. LODGE FREEWAY" were erected in suitable positions to show motorists the alternate route. These improvements made the alternate route more attractive to motorists diverting to it from the Freeway.

DESIGN OF RAMP CONDITION INFORMATION SIGNS

Two antecedent sign designs were followed in the development of the ramp condition information signs by the research agency. In 1965 four dynamic signs depicting the conditions at two metered entrance ramps and on the Eisenhower Expressway were placed at two intersections by the Chicago Area Expressway Surveillance Project to give drivers an opportunity to divert to an alternate route (42). The signs presented a simplified map of the freeway, the two cross streets from which the entrance ramps extended, and the alternate route between the two ramps. Changeable color arrows in green, yellow and red to indicate no delay, moderate congestion, or congestion, respectively, were used to describe current conditions at both ramps and on the freeway just downstream of the ramps. Static explanatory signs were placed in advance of the dynamic signs, which in turn were located 300 feet in advance of the intersections.

The driver could thus base his routing decision on ramp and expressway conditions before reaching the decision point. Although traffic counts showed little if any diversion generated by the signs, a questionnaire given drivers indicated that nearly half those passing the signs claimed to use them. The level of comprehension was high although the most frequent comments were that the signs were too complicated or inaccurate (42). A few drivers indicated that they regularly avoided the expressway during the rush hour regardless of the message displayed by the signs.

Four bits of information were displayed on each of the Chicago signs, traffic conditions at the two entrance ramps and at two freeway locations. The questionnaire comments on sign complexity raised the question of just how much information can be presented to drivers who must also cope with traffic on busy arterials. Several respondents suggested the use of words instead of symbolic arrows.

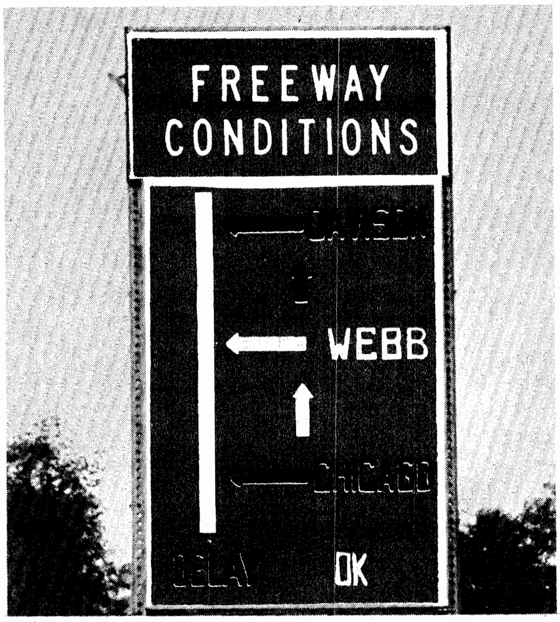
The ramp condition information signs installed by TTI in 1968 were of the same level of complexity as the Chicago signs (18). Although freeway flow conditions were not displayed, the queue status at as many as four entrance ramps were indicated on the signs. The TTI sign in advance of the Chicago Avenue entrance ramp is depicted in Figure 4a. To supplement these signs to give information on freeway conditions, blank-out signs previously installed by the National Proving Grounds at the head of the ramps to effect ramp closure were modified to read "FREEWAY STOPPED AHEAD" (12). Thus the potential freeway user had this additional information to read, assimilate and act upon in making his decision on where to leave the alternate route and enter the

Freeway. At Chicago and Webb he had already left the alternate route before reaching the location of this second sign and thus had committed himself to freeway entrance. The information signs were computer-controlled while the blank-out signs were activated manually at the Control Center when severe congestion was present or lane blockages observed on the television monitors.

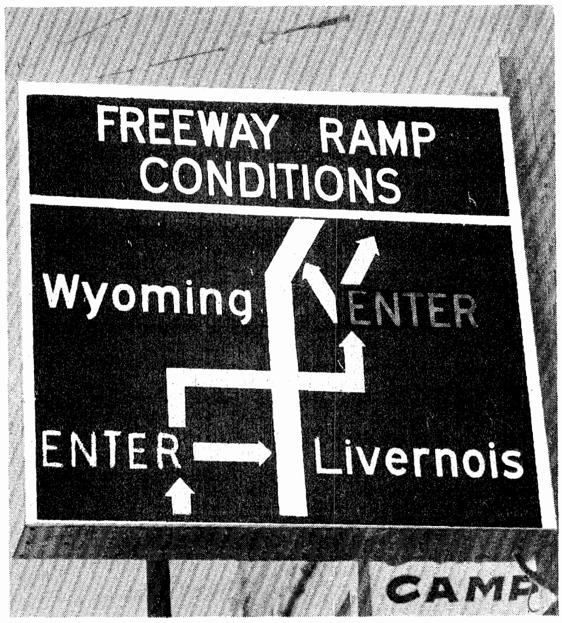
As shown on Figure 4a, the TTI ramp condition information signs presented internally illuminated messages consisting of ramp names and arrows delineating the alternate route and the turning movement necessary to reach the ramp. Although words were employed, the message was basically symbolic with red indicating ramp congestion and green the lack of congestion. The legend color code was presented on each sign rather than on a static explanatory sign as in Chicago. The following mode of operation was employed:

1. When there was no delay at the ramp adjacent to the sign location, the "OK" indication, the adjacent ramp name and the ramp arrow were illuminated in green. Other ramp legends and arrow symbols were not illuminated.

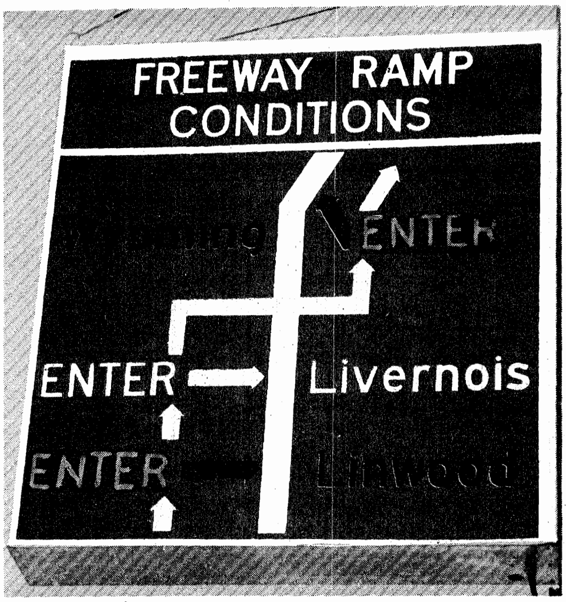
2. When there was delay at the adjacent ramp, the "delay" message was illuminated in red and the names of all the remaining downstream ramps were



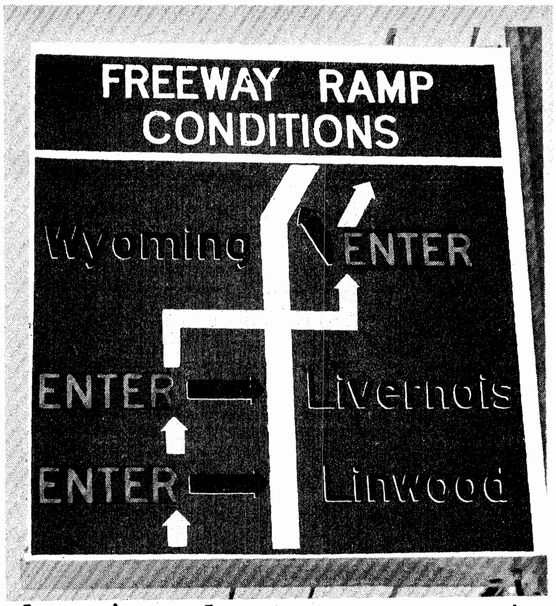
a. Texas Transportation Institute Ramp Information Sign at Chicago Avenue (Display: Webb Congested).



b. Livernois Entrance Ramp Sign (Display: Enter at Livernois; Both Ramps Uncongested).



c. Linwood Entrance Ramp Sign (Display: Linwood and Wyoming Ramps Congested; Enter at Livernois Ramp).



d. Linwood Entrance Ramp Sign (Display: All Ramps Congested; Proceed on Alternate Route).

FIGURE 4

RAMP CONDITION INFORMATION SIGNS
IN THE JOHN C. LODGE FREEWAY CORRIDOR

illuminated in either green or red depending upon the congestion at the ramp.

3. When the downstream ramp names were illuminated, the vertical alternate route arrows were also illuminated in green as far as the last green ramp and red beyond that point.

This mode of operation resulted in nine possible messages at West Grand Boulevard and Seward Avenue where the conditions at four ramps were displayed. There were five message states for the Chicago Avenue sign which displayed information on three ramps, and three states for the sign at Webb Avenue which included only two ramps (Webb and Davison).

When The University of Michigan first considered the extension of the alternate route system, it was concluded that there were design deficiencies in the TTI signs and that they should be replaced. Also, their replacement assured uniformity in the eight signs planned for the extended alternate route.

Although no information was available on public response to the TTI signs, it was believed that presenting information on four ramps was not necessary and potentially detrimental to sign effectiveness. Thus, it was decided to reduce the maximum number of ramp condition indications to three although it was considered possible that such signs could be equally effective by showing the conditions at only one ramp if they caught the driver's attention. Giving information on only one ramp, however, means that for the majority of the time the signs are operating a driver would be presented with only a negative message and no positive information on which to base his driving actions.

Another possible improvement was the opportunity to always provide positive guidance. In the TTI system it was possible to have an all-red display of ramp names and arrows and no recommended procedure presented to the driver.

Examples of the ramp condition information signs developed by The University of Michigan are presented in Figures 4b, 4c and 4d. The Livernois Avenue sign in Figure 4b has only two indications, since the system ends two ramps further downstream. Figures 4c and 4d depict two of the ramp displays typical of the remaining signs with one other exception. The last alternate route sign at the Wyoming Avenue ramp displays conditions only for that ramp. From that point a continuous frontage road is present and the driver can directly observe freeway conditions unhindered by ramp queues caused by metering or the lack of a frontage road.

The following changes were made by The University of Michigan in designing the replacement signs:

1. A positive route is given so that the motorist always has a path to follow. The message includes the flashing word "ENTER" beside the nearest uncongested ramp. In addition, the green alternate route arrow at the top of the sign flashes to advise motorists to continue along the alternate route if all ramps shown on the sign are congested as shown in Figure 4d.

2. The overall size of the sign was increased. The signs with three ramp displays are 58" wide and from 53" to 61" in height as necessary to accommodate the routing display. The Livernois sign (Figure 4b) is 49" in height and the single ramp Wyoming sign is 33" in height. Both are 58" wide.

3. A complete display of conditions on successive ramps is given during the peak period regardless of the sign state so that, unlike the TTI signs, the new signs are always fully illuminated.

4. The display of directional arrows was enlarged and upper and lower case letters were employed instead of all capitals to conform with interstate guide sign practice. Specifications for

the lettering are given in Appendix D. All capital letters are four inches in height.

5. Information for three rather than four ramps is displayed to reduce reading and comprehension time.

6. Flashing indications are used to emphasize recommended movements.

For the purpose of guidance during off-peak periods, the ramp name and arrow and the word "ENTER" are illuminated at all times.

In the original design of the new signs the printed legend "FREEWAY RAMP CONDITIONS" appeared above the illuminated portion of the sign. When the nearest ramp was illuminated in red (indicating not to enter), however, it was possible that one might be confused as to the recommended path to the Freeway. Just past the ramp signs were static guide signs bearing the legend "TO NORTHBOUND JOHN C. LODGE FREEWAY" which pointed toward the ramp.

Detailed specifications for the new signs are given in Appendix D. There were eight possible sign states or messages for the signs displaying conditions at three ramps, four sign states for the Livernois sign, and two for the Wyoming sign. The eight signs were put into operation in

June 1969, and an explanatory leaflet was passed out to users of the eight entrance ramps along the alternate route the day before they became operational. An extensive public relations campaign detailed in Appendix B was conducted in order to assure that a maximum number of freeway users would be made aware of the new signs and their operation.

Along with the installation of the new signs, the blank-out signs reading "FREEWAY STOPPED AHEAD" were removed from the entrance ramps at West Grand Boulevard and Seward Avenue. At the Chicago and Webb entrance ramps the blank-out messages were changed to "DON'T ENTER RAMP" and activated when ramp congestion was present. Thus, the new alternate route information system presented no information on freeway conditions to the driver except that which could be inferred from ramp conditions. Since the blank-out signs at Chicago and Webb could be seen only after the driver had left the alternate route and could not be expected to backtrack, these two signs were incorporated into a more extensive corridor routing study conducted later in 1969 and 1970 (54).

RESEARCH APPROACH

The ramp condition information signs installed in 1968 were evaluated by the Texas Transportation Institute by estimating the improvements in total travel time in the Freeway Corridor resulting from more efficient allocation of entrance ramp demand and the effects of diversion from the Freeway to alternate surface routes (18). The University of Michigan also investigated these system effects, but to a lesser extent because it was believed that important aspects of the impact of the signs were thereby obscured. Since the ramp signs need to be seen before the driver reaches his decision point for ramp entry and then understood and respected, the main thrust of the 1969 research was the investigation of individual driver response to these signs.

The signs were thus evaluated in terms of the following measures of effectiveness:

1. Sign visibility;
2. Sign legibility;
3. Driver comprehension of the presented message;
4. Driver obedience and persistence in following an alternate surface street routing; and
5. Changes in traffic routing patterns induced by the signs.

Three research studies were conducted to obtain answers to the above objectives. The first was a driver behavior study where test subjects were directed along the alternate route to determine the effectiveness of the new signs in terms of visibility distance, message legibility distance and the subject's understanding of and obedience to the messages. This study was conducted for both the TTI signs and those designed by The University so that the design modifications in the new signs could be evaluated. A questionnaire was also developed and issued to ramp users to determine the comprehension level of actual freeway users and survey public attitude and respect for the signs. Since what people say they would do on a questionnaire and what they actually do may differ, the third research study was a traffic routing survey to measure directly the ramp diversion resulting from changes in the sign messages. This study also included a long-term evaluation of daily ramp volume changes caused by the introduction of ramp metering and the later addition of ramp information signs both by TTI and The University of Michigan.

DRIVER BEHAVIOR STUDY

The study of driver response to ramp information signs was conducted by the Human Factors Group of the Highway Safety Research Institute. The aspects of driver behavior considered were the distances required to see and then read the signs, the ability to understand the sign messages, and driver willingness to obey the messages. Students and staff members of The University of Michigan and nearby Wayne State University were used as test subjects in these experiments. There were two phases to the study, the determination of the sign visibility and message legibility distances, and the determination of message comprehension.

A 1969 Ford four-door sedan was used as the test vehicle for the visibility and legibility study. The vehicle was equipped with two precision electronic counters to measure distance to the nearest 0.1 foot by means of a fifth wheel and an instrument with which the observer recorded the point at which the subject first saw and then read the signs.

Ten subjects were used to test both the TTI signs and the new signs. The latter study took place ten days after the first one after the new signs had been installed. The subject was read an instruction sheet (Appendix C) which told him to follow all traffic information and regulatory signs on the route he was directed along. He was shown a photograph of a ramp information sign and instructed to indicate when he first saw and subsequently could read each such sign he came across. He was then directed by the observer to a position one block south of the Seward Avenue ramp information sign. He followed the Service Drive and Hamilton Avenue past three ramp information signs. The signs were displayed so that the first two signs (at Seward and Chicago) advised the driver to continue on to the third entrance ramp (Webb Avenue).

The observer sat in the right rear seat of the vehicle. He operated the counters to record the oral reporting of each subject on his ability to see and read each ramp information sign he passed. As soon as the back edge of the left rear door passed the sign support the experimenter stopped the counters and recorded the two distance counts from the fifth wheel. The recorders were then cleared for repeating the measurements at the next sign.

The second phase of the driver behavior study was that of sign comprehension. Twelve subjects were used to test the TTI signs and nine different subjects were used for the new signs. A 1968 Plymouth four-door sedan was the test vehicle. The observer, in this second study, had the responsibility of recording the responses of the test subjects to the sign messages.

At the beginning of a run the subject was again read to from an instruction sheet (Appendix C). The subject was then directed to a point on the Service Drive one block south of the southernmost sign. From that point the subject followed his own path, with the sole objective being to enter the Freeway at one of the available entrance ramps. The observer sat in the front seat and recorded the response to each sign and the entrance ramp where each subject entered the Freeway.

Three TTI signs, at Seward, Chicago and Webb Avenues, were employed in the study. The messages were controlled to display ramp congestion at Seward and Chicago and uncongested conditions at the third ramp, Webb Avenue. If the subject entered the Freeway at a ramp not recommended by the sign message, he was told to return to a position one block south of the next sign. At the end of the experiment the subject was shown an example of the ramp information signs and asked if he had seen any signs like it and how many.

The West Grand Boulevard sign was included in the comprehension studies of the new signs. A display of messages directing the driver to the Webb Avenue entrance ramp was used in this study, with congestion indicated at the first three ramps.

SURVEY OF PUBLIC RESPONSE TO RAMP INFORMATION SIGNS

It was expected that a fraction of the drivers would not follow the path recommended by the signs. The possible reasons for this include failure to see the signs, misinterpretation of their message, or a conscious decision to ignore their recommendation. The driver behavior study would not be expected to accurately reflect these factors since it involved a limited number of test subjects in a test situation. Thus, in order to evaluate public attitudes, a questionnaire was developed and issued to users of the eight metered ramps and the Wyoming ramp on Thursday, July 17, 1969. The questionnaires (Plate 1) could be folded and sealed to form a prepaid business mailer. Public relations efforts in the design and distribution of the questionnaire are presented in Appendix B.

The questionnaire was intended to provide a fairly wide range of information, although it was designed to be simple in format and readily comprehensible in order not to discourage response. There were ten questions which included requests for origin-destination information, a test of sign comprehension based on a picture of the Webb sign, a question to test the willingness of drivers to follow an alternate route by asking their response to a sign displaying all ramps as congested, and lastly a question on the effectiveness of the publicity campaign surrounding the installation of the new signs. Upon return, the questionnaires were coded and the information transferred to IBM cards for data reduction and analysis.

The last origin and destination study in the Lodge Freeway Corridor was made by the Texas Transportation Institute in 1967 prior to the installation of ramp metering (62). The new origin and destination data from the questionnaires was expected to provide information on the changes in traffic patterns in the two years resulting from the presence of ramp metering and the more recent addition of ramp information signs. The results became available too late to be used for the placement of the trailblazer signs along arterials in the corridor directing drivers to the Freeway, but it was anticipated that the information would be incorporated into the evaluation of long-term driver response to Freeway communication and control systems projected for the 1970 research (54).

The entrance ramp where the respondent received his questionnaire was already stamped in the space provided and he was asked to supply his exit ramp and nearest intersection to the origin and destination of his trip. A map of the cities of Detroit and Highland Park was subdivided into zones forming a basic grid pattern. The zone boundaries were drawn so that there would be a logical entrance and exit ramp for every respondent regardless of how far his origin or destination was from the Lodge Corridor. Whenever possible, zone boundaries included barriers to travel such as railway lines. Furthermore, boundaries were drawn at

PLATE 1 (opposite page)

1969 QUESTIONNAIRE TO
DETERMINE PUBLIC RESPONSE
TO THE ALTERNATE ROUTE
INFORMATION SYSTEM

YOU WERE GIVEN THIS QUESTIONNAIRE AS YOU ENTERED THE JOHN C. LODGE FREEWAY BY THE

____ RAMP.

1. WHERE DID YOU BEGIN THIS TRIP ? ____
(STREET AND NEAREST CROSS STREET)

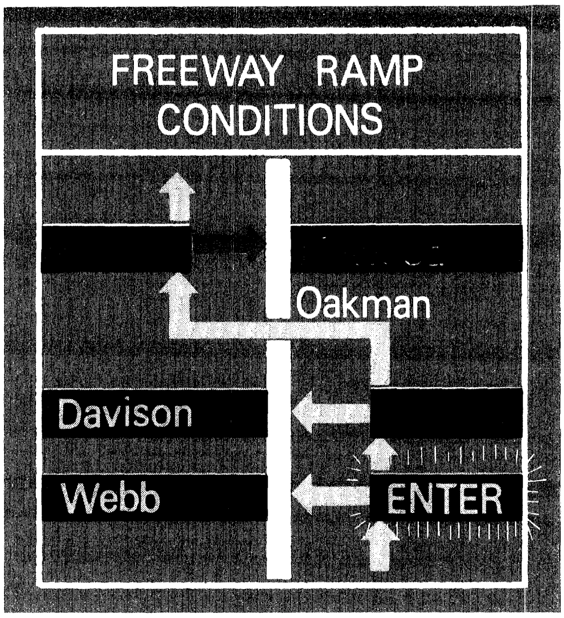
2. WHERE DID YOU END THIS TRIP ? ____
(STREET AND NEAREST CROSS STREET)

3. WHICH RAMP DID YOU USE TO EXIT FROM THE FREEWAY ? CHECK ONE:

CLAIRMOUNT AVE . . . . ☐	DAVISON WEST ☐	WYOMING RD . . . . ☐
HAMILTON AVE, CHICAGO BLVD ☐	DAVISON EAST ☐	MEYERS RD, McNICHOLS RD . ☐
WEBB AVE . . . . ☐	LINWOOD AVE ☐	7 MILE RD . . . . ☐
GLENDALE AVE . . . . ☐	LIVERNOIS AVE ☐	8 MILE RD, GREENFIELD AVE ☐
OTHER . . . . ☐	(PLEASE SPECIFY) _______________________________	

4. HOW OFTEN BETWEEN 2:30 P.M. AND 6:30 P.M. DO YOU ENTER THE RAMP WHERE YOU RECEIVED THIS QUESTIONNAIRE ? CHECK ONE:

NEVER BEFORE ☐	ABOUT ONCE A WEEK ☐	ALMOST EVERY DAY ☐
SELDOM ☐	ABOUT TWICE A WEEK ☐	



5. HAVE YOU EVER SEEN A SIGN SIMILAR TO THE EXAMPLE SHOWN ? YES ☐ NO ☐

6. DO YOU USE THESE SIGNS TO HELP YOU DECIDE WHERE TO ENTER THE FREEWAY ? YES ☐ NO ☐

7. ACCORDING TO THE EXAMPLE:

IS THE WEBB RAMP CONGESTED ? . . . . . YES ☐ NO ☐
IS THE DAVISON RAMP CONGESTED ? . . . YES ☐ NO ☐
IS THE LINWOOD RAMP CONGESTED ? . . . YES ☐ NO ☐

8. AT WHICH RAMP ARE YOU ADVISED TO ENTER THE FREEWAY ?

WEBB ☐ DAVISON ☐ LINWOOD ☐

9. IF ALL THREE RAMPS SHOWN ON ANY SIGN ARE CONGESTED, THE ARROW AT THE TOP OF THE SIGN FLASHES IN GREEN. WHAT WOULD YOU DO IN THIS CASE ? CHECK ONE:

ENTER AT THE FIRST RAMP (EVEN IF SHOWN IN RED) . . . . ☐
GUESS THE LEAST CONGESTED RAMP AND ENTER THERE . . . . ☐
CONTINUE ON THE TRAIL OF SIGNS UNTIL AN UNCONGESTED RAMP IS FOUND . . . . ☐
DECIDE NOT TO ENTER THE FREEWAY AT ALL . . . . ☐

10. HAVE YOU PREVIOUSLY RECEIVED ANY INFORMATION ABOUT THESE SIGNS ? YES ☐ NO ☐
FROM WHICH SOURCES ?
TV ☐ RADIO ☐ NEWSPAPER ☐ LEAFLET ☐ OTHER ☐

REMARKS:

Prepared By The
Traffic Safety Association
Of Detroit For The
University of Michigan
Highway Safety
Research Institute

YOUR CO-OPERATION IS REQUESTED

The Highway Safety Research Institute of The University of Michigan and several city, state, and federal agencies are co-operating in an attempt to find ways of reducing congestion on freeways so you can get home quicker.

The John C. Lodge Freeway Corridor is currently the site of a research project testing many new techniques of providing the individual motorist with information on the best route to his destination. The latest of these innovations is a series of ramp condition information signs recently installed on the northbound Lodge Freeway.

Your answers to the questionnaire on the other side of this page will be an important contribution in helping us to evaluate these signs to determine what improvements are needed. Any other comments you wish to add are also welcome.

Please check the appropriate answers and mail the questionnaire as soon as possible (the postage has already been paid). You need not sign the questionnaire.

Thank you for your assistance and co-operation.

FIRST CLASS
PERMIT NO. 1597
ANN ARBOR, MICH.

BUSINESS REPLY MAIL

NO RETURN STAMP NECESSARY IF MAILED IN THE UNITED STATES.

POSTAGE WILL BE PAID BY

THE UNIVERSITY OF MICHIGAN
HIGHWAY SAFETY RESEARCH INSTITUTE
ROOM 319 HIGHWAY SAFETY RESEARCH INSTITUTE BLDG.
HURON PARKWAY AND BAXTER ROAD
ANN ARBOR, MICHIGAN 48105

mid-block to avoid ambiguity in assigning intersections to zones. An effort was made to conform to the zones of the 1965 National Proving Ground O-D study (45). A total of 45 zones of origin and 51 zones of destination were established (Figures 5 and 6).

At the nine distribution ramps, 10,601 questionnaires were given to an estimated 90% of the motorists using the ramps that day. The number distributed and the number returned for each ramp is presented in Table 2. The 22.8% return is not unusual for postal questionnaires, and was sufficient for major statistical analyses.

There was a highly significant statistical difference in the percentage returned by ramp. The returns from the West Grand Boulevard and Seward Avenue ramps are higher than average while the returns at the remaining ramps were lower than average. Since it is impossible to enter the West Grand Boulevard or Seward ramps without passing a sign, it may be that the higher return at these two locations reflects a tendency for a greater number of those people familiar with the signs to return their questionnaire.

STUDY OF TRAFFIC ROUTING PATTERN CHANGES

In order to test the comprehension of and obedience to the signs by drivers in actual traffic situations rather than on paper or in a test situation, a routing study was

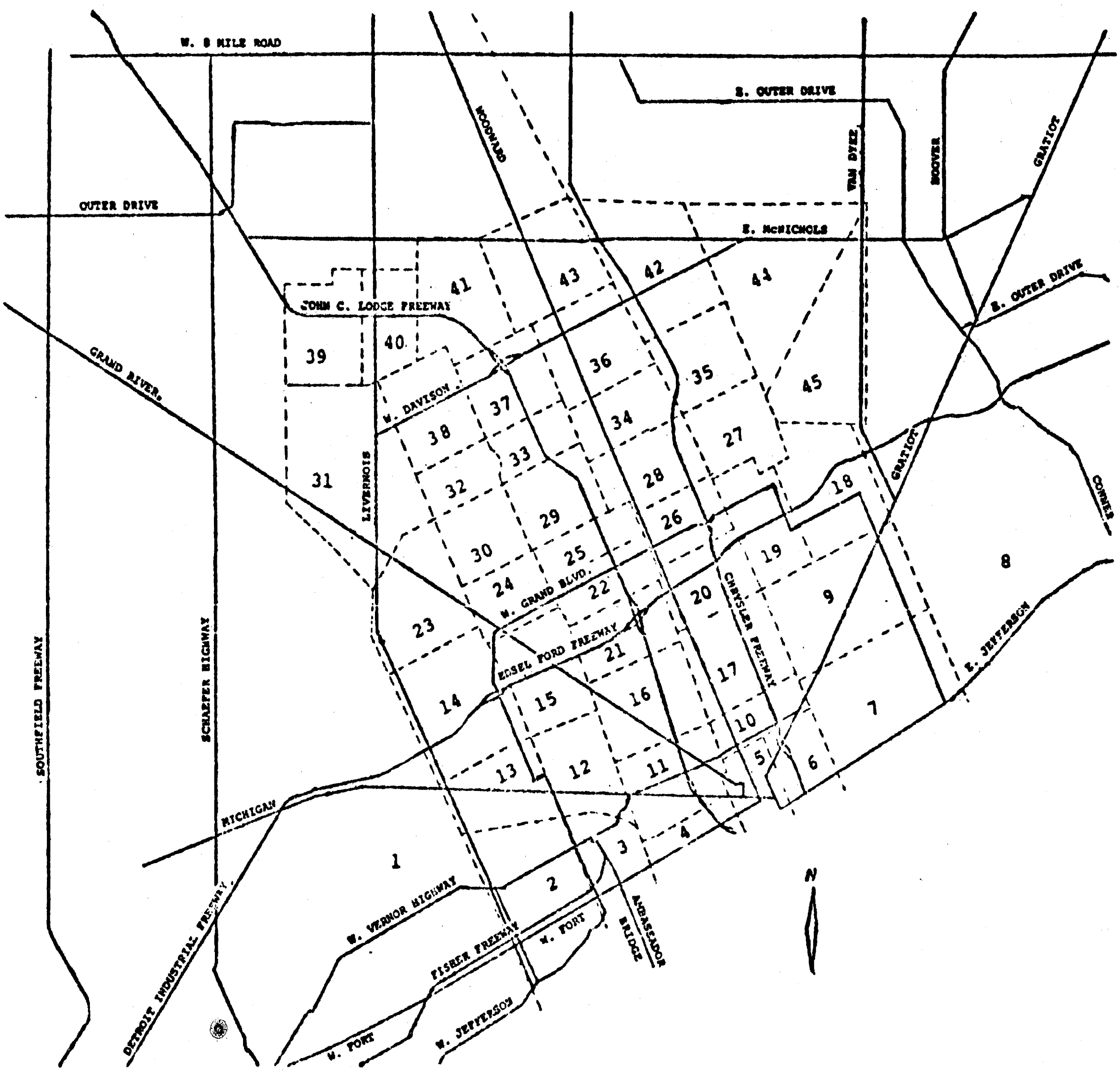


FIGURE 5

ORIGIN ZONES

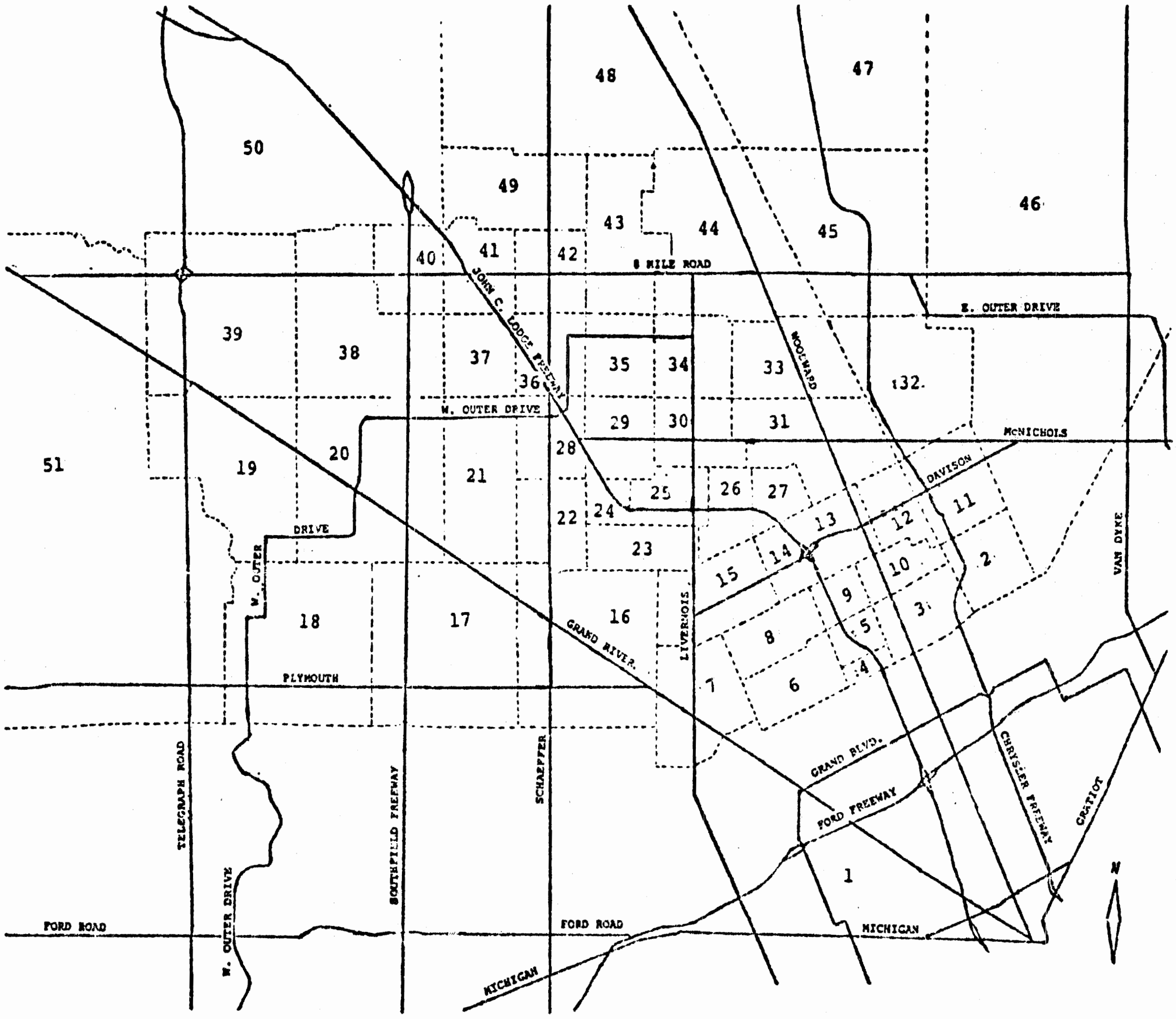


FIGURE 6

DESTINATION ZONES

TABLE 2

QUESTIONNAIRE DISTRIBUTION AND RETURN

RAMP	NUMBER DISTRIBUTED	NUMBER RETURNED	PERCENT RETURNED
West Grand Boulevard	2,438	665	27.2
Seward	819	237	28.9
Chicago	1,067	218	20.4
Webb	804	169	21.0
Davison	2,473	537	21.7
Linwood	1,000	191	19.1
Livernois	1,000	175	17.5
Wyoming	1,000	227	22.7
Total	10,601	2,419	

Overall Percent Returned 22.8

performed. License plate numbers were recorded for traffic passing the TTI signs before their removal and later the new signs. Both these sets of numbers were correlated with those of vehicles entering the ramps. Also, the new signs were turned off for one week (Appendix B, Figure B-8) to obtain data for the situation of no signs. This procedure was considered to be more reliable than using data collected before the installation of the old signs, since the origins and destinations of trips could have changed over this period.

Changes in corridor operations, as measured by total travel and total travel time, induced by the ramp information signs are rather difficult to measure. The presence of ramp metering created a delay component at the ramps that must be added to each driver's journey time on the surface streets and the Freeway. The net reduction in ramp delay resulting from drivers being diverted to less congested ramps, however, could not be directly measured since ramp queue waiting time was not known to the desired accuracy. The ramp congestion estimates used in the sign logic were obtained from occupancy readings by detectors at the heads of each ramp and were not proportional to queue length. That is, these occupancy readings remained low until the queue neared the detector position, at which time the ramp queue occupancy increased rapidly.

The direct benefit to the potential ramp user is the additional information on congested ramps presented by the signs. When he is confronted with a sign indicating a congested ramp, he must decide to either accept the ramp delay or proceed along the alternate route to another ramp. No information is available or presented to the driver on the expected delay duration at the ramp, so the driver is left with the decision of selecting a route based on personal criteria that may or may not include his expected trip time. He may reduce his delay at the entrance ramp used by following the directions displayed by the ramp information sign, but this may be negated by the increased travel time on the alternate route.

TTI in 1968 assumed that diversion to the surface street would increase corridor travel time since operating speeds were lower than on the Freeway and would be adversely affected by increased surface street volume (18). Again, this is difficult to measure since the expected response to a red display by the signs would be a surge of diverted vehicles which would impose greater than normal demand at intersections along the alternate route. Thus, demand fluctuations would be quite variable depending on the sign message states. The only reasonably sure conclusion that can be made on diversion is that potential freeway users who are diverted will spend a greater proportion of their trips on surface streets with a consequent increase in travel time unless this is compensated for by reduced ramp queue delay.

The effectiveness of the TTI ramp information signs was measured by calculations of corridor total travel time changes based on three components (18):

1. Travel time decrease resulting from transfer of travel from the surface streets to the Freeway.

2. Travel time decrease resulting from earlier satisfaction of the travel demand.

3. Travel time increase due to the lowering of speeds on the surface streets resulting from the addition of diverted vehicles.

There was an increase in ramp demand during the study period following the installation of the TTI signs which was attributed to the signs encouraging increased use of the Freeway. That is, it was concluded that some vehicles previously diverted away from the Freeway as a result of ramp congestion were encouraged to enter the Freeway farther downstream because of the signs, rather than not enter the Freeway at all. However, this is speculative and may only indicate a change in demand in the "after" period. Conversely, a reduction in ramp use also could be explained logically as the discouragement of short trips resulting from all-red displays. Of the total travel time saving of 163 vehicle-hours per day attributable to the signs, this diversion back to the Freeway accounted for 11 vehicle-hours since freeway speeds were assumed to be greater than on the surface street and changes in trip length were neglected.

TTI also investigated the cumulative ramp volume increase by half hour intervals as depicted in Figure 7, an adaptation of Figure D-13 in their final report on the Lodge Project (18). The ramp volume increases noted during the early and late portions of the peak period, 2:30 to 4:00 p.m. and after 5:30 p.m., respectively, were attributed to diversion to downstream ramps when the information signs indicated uncongested ramps downstream. The decrease relative to the "before" period between 5:00 and 5:30 p.m. was attributed to more drivers being diverted by the all-red displays prevalent during this most congested period than were previously diverted following driver inspection of ramp congestion.

Despite this assumption of first, a shift in traffic flow onto the Freeway, and later away from the Freeway, TTI concluded that "the demand was satisfied earlier" with resultant travel time savings as indicated by the shaded area in Figure 7. The placement of the lower boundary of the shaded area in that figure represented an arbitrary, if conservative, estimate of the savings. Actually, the demand was not satisfied earlier, but rather shifted to the surface

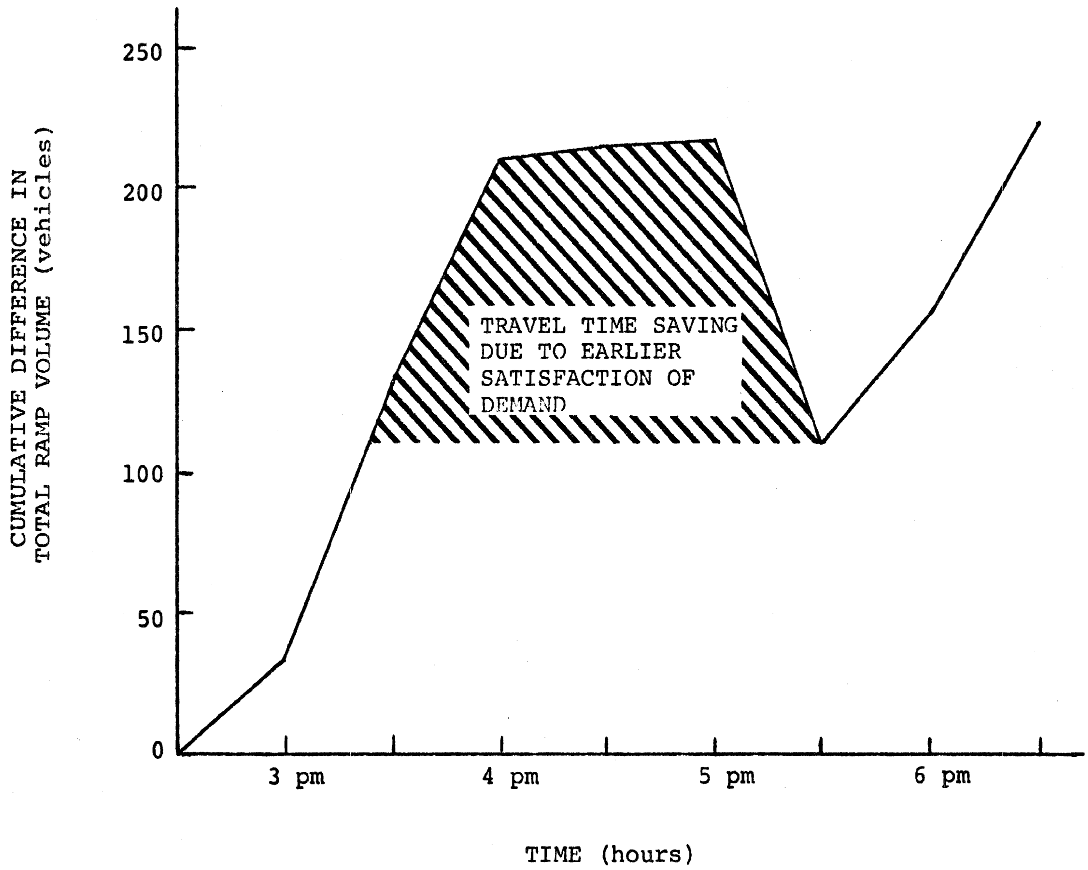


FIGURE 7

TTI METHOD OF ESTIMATING TRAVEL TIME
SAVINGS FROM CUMULATIVE RAMP VOLUME INCREASE

streets and thus was no longer a factor in ramp calculations. The shaded area, 1637 vehicle-hours per day, greatly exaggerates the savings by using cumulative volume differences rather than the actual numbers of vehicles involved in the diversion. Those drivers who diverted, but would not have done so before the introduction of the signs, decreased their travel times by avoiding congested ramps at the expense of a presumably longer trip duration via the surface streets. The net change in travel time for this group represents the true value for the second component of the TTI evaluation method.

The third component was the increased travel times for non-freeway, surface street users as a result of the diversion of traffic caused by the information signs from 4:00 to 5:30 p.m. Changed travel times were directly measured by floating car studies to produce an increase of 12 vehicle-hours per day. Thus, the net decrease for freeway corridor total travel time for the three components was 163 vehicle-hours per day.

With the exception of the second component, the TTI approach does consider the factors that contribute to corridor travel time changes. These factors, however, are difficult to estimate and extremely vulnerable to changes in traffic demand. Thus it was anticipated that the 1969 study techniques, with the emphasis on individual driver response, would more accurately determine the net effect of ramp information signs. The only macroscopic evaluation contained in this study is an investigation of daily ramp volumes over a two-year period and during various, different surveillance schemes to determine the impact of the additions of ramp metering and information signs in the short run and over periods of up to six months after the changes were made. Thus, the study conducted by TTI immediately after the installation of the signs would be expected to demonstrate some initial impact on corridor operations as drivers experiment with sign usage. These changes, however, would be temporary if drivers do not perceive any advantage to following the directions on the signs. The repetition of volume surveys several months after the installation of the signs served to indicate those more permanent changes in traffic patterns that represented what freeway users found to be their optimal travel paths to the Freeway.

CHAPTER TWO

FINDINGS

VISIBILITY AND LEGIBILITY DISTANCES FOR THE RAMP CONDITION INFORMATION SIGNS

As described in Chapter One, ten subject drivers were directed to drive along a route which passed the three ramp condition information signs on the alternate route between Seward Avenue and Webb Avenue. The distances at which they first perceived each sign and then were able to read the sign messages were recorded by an observer in the vehicle. The tests were conducted for both the TTI signs and the new signs designed by The University of Michigan (UM).

As can be seen in Figure 8, the average visibility distance for the new signs is 920 feet, an increase of 200 feet over the TTI signs. Similarly, the average legibility distance for all of the UM signs tested is 305 feet compared to 195 feet for the TTI signs. A two-way analysis of variance was carried out for both the visibility and the legibility measures. In both cases, the results showed the statistical significance of these differences between the two sign designs. It also confirmed that the small interaction between sign design and location was not significant. When the location of the sign affected the distances at which the sign could be seen or read, this effect was similar for both types of signs.

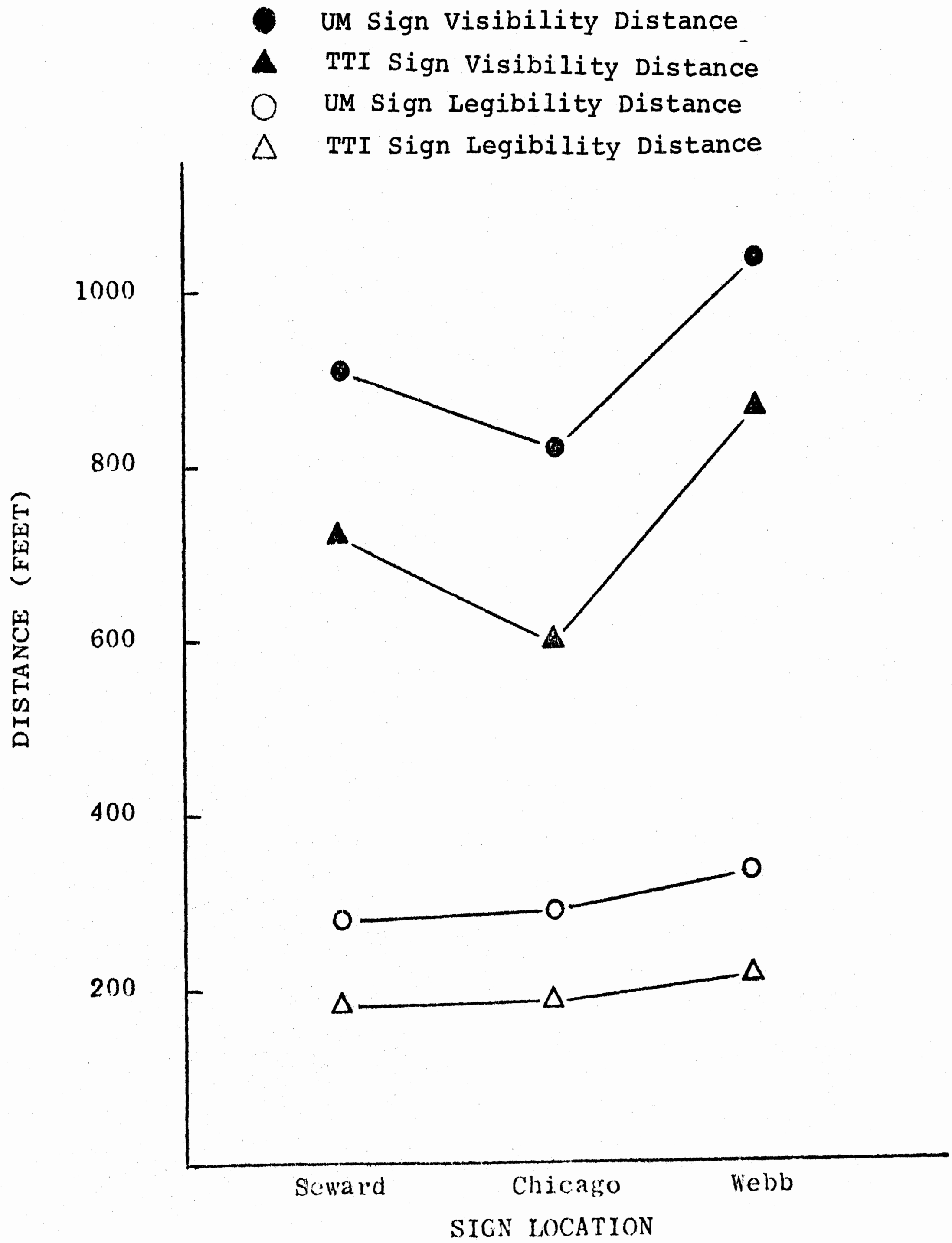


FIGURE 8

TTI AND UM RAMP CONDITION INFORMATION
SIGN VISIBILITY AND LEGIBILITY DISTANCES

Examination of Figure 8 shows that in terms of visibility for both TTI and UM signs, the sign for the Webb ramp is the most favorably positioned, with the Seward and Chicago signs positioned less favorably. The sign at the Chicago ramp, due to the presence of curved fences on the frontage road, is so positioned that it comes into view at a distance much closer to the point where it becomes legible than do the other two signs. Therefore, the driver has a shorter but still adequate amount of time to react to the sign.

Although the Chicago sign is slightly less favorably positioned than is the Seward sign, its legibility distance is in both instances greater. In fact, as shown in Figure 8, legibility distances increased with each succeeding sign the subject driver saw. This may indicate a slight learning effect such that the more familiar the driver is with the signs, the sooner he is able to read them. Figure 9 illustrates the average legibility distance reported by each individual subject. The increases for the UM signs may also be biased by the subjects being more familiar with the test and the types of signs in the "after" study. The studies do indicate, however, consistent improvements and demonstrate that the UM signs can be interpreted by drivers in sufficient time for the routing decision to be made. The results for test subjects can be expected to be comparable to the daily user of the Freeway and alternate route.

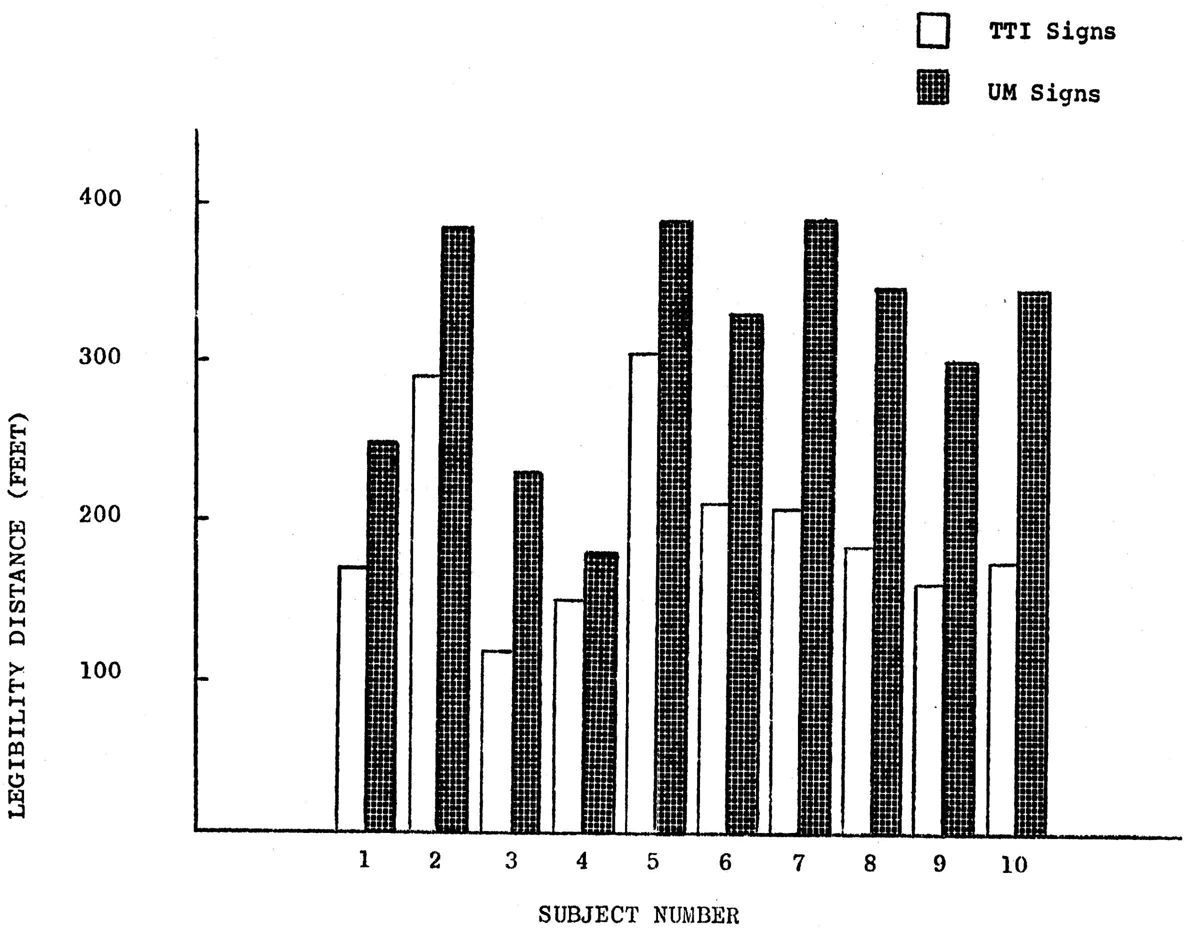


FIGURE 9

LEGIBILITY DISTANCES FOR TTI AND UM
RAMP INFORMATION SIGNS

ABILITY OF THE RAMP CONDITION INFORMATION SIGNS TO COMMAND DRIVER ATTENTION

Evaluation of the public relations campaign by means of the question "Have you previously received any information about these signs?" (Appendix B) disclosed that less than half of the ramp users recalled receiving information on the signs. Thus, it was important that the signs be able to command driver attention amid the many distractions of the urban traffic environment. It was believed that the large size of the signs and the illuminated messages with either the word "ENTER" or the alternate route arrow at the top of each sign flashing continuously would receive the attention of virtually every potential ramp user along the alternate route. However, results from the questionnaire evaluation and the test subject comprehension study indicated that the signs were less effective than had been anticipated.

Test subjects who had been told what to look for in the sign visibility and legibility studies experienced little difficulty in seeing the ramp condition information signs. However, in the similarly conducted comprehension studies involving 21 test subjects who were not told specifically what to expect along the route, detection was less satisfactory. The 12 test subjects observing the TTI signs noticed them 72% of the time. This was increased to 80% for nine different test subjects with the UM signs. Although not statistically significant, this result corroborates the previous studies which found the new signs to be visible at greater distances than were the TTI signs. Results for the individual signs studied are presented in Table 3.

TABLE 3

SIGHTING OF SIGNS

ENTRANCE RAMP	TTI SIGN (12 subjects)	UM SIGN (9 subjects)
West Grand Boulevard	----	89%
Seward Avenue	83%	89%
Chicago Boulevard	58%	67%
Webb Avenue	75%	78%
Average	72%	80%

Detection is slightly better for each of the UM signs. The results for the Chicago and Webb signs evidently reflect the greater likelihood of a sign being overlooked on an arterial than on the frontage road adjacent to the ramp of interest, the location of the Seward and West Grand Boulevard signs. In particular, the Chicago sign is located at the point where the frontage road sweeps away from the Freeway and becomes

Hamilton Avenue. The two previous signs passed by the test subject are located adjacent to the ramps in question, while the Chicago sign is the first of the series placed in advance of the nearest intersection to the ramp. The potential for disorientation on the part of the test subject may explain the greater difficulty in seeing this sign. Finally, the Webb Avenue sign must compete with the typical visual distractions found on urban arterials.

Since the research effort was primarily directed to the regular user of the Lodge Freeway, it was desirable to have information on the proportion of frequent users in the corridor and with this information to see if frequency of freeway use did or did not increase the probability of seeing the signs. Likewise, information on driver origins would show the proportion of drivers that would probably not even pass a ramp condition information sign on their trip to the Freeway. More accurate information on the visual impact of the sign was obtained by taking these factors into consideration.

Results from the questionnaire study showed that about 66% of the ramp traffic consisted of daily users. The proportion of daily users by individual entrance ramp is given in Table 4. The higher fractions are observed near intersections with major arterials and the lower percentages with local service and collector street linkage.

TABLE 4

SIGHTING OF RAMP CONDITION INFORMATION SIGNS TO COMMAND ATTENTION

ENTRANCE RAMP	PERCENT USING FREEWAY DAILY	PERCENT PASSING SIGN	PERCENT HAVING SEEN A SIGN BEFORE
West Grand Boulevard	70%	100%	80%
Seward Avenue	63%	100%	82%
Chicago Boulevard	48%	29%	81%
Webb Avenue	57%	8%	79%
Davison Expressway	72%	8%	49%
Linwood Avenue	64%	11%	61%
Livernois Avenue	73%	63%	56%
Wyoming Road	70%	100%	70%
Average	66%	64.9%	69.4%

Work trips are more prevalent on the ramps linking the Freeway and major street system. The West Grand Boulevard and Seward Avenue ramps serve the New Center office complex and the Davison Expressway ramp receives traffic from adjacent industrial facilities. In the northern end of the corridor, Livernois Avenue and Wyoming Road are major north-south arterials serving the large automobile factories of western Detroit and Dearborn. In fact, more than 25% of the ramp traffic at Wyoming Road is generated from this area several miles to the south.

In order for the information signs to be of value, drivers must pass by them on their way to the entrance ramps. At the three entrance ramps extending directly from frontage roads, West Grand Boulevard, Seward and Wyoming, the signs were near the heads of the ramps and thus visible to all ramp users. For the remaining ramps, however, the signs were placed in advance of only one approach to the intersection. It was realized that many ramp users would not pass by any sign, particularly in the northern half of the corridor, but a later traffic survey found the proportions to be as low as 6.3%. The percentages for each ramp are presented in Table 4. They were lower than anticipated, with the unfortunate consequence of rendering the five northernmost signs incapable of diverting a significant amount of ramp traffic, even with complete obedience.

It was anticipated that the signs would generate some additional demand along the alternate route. It was also realized that the vast majority of drivers whose trips originated southwest of the Freeway could not be diverted to the alternate route. These factors, however, did not negate the results to be obtained from evaluation of the feasibility of alternate route information systems since the possible diversion was still large. Further efforts were made by The University of Michigan in 1969 to provide information on other arterials in the Lodge Corridor by means of dynamic trailblazer signs which indicated the preferred route to the Freeway at choice points (54).

In the questionnaire the respondent was asked if he had ever seen a ramp condition information sign before. Of those drivers who answered this question about 70% had seen one similar to the example depicted on the questionnaire. The proportions by entrance ramp given in Table 4 range from 49% to 82%. To a certain extent these proportions reflect the proportion of ramp users who pass a sign, but it is evident that a majority of ramp users at any ramp operate enough in the corridor to have passed these signs sometime in the one month of sign operation prior to the distribution of the questionnaire. It is surprising that only 70% to 80% of the users at the three entrance ramps where all must pass a sign recalled seeing one. Considering the size of the signs compared with guide signs regularly found on surface streets, the presence of internal illumination and flashing, it would be expected that virtually every driver at the West Grand Boulevard, Seward Avenue and Wyoming Road ramps would have recalled noticing the signs.

The proportions sighting a sign previously at the other five ramps were of only slightly less magnitude despite the small number of ramp users who regularly pass the signs. The implication that passing the signs more frequently does not greatly increase the likelihood of noticing them was further explored by relating the frequency of ramp usage with sign sighting.

Respondents were placed in three categories according to their regularity of use: never or seldom, once or twice a week, or practically daily. Data for all of the entrance ramps in Table 5 show that the proportion having seen a sign is not statistically, significantly different at the five percent level although there is a small tendency toward increased sighting with greater frequency of ramp usage. Table 6 presents data for the West Grand Boulevard entrance ramp where all drivers passed a sign. There was a highly significant increase in sign sighting with increase use to a level of 89% by daily ramp users. Signs had been seen by only 52% of those who infrequently use this ramp, perhaps indicating that the West Grand Boulevard sign was overlooked by drivers distracted by the congestion frequently present adjacent to the ramp. For comparison purposes, data for the entrance ramp with the smallest proportion of ramp users passing the sign, Livernois Avenue, were compiled in Table 7. It was concluded that sign sighting was independent of frequency of use and that the results are easily consistent with this belief at the five percent level.

Since the signs are rather large and prominent, the above results have implications for the development of optimal means for communicating routing or other information to drivers. It would appear that after a month of operation the signs had been noticed at least once by 89% of the frequent ramp users passing the signs. Further discussion on the relative advantages of dynamic signs and other means for communicating with drivers is presented in Chapter Three.

TABLE 5

RELATIONSHIP BETWEEN SIGHTING SIGN AND RAMP USAGE FOR ALL ENTRANCE RAMPS

FREQUENCY OF USE	SEEN THE INFORMATION SIGN			PERCENT
	YES	NO	TOTAL	YES
NEVER OR SELDOM	290	155	445	65%
ONCE OR TWICE A WEEK	256	112	368	69%
DAILY	1127	471	1598	71%
OVERALL	1673	738	2411	

$X^2 = 4.70 \quad X^2_{.05} = 5.99$

TABLE 6

RELATIONSHIP BETWEEN SIGHTING SIGN AND WEST GRAND BOULEVARD RAMP USAGE

FREQUENCY OF USE	SEEN THE INFORMATION SIGN			PERCENT
	YES	NO	TOTAL	YES
NEVER OR SELDOM	51	47	98	52%
ONCE OR TWICE A WEEK	77	28	105	73%
DAILY	407	55	462	89%
OVERALL	535	130	665	

$X^2 = 70.82 \quad X^2_{.05} = 5.99$

TABLE 7

RELATIONSHIP BETWEEN SIGHTING SIGN AND LIVERNOIS AVENUE RAMP USAGE

FREQUENCY OF USE	SEEN THE INFORMATION SIGN			PERCENT
	YES	NO	TOTAL	YES
NEVER OR SELDOM	16	9	25	64%
ONCE OR TWICE A WEEK	13	9	22	59%
DAILY	69	59	128	54%
OVERALL	98	77	175	

$X^2 = 0.97 \quad X^2_{.05} = 5.99$

COMPREHENSION OF THE RAMP CONDITION INFORMATION SIGNS

Driver comprehension of the ramp information signs was evaluated both by the response of test subjects driving along the alternate route seeking to enter the Freeway and by means of questions concerning the meaning of the display on a typical sign pictured in the questionnaire handed ramp users. It was assumed that if the test subjects took the action suggested by the sign message when passing each sign they were comprehending it. They had received no prior information regarding these signs.

Twelve test subjects were directed past the three TTI signs used in the comprehension study for a total of 36 opportunities or decision-points. Nine test subjects were directed past four of the UM signs to again yield 36 decision-points. As presented in Table 3, the TTI signs were seen 72% of the time and the new UM signs 80% of the time. For those subjects who saw the signs, the correct responses noted for each are presented in Table 8.

TABLE 8

COMPREHENSION OF SIGN MESSAGE BY TEST SUBJECTS

ENTRANCE RAMP	CORRECT RESPONSE PERCENTAGE	
	TTI SIGNS	UM SIGNS
West Grand Boulevard	---	13%
Seward Avenue	20%	50%
Chicago Boulevard	71%	100%
Webb Avenue	56%	86%
OVERALL	46%	59%

Statistically significant improvements in correct responses to sign messages were noted for each of the three new signs in comparison with the TTI signs. An interesting result of this study is the extremely low percentages of correct response to the first sign passed in both the TTI and UM sign evaluations. Inspection of the instructions given to the test subjects in Appendix C shows that they were told to enter the Freeway at the first opportunity while following all "traffic and information signals." They were not specifically informed of the ramp information signs, but over 80% of the visibility test subjects did see the TTI sign at Seward and the UM sign at West Grand Boulevard. For both locations, of course, the entrance ramp is visible immediately beyond the signs and undoubtedly the test subjects observed other vehicles entering both of these busy ramps. The information signs displayed red for ramp congestion throughout the test situation, but in the TTI comprehension study 80% of those seeing the sign entered the Seward ramp and in the UM comprehension study 87% entered the West Grand Boulevard ramp when it was the first one encountered.

It is apparent that in the test situation the signs lacked sufficient "punch" to overcome the subject's goal of getting on the Freeway. As explained in Chapter One, those drivers incorrectly entering the Freeway were directed back to a point one block south of the next sign and the experiment resumed. Those responding correctly passed all the signs because the correct response was to enter at the furthest downstream entrance ramp (Webb Avenue). The dramatic improvement in comprehension at the downstream signs may partly be a result of the test subjects becoming aware that the ramp information signs were the factor being evaluated in the study since no matter what response they made they were directed to pass every entrance ramp along the route.

Results of the experiment support the expectation that the new sign design, with its improved visibility and legibility, did promote increased comprehension of the message displayed. With the new signs being both visible and legible sooner, the driver had more time to assimilate and interpret the information.

Ramp users were tested for sign comprehension in the questionnaire by their answers to two questions concerning the message displayed on the example sign (Webb Avenue) depicted in the questionnaire and shown in Plate 1. The two questions were:

7. According to the example:
   Is the Webb Ramp congested?
   Is the Davison Ramp congested?
   Is the Linwood Ramp congested?

8. At which ramp are you advised to enter the Freeway?

Those respondents answering both questions correctly were considered to have comprehended the signs while those with one or more errors did not. Both questions were answered correctly by 68% of the respondents. This level of comprehension was about the same for drivers at every entrance ramp.

As shown in Table 9, the frequency of ramp use was found not to be a factor in sign comprehension. However, Table 10 shows that respondents who had previously seen the signs had a significantly higher level of comprehension, 73%, than the 56% who never had seen a sign except the picture on the questionnaire. Those respondents having previously received information about the signs from explanatory leaflets, newspaper articles and television or radio, also had a significantly greater level of comprehension than those who had not (Table 11).

In summary, the ramp information signs installed by The University of Michigan were understood by 68% of the ramp users. The improvement in the proportion of correct responses to the signs by test subjects at successive signs suggests that a learning effect is present as drivers become more familiar with the signs, although this could not be verified with the questionnaire data on frequency of ramp usage. The signs do appear to be more easily understood by those who have seen them in the field. The fact that drivers previously receiving information about the signs also understood them better demonstrates the possible usefulness and importance of the public relations campaign surrounding their installation.

TABLE 9

RELATIONSHIP BETWEEN SIGN COMPREHENSION AND FREQUENCY OF ALL RAMP USAGE

FREQUENCY OF USE	SIGN COMPREHENSION YES	NO	TOTAL	PERCENT YES
NEVER OR SELDOM	312	133	445	72%
ONCE OR TWICE A WEEK	253	115	368	69%
DAILY	1086	512	1598	68%
OVERALL	1651	760	2411	69%

$X^2 = 0.76 \quad X^2_{.05} = 5.99$

TABLE 10

RELATIONSHIP BETWEEN SIGN COMPREHENSION AND PREVIOUS SIGHTING OF SIGNS

SIGHTING OF SIGNS	SIGN COMPREHENSION YES	NO	TOTAL	PERCENT YES
SEEN THE SIGNS PREVIOUSLY	1217	459	1676	73%
NEVER SEEN A SIGN BEFORE	437	306	743	59%
OVERALL	1654	765	2419	68%

$X^2 = 44.69 \quad X^2_{.05} = 3.84$

TABLE 11

RELATIONSHIP BETWEEN SIGN COMPREHENSION AND PREVIOUS RECEIPT OF INFORMATION ON SIGNS

PREVIOUSLY RECEIVED INFORMATION	SIGN COMPREHENSION YES	NO	TOTAL	PERCENT YES
YES	842	316	1158	73%
NO	812	449	1261	64%
OVERALL	1654	765	2419	68%

$X^2 = 18.94 \quad X^2_{.05} = 3.84$

DRIVER RESPONSE TO SIGN MESSAGE

As detailed in Chapter One, the ramp condition information signs installed by The University of Michigan in 1969 display the presence or lack of ramp congestion at three succeeding entrance ramps along the alternate route being followed by the driver. The word "ENTER" flashes beside the name of the nearest of the next three ramps that is uncongested, or if all ramps are congested, all ramp names appear in red, the alternate route in green and the arrow at the top of the sign signaling to continue on the alternate route flashes in green. Thus the signs, although informational rather than regulatory in function, do suggest explicitly the response to be taken by the driver.

Driver response to these messages was determined by recording whether or not those drivers passing the signs entered the nearest ramp and comparing this action with the sign display state. This was accomplished by matching the license plate numbers of vehicles passing the signs and those at the respective entrance ramps. Comparisons were also made between this information and the levels of usage claimed by respondents to the questionnaire. The responses of test subjects were not considered since they were not required to base their routing decision on anything other than simply entering the Freeway at the first entrance ramp suggested by the signs.

At West Grand Boulevard and Seward Avenue, where all ramp users passed the information signs, testing of driver response was accomplished by comparing volumes entering and not entering the ramps for different sign displays.

The results at the West Grand Boulevard ramp are presented in Table 12. A significant difference in response was observed for the TTI sign for which over 67% entered there as suggested and 47% did not enter when the ramp was described as congested. This result was not found for the UM sign. The possible reasons for this difference were not apparent.

Based on the above data, the TTI sign at West Grand Boulevard was capable of reducing ramp demand some 30%. For control purposes the UM sign was found to be ineffective in diverting sufficient vehicles to either reduce ramp congestion or generate a worthwhile redistribution of ramp traffic in the corridor.

Results for the Seward Avenue entrance ramp are presented in Table 13. Geometrically, the situation at Seward is similar to that at West Grand Boulevard and the TTI sign

TABLE 12

DRIVER RESPONSE TO WEST GRAND BOULEVARD
RAMP CONDITION INFORMATION SIGN

TTI SIGN

SIGN STATE	ENTERED RAMP YES	ENTERED RAMP NO	ENTERED RAMP TOTAL	PERCENT ENTERED
GREEN	825	399	1224	67.4%
RED	1420	1598	3018	47.1%
TOTAL	2245	1997	4242	52.9%

$X^2 = 143.94 \quad X^2_{.05} = 3.84$

UM SIGN

SIGN STATE	ENTERED RAMP YES	ENTERED RAMP NO	ENTERED RAMP TOTAL	PERCENT ENTERED
GREEN	1699	1372	3071	55.3%
RED	889	757	1646	54.0%
TOTAL	2588	2129	4717	54.9%

$X^2 = 0.69 \quad X^2_{.05} = 3.84$

TABLE 13

DRIVER RESPONSE TO SEWARD AVENUE
RAMP CONDITION INFORMATION SIGN

TTI SIGN

SIGN STATE	ENTERED RAMP YES	NO	TOTAL	PERCENT ENTERED
GREEN	2303	1416	3719	61.9%
RED	366	447	813	45.0%
TOTAL	2669	1863	4532	58.9%

$X^2 = 78.08 \quad X^2_{.05} = 3.84$

UM SIGN

SIGN STATE	ENTERED RAMP YES	NO	TOTAL	PERCENT ENTERED
GREEN	108	318	426	25.4%
RED	171	1000	1171	14.6%
TOTAL	279	1318	1597	17.5%

$X^2 = 24.29 \quad X^2_{.05} = 3.84$

produced a quite similar diversion pattern to its counterpart at West Grand Boulevard. The sign was found to be capable of diverting 27% of the ramp demand when the display was changed from green to red. There was a striking decrease in the overall proportion of those passing the sign who also entered the ramp, from 58.9% for the TTI sign to 17.5% for the UM sign. Prevailing daily ramp volumes when the TTI evaluation was made in May 1969 were 1483 vehicles per day. This decreased 34% to an average of 984 vehicles per day when the UM sign was evaluated in July, as compared to an average decrease of 10% for all the entrance ramps in the corridor during this period attributable to summer travel demand pattern changes.

Other than the installation of a different information sign which in itself would hardly be expected to so discourage ramp use, the only other surveillance control changes at Seward were modifications in the metering hardware which reduced the violation rate from over 40% to about 10% (14). This ramp metering change would make Seward less attractive to ramp users seeking to avoid ramp delay and thus could partially account for the decrease in demand.

The UM sign at Seward Avenue was found capable of reducing ramp demand by 43%, which is statistically significantly greater than the diversion attributable to the TTI signs at West Grand Boulevard and Seward Avenue. This level is sufficient to be productive in redistributing ramp demand. For example, assuming demand at West Grand Boulevard to approximate the maximum metering rate of 25 vehicles per minute as was frequently observed during the peak hours, this magnitude of diversion could result in about eight vehicles per minute being sent along the alternate route system past the Seward ramp and beyond. Coupled with the diversion at Seward, these vehicles are capable of greatly altering the short run demand patterns on the Freeway as well as at the downstream ramps. A possible consequence not taken into account in the development of the alternate route network was the diversion of such queues of vehicles to a supposedly uncongested downstream ramp. Upon arrival at that ramp, these vehicles may create congestion causing the drivers frustration in their expectation of prompt entry to the Freeway. This potential defect in the alternate route, the generation of unstable oscillations in an otherwise stable demand distribution, is further discussed in Chapter Three.

Some vehicles will not pass an information sign on their way to an entrance ramp. In fact, as indicated previously, only a small proportion of the ramp users at the five information signs located some distance from the Freeway have occasion to pass the signs. License plates of vehicles passing the signs were matched with those of entrance ramp vehicles to yield the diversion figures given in Table 14 for the remote signs associated with the Chicago Boulevard, Webb Avenue, Davison Expressway, Linwood Avenue and Livernois Avenue entrance ramps.

For every information sign, including the TTI Chicago and Webb signs, there was a statistically significant (.01 level) level of diversion attributable to the sign state based on the number of vehicles passing and entering the ramp and those entering the ramp without passing the sign. In every case, the number entering on green exceeds the number entering on red by a factor of two or more. The implied level of diversion is greater than at West Grand Boulevard and Seward. It appears that drivers are more willing to follow the recommendation of the signs when the ramp is not in sight. At West Grand Boulevard and Seward the signs merely indicate what the driver can see for himself and thus are merely another factor in his decision-making.

With regard to the Webb sign, there was a significant increase in the proportion entering the Webb ramp when it was shown in green. Both this sign and the Livernois sign seldom displayed red during the study, resulting in an inadequate sample of driver response to the red indication. It was not considered desirable, however, to arbitrarily display a red indication and possibly undermine motorist confidence in the reliability of the signs.

TABLE 14

DRIVER RESPONSE TO NON-FRONTAGE ROAD RAMP INFORMATION SIGNS

ENTRANCE RAMP	RAMP CONGESTION DISPLAY	PERCENT PASSING TTI SIGN		PERCENT PASSING UM SIGN	
CHICAGO	GREEN	3.0	(28)	29.3	(113)
	RED	1.5	(14)	19.6	(39)
WEBB	GREEN	0.2	(4)	7.5	(47)
	RED	0.0	(0)	0.0	(0)
DAVISON	GREEN	-------		7.6	(157)
	RED			4.3	(53)
LINWOOD	GREEN	-------		11.1	(96)
	RED			1.8	(4)
LIVERNOIS	GREEN	-------		6.3	(40)
	RED			5.0	(1)

There are considerable differences in the proportions entering the Freeway for the TTI signs and the UM signs. For both Seward signs it has already been shown that the percentage entering on green was reduced from 62% to 25% (Table 13). At Chicago and Webb the percentage passing on green and entering increased from three percent to 27% and from 0.2% to 7.5%, respectively. In numbers of vehicles these increases were substantial.

In order to determine the source of this increased demand the prevailing ramp volumes during the evaluations of the UM signs were compared with the volumes during the studies of the TTI signs, the latter volumes adjusted to compensate for demand changes by making equal the ramp volume totals for all eight entrance ramps along the alternate route. Table 15 gives the ramp volumes for the first four ramps.

TABLE 15

AVERAGE PEAK PERIOD RAMP VOLUMES

ENTRANCE RAMP	TTI SIGNS (ADJUSTED)	UM SIGNS	DIFFERENCE
West Grand Boulevard	3383	3164	- 219
Seward Avenue	1351	984	- 367
Chicago Boulevard	964	1040	+ 76
Webb Avenue	752	821	+ 69

These figures confirm the increased demand at Chicago and Webb found via the license plate studies of Table 14. The demand decreases at West Grand Boulevard and Seward suggest that the increased demand downstream is largely the result of diverted vehicles along the alternate route. This seems a more likely explanation than concluding that the Chicago and Webb UM signs attracted more alternate route users than the TTI signs had, although it is true that the new Webb sign was considerably larger than the TTI Webb sign which, being the last of the sequence, displayed only two ramps rather than the three on the UM sign (Plate 1).

It cannot be concluded that the relative changes in ramp volume were generated simply by the installation of different information signs. The TTI studies were carried out in May and the UM sign studies in July and August. The traffic patterns for the two studies were most likely different due to seasonal variations. It is evident that many factors can contribute to traffic patterns in the corridor, and an attempt is made in the following section to comprehensively review the long-term effects of the various surveillance activities in 1967, 1968 and 1969.

The questionnaire was also used to determine driver response to sign messages. Questionnaire respondents were asked if they used the ramp condition information signs to help them decide where to enter the Freeway. The proportions by ramp varied from 25.3% to 64.2% with an overall 41% of the respondents reporting that they use the signs as indicated in Table 16. The proportions by ramp of those who have seen and claimed to use the signs is also given in Table 14, and it is seen that in every case the latter percentages exceed those for all ramp users. Those motorists who have not seen the signs before would not be expected to use the signs.

The information signs are used least by West Grand Boulevard and Davison Expressway traffic. These two ramps are distinguished from the rest of the ramps by allowing more than one vehicle at a time to be metered through in order to handle the greater ramp demand (14). Drivers anticipating smaller ramp delay through experience would be less inclined to use the information signs. The greater proportions at Chicago Boulevard and Webb Avenue may reflect the diversion from upstream ramps.

The relationship between sign usage and regularity of ramp use was investigated and the results are shown in Table 17. It was found that significantly fewer frequent ramp users use the signs than infrequent users. This would seem to be an adverse reaction to the alternate route and information system by these drivers. Frequent ramp users

TABLE 16

DRIVER USAGE OF RAMP CONDITION INFORMATION SIGNS

ENTRANCE RAMP	PROPORTION OF RAMP USERS CLAIMING TO USE THE SIGNS	
	All Ramp Users	Ramp Users Having Seen the Signs
West Grand Boulevard	42.3%	45%
Seward Avenue	50.2%	56%
Chicago Boulevard	64.2%	73%
Webb Avenue	60.9%	73%
Davison Expressway	25.3%	41%
Linwood Avenue	34.6%	49%
Livernois Avenue	32.0%	49%
Wyoming Road	40.1%	53%

TABLE 17

RELATIONSHIP BETWEEN SIGN USE AND FREQUENCY OF RAMP USE

FREQUENCY OF USE	USE INFORMATION SIGNS			PERCENT YES
	Yes	No	Total	
Never - Seldom	205	240	445	46%
Once or Twice a Week	193	175	368	52%
Daily	591	1007	1598	37%
Overall	989	1422	2411	41%

$$X^2 = 35.29$$

$$X^2_{.05} = 5.99$$

would be expected to be the most familiar with the Lodge Corridor. It would appear that they would be the drivers most inclined to use the signs since their time and convenience savings over many days would be greater than those for infrequent freeway users. It appears that some frequent ramp users have experimented with the alternate route and found no advantage in following the signs, possibly because of delay along the alternate route, failure to find an uncongested entrance ramp as promised by the signs, or other reasons.

The less frequent user is less likely to have been frustrated by the system and more inclined to consider the system theoretically useful. Since 46% of those who seldomly travel the Freeway claim to use the signs, it is suspected that this includes drivers who think they would use them if the occasion ever arose but who in fact might find an alternate route unappealing if they were familiar with the corridor.

Driver willingness to follow the alternate route was tested by asking their response to signs with an all-red display (Question 9 on the questionnaire). The results for those drivers who understood the signs are presented in Table 18. The "correct" response of continuing along the alternate route was given by 44% of the respondents, a

TABLE 18

RESPONDENTS ENTERING AT EACH ON-RAMP AND THEIR ATTITUDE TOWARD AN ALL RED DISPLAY*

ATTITUDE	ON-RAMP** (PERCENT IN PARENTHESES)								TOTAL RESPONSES
	1	2	3	4	5	6	7	8	
Enter at First Ramp	196 (31.2)	55 (24.9)	28 (13.5)	12 (7.8)	49 (9.6)	15 (8.3)	13 (7.9)	13 (6.0)	381 (16.7)
Guess Least Congested Ramp	20 (3.2)	23 (10.4)	22 (10.6)	18 (11.8)	27 (5.3)	6 (3.3)	12 (7.3)	11 (5.1)	139 (6.1)
Continue on Trail of Signs	241 (38.3)	73 (33.0)	92 (44.4)	76 (49.7)	252 (49.4)	80 (44.4)	71 (43.0)	119 (54.8)	1004 (44.0)
Abandon Freeway	151 (24.0)	61 (27.6)	62 (30.0)	42 (27.4)	138 (27.1)	60 (33.3)	54 (32.7)	58 (26.7)	626 (27.4)
Did Not Answer	21 (3.3)	9 (4.1)	3 (1.4)	5 (3.3)	44 (8.6)	19 (10.6)	15 (9.1)	16 (7.4)	132 (5.8)
TOTAL	629	221	207	153	510	180	165	217	2282

*An all red display indicates that all ramps shown on the sign are congested. Only those respondents who correctly answered Question 7 and Question 8 which tested comprehension of the signs were used in this analysis.

** 1. West Grand Boulevard
2. Seward Avenue
3. Chicago Boulevard
4. Webb Avenue
5. Davison Expressway
6. Linwood Avenue
7. Livernois Avenue
8. Wyoming Road

figure that supports the proportion who claim to use the signs. The response varies by entrance ramp from 33.0% of those entering at Seward to 54.8% of the drivers using the Wyoming Road ramp. The result at Wyoming Road is intriguing since these ramp users are confronted with a sign which displays only the adjacent ramp and very infrequently in red. This may indicate the response of diverted motorists at Wyoming who followed the alternate route to that ramp.

Overall, 22.8% of the respondents would either enter at the first ramp or guess the least congested one and enter there. At West Grand Boulevard and Seward Avenue the proportions choosing to enter at the first ramp, 31.2% and 24.9%, respectively, are considerably greater than at the other ramps. Since the signs are adjacent to the ramps, this result is to be expected as these drivers are able to judge ramp congestion for themselves and determine if they can save time by taking the alternate route. The same situation exists at Wyoming Road, and despite there being no metering only a few users say they would enter when red was displayed.

Quite consistent results by entrance ramp were obtained for respondents declaring that they would not enter the Freeway at all when confronted by an all-red display. Overall, 27.4% of the respondents, the second most frequent response to an all-red display, said they would abandon the

Freeway. These respondents would include drivers with relatively short trips on the Freeway where ramp congestion negates the potential time saving. Some drivers may interpret the display to reflect congested freeway conditions (in most cases correctly), thus supporting the contention that drivers desire and will respond to information on freeway flow conditions.

To further explore driver response to a sign display, traffic routing patterns as related to the variety of sign states were studied at each entrance ramp. Unfortunately, at all the ramps except West Grand Boulevard and Seward Avenue there was insufficient data for all but a few of the sign states. This was a consequence of the decision not to arbitrarily vary the states in order to increase the sample size but also reduce their long-term credibility to drivers.

There are eight possible sign states for both the West Grand Boulevard and Seward Avenue entrance ramps. The volumes entering the ramps as a percentage of the total number passing the signs is presented in Table 19. While there are inconsistencies, it appears that motorists are more reluctant to enter when any ramp, not necessarily the adjacent ramp, is red. The proportion entering also tends to decrease as the number of red ramps per sign state increases.

TABLE 19

ENTERING VOLUME AT WEST GRAND BOULEVARD AND SEWARD BY SIGN STATE

	"THIS RAMP" GREEN			
	West Grand Boulevard		Seward Avenue	
SIGN STATE*	Percent Entering	Total Volume	Percent	Volume
GGG	55.2%	1682	26.4%	205
GRG	49.6%	343	31.9%	91
GGR	61.1%	714	-----	----
GRR	49.7%	332	19.3%	130
TOTAL	55.3%	3071	25.4%	426

	"THIS RAMP" RED			
	West Grand Boulevard		Seward Avenue	
SIGN STATE*	Percent Entering	Total Volume	Percent	Volume
RGG	63.1%	222	23.2%	155
RRG	57.1%	140	14.9%	396
RGR	56.5%	568	-----	----
RRR	48.6%	716	12.3%	620
TOTAL	54.0%	1646	14.6%	1171

* Sign State refers to the color for each of the three ramps displayed on the sign, either green (G) or red (R), in order; West Grand Boulevard, Seward Avenue, and Chicago Boulevard.

These results do not explain the behavior at West Grand Boulevard, but they confirm the driver attitude of avoiding the Freeway when confronted by a red display.

ALTERNATE ROUTE AND RAMP USAGE PATTERNS AND ORIGIN-DESTINATION CHARACTERISTICS

As indicated in Figure 1, the Lodge Freeway follows an alignment that does not parallel any single major arterial. The net result of this is that the Freeway presents a highly attractive means for travel between the major center city traffic generators (including the Central Business District, Wayne State University and the New Center area) and northwestern Detroit and Oakland County. Suburban growth in populous Oakland County can in part be attributed to the existence of the Lodge Freeway, so it is anticipated that such long distance travel patterns were well established by the time of this study. This demand theoretically constitutes much of the population of vehicles divertable to the alternate route.

Travel patterns were studied by means of the origin-destination data compiled from the 1969 questionnaire. At the time of the study, July, the UM ramp information signs had been in operation for one month. Preceding the installation of the UM signs, the four ramp information signs installed by TTI along the alternate route between West Grand Boulevard and Davison had been operating since September 1968.

Thus, the alternate route as far as the Davison Expressway had been in existence for more than ten months prior to the questionnaire distribution. As some motorists did divert from the Freeway to surface streets even prior to the advent of freeway surveillance in 1965, the TTI signs served to reinforce the previously existing diversion patterns (45). Along the alternate route north of Davison a relatively small proportion of ramp users were found to actually pass the signs, and since the signs had been in place a month, it is doubtful that origin-destination patterns had been significantly affected by the signs. Furthermore, it is impossible to separate the effects of ramp metering in the corridor from the information signs as the previous O-D study by TTI predated ramp metering. Comparison of the two studies would be expected to demonstrate a tendency for fewer short trips on the Freeway, but any tendency for the signs to encourage more of these trips by showing an uncongested ramp to the Freeway farther upstream would be obscured. Hence, conclusions from the 1969 origin-destination data, coupled with comparisons of previous data sets from 1965 and 1967, apply to the combination of ramp metering control and the ramp information signs.

The number of responses for each of the 45 zones of origin (Figure 5) by entrance ramp is given in Table 20. The

TABLE 20

NUMBER OF RESPONSES FOR EACH ORIGIN ZONE BY ENTRANCE RAMP

ORIGIN ZONE	WEST GRAND BOULEVARD	SEWARD	CHICAGO	WEBB	DAVISON	LINWOOD	LIVERNOIS	WYOMING	TOTAL
1	1	1	0	0	0	4	5	66	77
2	0	0	0	1	0	0	19	0	20
3	0	0	0	0	0	0	0	0	0
4	0	0	1	1	0	1	1	0	4
5	6	2	4	3	7	2	2	2	28
6	3	0	1	1	0	0	0	0	5
7	0	0	1	0	0	0	0	0	1
8	2	0	0	2	16	1	1	0	22
9	0	1	1	0	0	0	0	0	2
10	2	0	0	0	1	1	0	0	4
11	0	0	0	1	1	3	0	1	6
12	1	0	0	0	0	0	3	0	4
13	1	0	0	0	0	0	21	1	23
14	0	0	0	0	0	0	13	0	13
15	1	0	1	0	0	1	1	0	4
16	3	0	1	2	1	2	1	1	11
17	17	5	9	2	3	2	1	0	39
18	2	0	1	1	4	0	0	0	8
19	7	1	0	1	10	0	0	0	19
20	16	15	2	3	6	2	0	0	44
21	158	13	12	6	4	2	0	1	196
22	348	92	59	50	21	9	3	1	583
23	1	0	1	0	0	0	20	3	25
24	2	1	3	0	0	1	2	0	9
25	3	55	20	10	5	3	0	0	96
26	39	30	14	10	10	1	0	0	104
27	0	0	2	2	18	1	0	0	23
28	0	1	12	2	5	0	0	0	20
29	1	2	37	7	1	0	0	0	48
30	0	0	8	1	0	5	4	1	19
31	0	0	2	0	5	0	27	46	80
32	0	0	0	0	0	2	4	1	7
33	0	0	2	39	2	2	0	0	45
34	0	0	7	5	8	0	0	0	20
35	0	0	0	0	12	1	0	0	13
36	0	0	0	3	201	7	1	0	212
37	0	0	0	2	33	5	1	0	41
38	0	0	0	0	1	16	13	0	30
39	0	0	0	0	1	0	1	81	83
40	0	0	0	0	0	3	20	5	28
41	0	0	2	0	4	93	1	0	100
42	0	0	0	0	27	0	0	0	27
43	0	0	0	1	26	10	2	1	40
44	0	0	0	1	26	1	0	1	29
45	0	0	0	0	32	1	0	1	34
TOTAL	614	219	203	157	491	182	161	213	2246

three leading traffic generation zones encompass the major traffic generators in the corridor. The New Center area, Zone 22, accounted for 26% of the traffic origins and was the largest generator of traffic using the West Grand Boulevard, Seward Avenue, Chicago Boulevard and Webb Avenue entrance ramps. Wayne State University, in Zone 21, is located south of the Edsel Ford Freeway (Figure 1), but West Grand Boulevard is the most convenient downstream ramp for the University. Zone 21 was the second largest traffic generator with nine percent of the traffic origins, and because of reduced summer enrollment this is undoubtedly less than the demand prevailing the remainder of the year. At the time the 1969 questionnaire was distributed Wayne State enrollment was 16,972, some 50% less than the fall and winter term enrollments.[1]

In the Lodge Corridor south of the Davison Expressway a group of contiguous zones, 21, 22, 25 and 26, can be identified which constitute the primary area of generation for the four entrance ramps in this part of the corridor. This

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[1]Enrollment figures obtained from Registrar's Office, Wayne State University.

area is shaded in Figure 10, and includes the New Center area, Wayne State University and institutions along East and West Grand Boulevard including Henry Ford Hospital. Table 21 presents the proportion of entrance ramp traffic with origins in this area.

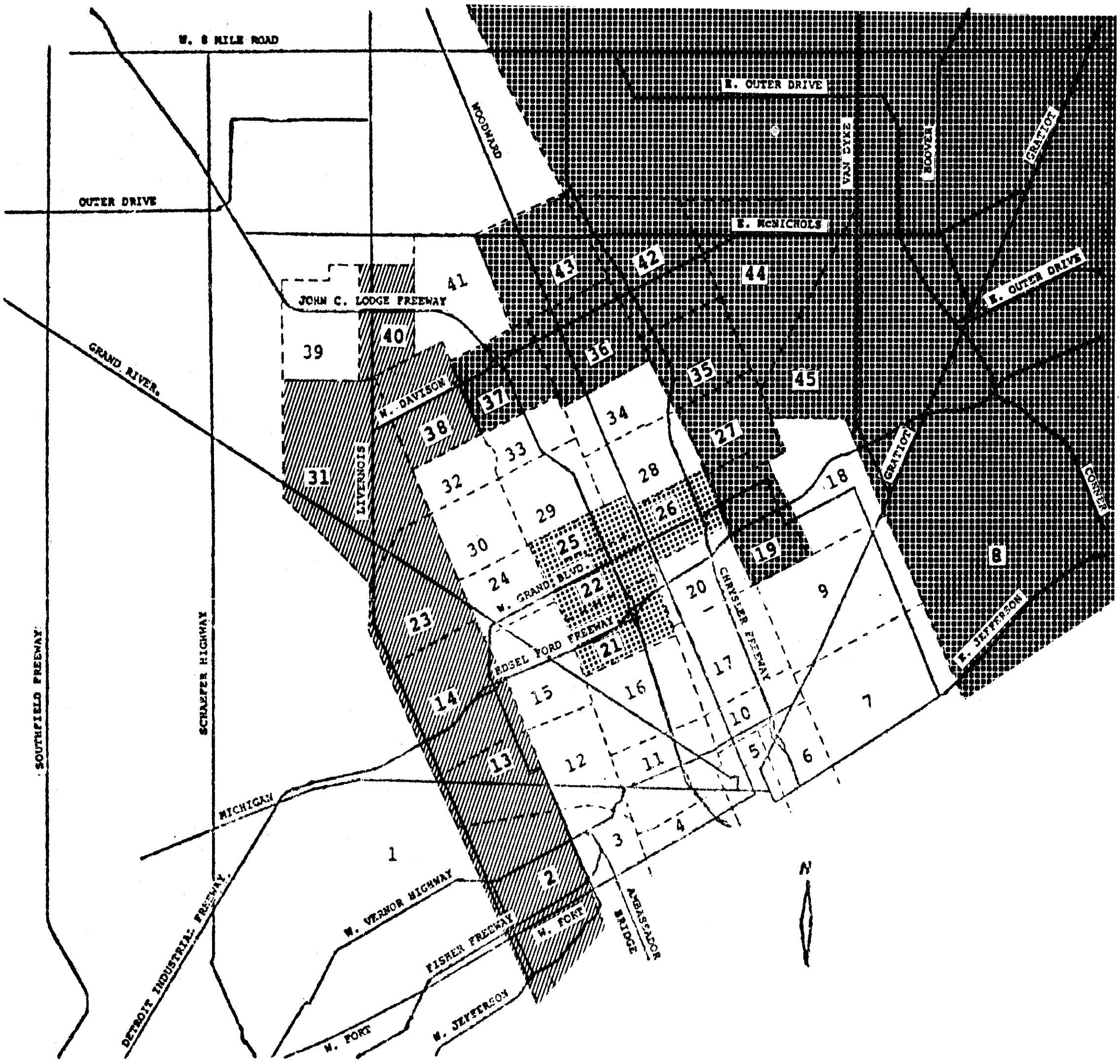
TABLE 21

PROPORTION OF RAMP TRAFFIC
FROM ZONES 21, 22, 25 AND 26

ENTRANCE RAMP	PERCENT OF ORIGINS USING RAMP	PERCENT OF RAMP TRAFFIC
West Grand Boulvard	56%	89%
Seward Avenue	19%	87%
Chicago Boulevard	11%	52%
Webb Avenue	8%	48%
TOTAL	94%	

These four zones contributed nearly 44% of the corridor demand. This is exemplified by the fact that the demand from the area covered by these zones was sizeable enough that eight percent of the drivers constituted 48% of the Webb entrance ramp traffic.

At the Seward, Chicago and Webb entrance ramps the origin zone adjacent to each ramp generated the second largest amount of ramp traffic after Zone 22 (New Center).



-- Traffic Generation Area for the Entrance Ramps South of Davison

-- Traffic Generation Area for Davison Entrance Ramp

-- Traffic Generation Area for Livernois I Entrance Ramp

FIGURE 10

MAJOR TRAFFIC GENERATION AREAS FOR INDIVIDUAL ENTRANCE RAMPS

At Chicago (Zone 29) and Webb (Zone 33) the proportion of ramp users, when combining these adjacent zones into the larger group of zones, was over 70% in both cases. Thus, it is seen that for these four entrance ramps the great majority of ramp users came from zones within the Lodge Corridor and no more than two miles from the Freeway. The alternate route, if a satisfactory level of service relative to the Freeway can be provided, should prove attractive to these ramp users.

Diversion to the Webb entrance ramp is well established, however, only six percent of the origins from Zones 21, 22, 25 and 26 entered at Davison or beyond, with most entering at Davison. Only a handful of these drivers went past Davison. By 5:00 p.m., and frequently by 4:00 p.m., the four ramps upstream of Davison were congested and all-red displays were generally shown until after 6:00 p.m. Thus the signs would have directed motorists at least to Davison and most probably beyond Davison.

At the Davison Expressway entrance ramp and the ramps farther downstream the origin pattern was somewhat different. The single most important zone of origin for Davison was Zone 36, which includes the Chrysler Corporation industrial complex. Zone 36 generated 9.4% of the corridor ramp demand. Of these drivers, 95% entered at Davison. The other important zones of origin for the Davison entrance ramp are more scattered than for the preceding ramps, but all are characterized as industrial zones. Eighty-two percent of the Davison ramp traffic came from the shaded zones in Figure 10. These drivers were making distinctly longer trips by surface streets and probably entered the ramp from the Davison Expressway itself. This explains the small 7.6% of Davison ramp users (Table 4) found to pass the ramp information sign placed on Hamilton Avenue. This had been recognized by the research staff and later in 1969 another information sign displaying the suggested alternate route was placed on the Davison Expressway. This sign was evaluated in another project report (54).

At the Linwood entrance ramp the pattern of origins was also more diffuse, although Zones 38, 41 and 43, which are in close proximity to the ramp, accounted for 65% of the ramp traffic. Forty-nine percent of the ramp demand originated in the zone (Zone 41) surrounding the ramp. These drivers would also appear to be good candidates for diversion along the alternate route because of a relatively short initial surface street trip, but as shown in Table 16 the 49% sign usage by those seeing a sign before (11% of ramp users pass the Linwood sign) was considerably less than at all the upstream ramps except Davison (41% usage).

The origin patterns at Livernois and Wyoming strongly reflect traffic generation along these north-south arterials. At Livernois, only 12% of the ramp demand originated from Zone 40 which surrounds the ramp. A full 80% of the demand was generated along the Livernois Avenue Corridor (shaded in Figure 10) stretching over six miles. Since the Livernois ramp information sign was located along Fenkell rather than Livernois, it was seen by the smallest proportion of ramp users (6.3% as given in Table 4) of any entrance ramp. In order to incorporate Livernois users into the alternate route system a sign directing northbound Livernois traffic to Fenkell would be required. It is, however, possible that these drivers would be less inclined to divert along the alternate route because of the distance they had already traveled on surface streets.

The Wyoming entrance ramp also serves a more diffuse range of origins that is apparently oriented to the Wyoming Road Corridor. Ninety-one percent of the Wyoming ramp users originated in Zones 1, 31 and 39. Zone 1 encompasses virtually the entire Detroit area west of Livernois Avenue and includes several major industrial areas. In particular, a likely generator of Wyoming traffic in this zone is the large River Rouge plant complex of the Ford Motor Company in the southern part of Zone 1. As at West Grand Boulevard and Seward, all Wyoming ramp users passed the ramp information sign. Despite the evident greater initial surface street distances traveled by Wyoming ramp users (a factor which seems to reduce the likelihood of sign obedience), the proportion claiming to use the sign was similar to that at the West Grand Boulevard and Seward entrance ramps (Table 16). It may be inferred then that this initial distance traveled is not a factor in sign usage, however, it should be recalled that the Wyoming sign displays conditions only at that ramp and seldom is congestion indicated or actually present. Therefore, obedience to the sign message rarely meant diversion past the Wyoming ramp.

In another attempt to determine driver willingness to follow an alternate surface street route, in fact their tolerance of surface street travel in general in getting to the Freeway, a "most convenient ramp" for each origin zone was established. The most convenient ramp (MCR) was defined as the nearest ramp downstream of the zone, disregarding such local details as traffic from parking lots entering one-way streets going the wrong way or the street network being so developed that a longer surface street journey is actually more convenient unless the driver backtracks. The number of drivers entering and not entering the MCR for each zone of origin is given in Table 22.

TABLE 22

NUMBER OF RESPONDENTS USING THE MOST CONVENIENT RAMP (MCR) TO THEIR ZONE OF ORIGIN (SOURCE: ENTRY RAMP, Q.1)

ZONE OF ORIGIN*	NUMBER ENTERING AT MCR	NUMBER NOT ENTERING AT MCR	TOTAL RESPONSES
22	348	235	583
23	1	24	25
24	1	8	9
25	55	41	96
26	39	65	104
27	2	21	23
28	12	8	20
29	37	11	48
30	8	11	19
31	5	75	80
32	0	7	7
33	39	6	45
34	5	15	20
35	0	13	13
36	201	11	212
37	33	8	41
38	1	29	30
39	81	2	83
40	20	8	28
41	93	7	100
42	27	0	27
43	10	30	40
44	26	3	29
45	0	34	34
	1044	672	1716
Others			530
Did not answer			173
TOTAL	1044	672	2419

* See Figure 10 for map showing zones of origin

No MCR is given for Zones 1 through 21 which are located upstream of West Grand Boulevard and thus outside of the corridor area. The proportion of all trips originating in these zones was approximately 24%. For 14 zones (22, 25, 26, 28, 29, 30, 33, 36, 37, 39, 40, 41, 42 and 44) the MCR was the most frequently used ramp. For nine zones (23, 24, 27, 31, 32, 34, 35, 38 and 45) the ramp used most often was located downstream of the MCR. This is the expected pattern if drivers are obeying the ramp metering and using the signs. Only for Zone 43 was the most frequently used ramp upstream of the MCR. This, however, was expected as the upstream ramp was Davison which would be preferred because of its less stringent metering strategy.

The most convenient exit ramp (MCR) was also defined as the nearest ramp to the trip destination zone. The most frequently used ramp for a third of the respondents, however, was either upstream or downstream of the MCR (Table 23). Some motorists left earlier or later because of more attractive surface routes to their destinations.

An analysis of origins and destinations, checking the frequency of use of the most convenient ramp for both on-ramp and off-ramp, would show whether or not motorists have gone out of their way to use the Freeway. As shown above, many motorists have entered downstream from their most convenient ramp. There is no evidence, however, that motorists consistently exited downstream or upstream from the most convenient ramp (Table 23). It appears that motorists do not use the Freeway unnecessarily. In fact, many users reduce their freeway trip length by entering downstream from their most convenient ramp.

The destinations by exit ramp were widely scattered as expected for predominantly work-to-home trips. Forty-one percent reported their destination as Zone 50 (Oakland County) and their exit at a ramp beyond Eight Mile Road. All of these drivers had long on-freeway trips, a minimum of three miles, and are less likely to be diverted away from the Freeway because of ramp metering. They should be more amenable to diversion along the alternate route should they find it an effective means of avoiding freeway and ramp congestion on the upstream portion of their freeway trip.

The trip origins were linked with the destination zones. Because of the large number of zones many small values were found in this tabulation. However, as a result of the concentration of trip origins in the New Center area defined by Zones 21, 22, 25 and 26 it was possible to find significant numbers of these drivers with destinations in northwest Detroit and Oakland County (see Figure 11). The Lodge

TABLE 23

NUMBER OF RESPONDENTS USING THE MOST CONVENIENT RAMP (MCR) TO THEIR ZONE OF DESTINATION (SOURCE: Q.3/Q.2)

ZONE OF DESTINATION*	EXITING AT MCR	NOT EXITING AT MCR	TOTAL RESPONSES
20	43	39	82
21	36	27	63
38	25	64	89
39	49	21	70
41	76	29	105
48	44	17	61
50	936	69	1005
51	1	167	168
Others	367	348	715
Did not answer			61
TOTAL	1577	781	2419

* See Figure 6 for map showing zones of destination

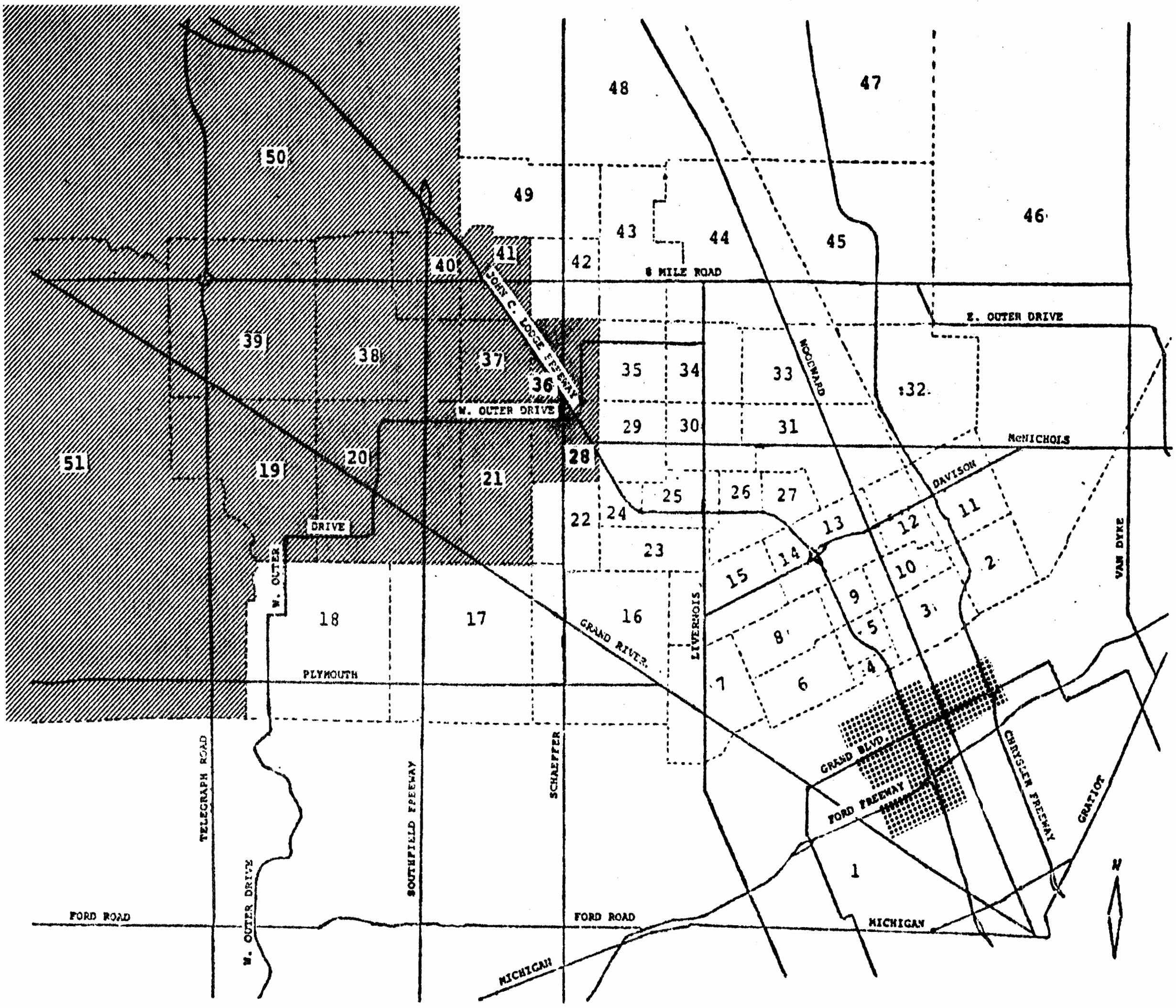
Freeway directly links these two areas, unlike any single arterial, and thus is the best route in terms of distance as well as time. Since the alternate route closely parallels the Freeway, these drivers represent a true estimate of the potential demand that can be diverted as the alternate route also minimizes distance traveled. Drivers with destinations as well as origins farther removed from the Freeway are using the Freeway to save time and thus would be less inclined to follow the alternate route for any considerable distance.

That portion of northwestern Detroit directly served by the Lodge Freeway from the New Center area comprises Zones 19, 20, 21, 28, 36, 37, 38, 39, 40, 41 and 51, and is shaded in Figure 11. Of the 2284 respondents who listed their destination, 36% had their destination in this area. In this group, 40% came from the New Center-Wayne State University area. Of the total of 954 origins from the latter area this represents 35% of that demand.

The single largest destination zone was Zone 50 which includes much of Oakland County, particularly the portion directly served by the Lodge Freeway (also shaded in Figure 11). Of the respondents, 1050 or 46% of the total had destinations in this zone. Among these 42% were from the New Center-Wayne State area.

As can be seen in Figure 11, there is more than one direct route to northwest Detroit and Oakland County. Besides the Lodge Freeway, the combination of West Grand Boulevard and Grand River Avenue is a direct surface street route to some northwest Detroit and Oakland County zones, but is not oriented to the Lodge Corridor. Drivers who have taken or are familiar with the route, however, are not likely to select the alternate route after rejecting the Freeway, but would turn towards Grand River. These drivers are not considered to be divertable to the Lodge Corridor.

Combining the destination zones for northwest Detroit and Oakland County, there were 769 vehicles coming from the New Center-Wayne State area traveling to destinations where the Lodge is the most attractive route. Of this total, questionnaire results indicate that only two vehicles traversed the full length of the alternate route. No information was gathered as to what proportion of the time the ramp information signs actually directed motorists the full length of the route, but the small fraction venturing beyond Davison indicates that considerably fewer drivers actually chose the alternate route in preference to the Freeway despite the recommendations of the signs. The conclusion is that drivers, when given the choice between a freeway and a surface street route both of which directly serve



-- New Center Traffic Generation Area (Origin Zones 21, 22, 25 and 26)

-- Portions of Northwest Detroit and Suburbs Directly Served by the Lodge Freeway

FIGURE 11

LONG DISTANCE TRIP DEMAND WHERE FREEWAY IS SHORTEST AND FASTEST ROUTE the region of their destination, choose a freeway. Considering that half or more of the drivers at each entrance ramp claimed to use the signs, it would appear that this usage doesn't imply compliance. Rather, it seems reasonable to conclude that the information presented on the signs becomes additional information processed by the driver as he makes his route choice. How this information is used may depend on whether or not the driver can see the freeway, how much red is displayed on a particular sign, alternate route traffic conditions, type of journey and attitudes that vary among drivers and may change for each driver from day to day. In the long run, driver acceptance of the alternate route depends on their experiences of finding the alternate route an effective means for avoiding ramp and on-freeway congestion.

The other concentrated zone of origin, Zone 36 with the Chrysler complex, generated 191 trips (eight percent of total respondents) to northwestern Detroit and Zone 50. Since few of these drivers passed the information sign at Davison, the entrance ramp used by virtually all of them, no diversion conclusions are feasible. The same is true for the ramps farther downstream.

A summary of the 1969 origin-destination study linking entrance ramp origins with exit ramp destinations is presented in Table 24.

TABLE 24

ON-RAMP TO OFF-RAMP ORIGINS AND DESTINATIONS
(SOURCE: ENTRY RAMP, Q.3)

OFF-RAMP	ON-RAMP								TOTAL RESPONSES
	West Grand Boulevard	Seward	Chicago	Webb	Davison	Linwood	Livernois	Wyoming	
Did not answer	10	2	7	10	36	17	7	14	103
Clairmount	2	2							4
Hamilton, Chicago	7	0							7
Webb	5	0	0						5
Glendale	4	0	0	1					5
Davison East	17	6	14	6					43
Davison West	9	6	8	0					23
Linwood	16	9	14	5	13				57
Livernois	25	14	8	3	19	7			76
Wyoming	62	21	22	21	49	13	6		194
Meyers, McNichols	88	31	46	22	77	38	20	7	329
Seven Mile	46	15	12	17	42	9	26	13	180
Eight Mile, Greenfield	122	27	28	24	85	28	37	46	397
Other	252	104	59	60	216	79	79	147	996
TOTAL	665	237	218	169	537	191	175	227	2419

As this project focused primarily on reducing travel time for trips which extended at least as far as Meyers Road, it is interesting to note the proportion of trips continuing to this point. Table 25 shows that the proportion of motorists with destinations at or beyond Meyers Road is high, generally increasing at ramps closer to Meyers, except for the concentration of New Center origins using the West Grand Boulevard and Seward ramps. This demonstrates that routing experiments attempting to show motorists the quickest route through the Corridor as far as the Meyers Road exit are potentially of great value.

TABLE 25

PROPORTION OF TRIPS TO
MEYERS ROAD OR BEYOND

ENTRANCE RAMP	PERCENTAGE
West Grand Boulevard	77%
Seward	75
Chicago	69
Webb	77
Davison	84
Linwood	88
Livernois	97
Wyoming	100

CHAPTER THREE

INTERPRETATION, APPRAISAL AND APPLICATION OF RESEARCH FINDINGS

DRIVER USAGE OF ADDITIONAL FREEWAY ROUTING INFORMATION

The provision of traffic and routing information in a usable format at the time the information is needed or desired by motorists is at present a paramount concern of highway engineers. This concern is evidenced by the existence of research such as that which is reported here and recently published evaluations of driver attitude studies toward possible information dissemination schemes (1, 6, 18, 19, 23, 24, 25, 26, 27, 38, 39, 40, 42, 43). As mentioned in Chapter One, Heathington found in Chicago that information on freeway conditions was the third most wanted addition of a suggested list of nine improvements to a freeway network (39). In that study the information was to be provided by means of "signs that can be electronically changed to furnish information about traffic conditions on the expressway ahead." Sixty-four percent of the respondents in the study indicated such an interest.

In this study such signs were installed along a six-mile section of surface street closely paralleling the John C. Lodge Freeway. It was determined by means of an origin-destination study that a considerable proportion of trips originating at the southern end of the Lodge Corridor extended the full length of the Freeway section under surveillance and, in fact, the Freeway was the best route in both distance and time for these users. Thus, the surface street route marked with ramp queue condition information signs should have provided the most attractive alternate route for users with trips extending the full distance of the urban corridor, as well as for many motorists with very short trips. Users of the alternate route were thus provided with information on ramp congestion conditions in advance of their desired point of entry to the Freeway. This information, however, only indirectly reflects on-freeway traffic conditions, the information desired by the Heathington study subjects.

Figure 12 depicts the public response to these ramp information signs. It was found that only a minority of the users of the five entrance ramps from Chicago Boulevard to Livernois Avenue actually passed the signs in reaching the ramp. This is because signs were placed only on the alternate route which was several blocks from the ramps in question. The legend and level of illumination of the UM signs were found to provide adequate visibility and legibility. Figure 12 shows that after a month of operation the signs had been sighted by about 90% of the ramp users.

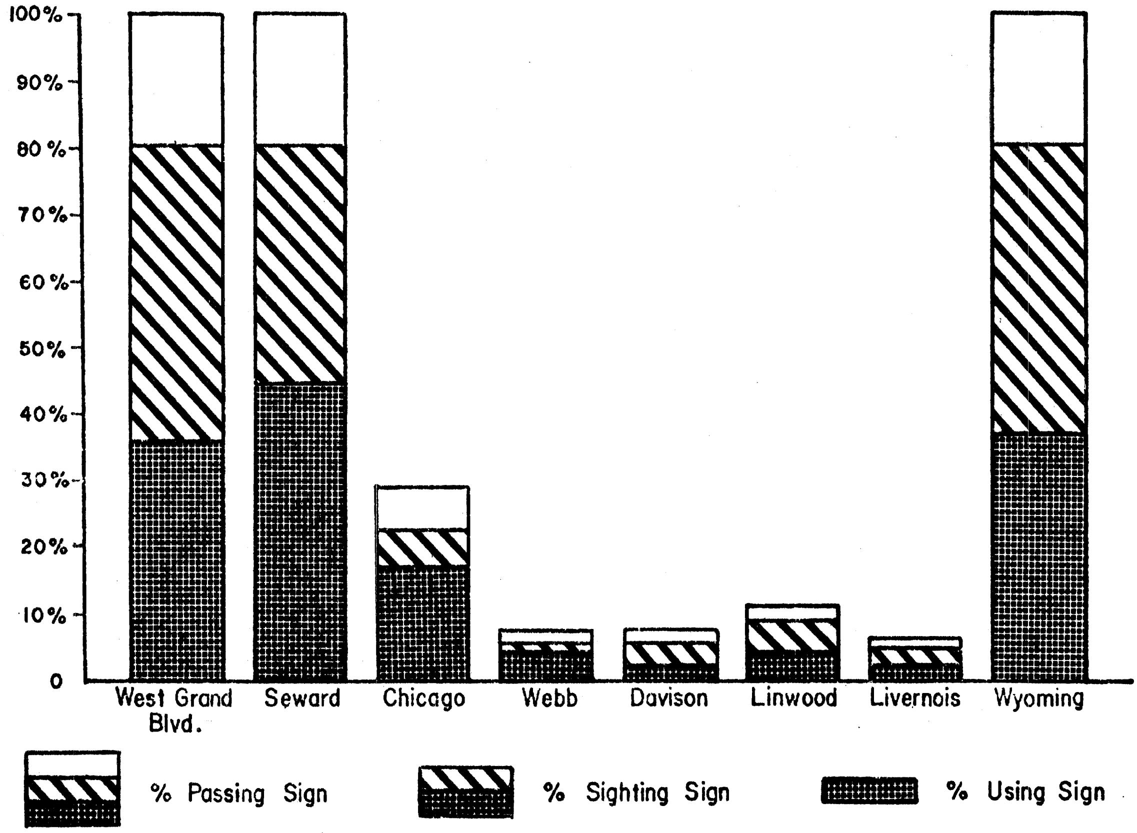


FIGURE 12

RAMP VOLUME DIFFERENCES DUE TO
NEW RAMP CONDITION INFORMATION SIGNS

At West Grand Boulevard, Seward Avenue and Wyoming Road all ramp users passed a sign to enter the ramp. Those not sighting the signs may partly be attributable to the fact that the signs had been in place only a month at the time public response was surveyed. However, at both West Grand Boulevard and Seward the signs previously installed by TTI had been in existence for nine months until taken down only a few days before the UM signs became operational. Drivers at these ramps should have been accustomed to the presence of ramp condition information signs. Considering the size and prominence of the signs, it is concluded that presenting ramp congestion information on signs is inadequate.

The questionnaire handed ramp users indicated that a large majority understood the signs, but it was found that a majority of motorists did not use the signs (Figure 12). Sign usage based on responses to the questionnaire was greater than that actually found from license plate studies of driver response to sign messages. The questionnaire asked, "Do you use these signs to help you decide where to enter the Freeway?" It may be that the driver's own interpretation of sign usage differs from the concept of the research staff which was to follow the alternate route as indicated by the signs. There is evidence that drivers misinterpreted the signs to mean the presence of freeway congestion since 27%

of the questionnaire respondents indicated they would abandon the Freeway when all the ramps displayed on a sign indicated congestion. The decision to use ramp conditions rather than freeway conditions was made on the assumption that ramp metering was serving to optimize freeway traffic and ramp delay was thus the most useful information that could be presented to the driver seeking to enter the Freeway. Excessive delay meant excess demand at a particular ramp which could be redistributed by the signs to less busy ramps.

Several observations can be made on the reasons for the less than anticipated level of correct sign usage. For the three signs located on the service drive adjacent to the ramps, it may be difficult to make the maneuver necessary to avoid entering the ramps. Each ramp is very close to an intersection, thus a motorist entering the service drive from the cross street will have very little time in which to read the sign and decide his route. This is especially true at West Grand Boulevard where the congestion around the ramp entrance may prevent a driver from leaving the queue waiting to enter the ramp. At other ramps, the motorist is advised of the recommended route by only one sign without any confirmation signs. This one sign could be missed or the motorist may be unable to make the necessary lane change in time.

None of this should apply to the frequent ramp user who, if he uses the signs, will be able to anticipate the presence of the signs and digest the sign message with sufficient time to make the proper response. The studies did, however, indicate that frequent ramp users were less likely to use the signs than less frequent users. It would appear that these drivers, being the most familiar with the signs and corridor traffic in general preferred the Freeway.

The alternate route is complex in that the major portion of it is some distance from the Freeway (Figure 1). It also crosses the Freeway twice, once westerly just beyond Davison and back to the eastern side of the Freeway at Wyoming. Some motorists may find the task of continuing on the alternate route beyond Davison too difficult and enter the Freeway there. From Davison, the alternate route continues on Hamilton and then turns left onto Oakman. It then crosses the Freeway, and with a right turn at 12th Street, continues on Fenkell. Another right turn is necessary at Linwood. Similarly, the route beyond Livernois is also complicated with the path continuing on Fenkell, then right to Wyoming and left to the service drive.

Despite the presence of considerable demand for travel the full length of the corridor there was virtually no diversion of drivers from the southern end of the corridor past the Davison entrance ramp. And since diversion patterns from West Grand Boulevard to Davison were established before surveillance began in 1965, the diversion noted in this area may not truly reflect the presence of the signs and may also be induced by other surveillance activities such as ramp metering. Long-term diversion trends in the corridor are discussed in the following section.

Misinterpretation of the ramp signs may also cause decreases in the level of sign usage. Some motorists may doubt that computer-controlled signs are receiving the proper information from the detectors or that the computer can make the correct calculations. The Freeway and the ramps can be seen from the service drive and, on some occasions, there may be very little congestion. In these circumstances a motorist may not believe the signs.

The detectors which give traffic volumes or the signs themselves were out of service occasionally. Although every effort is made to prevent and to immediately correct malfunctions, motorists will sometimes be given wrong information. Some of these motorists may lose confidence in the system and decide not to use the signs in future trips.

In 1967, 12th Street, about three blocks to the west of the Freeway, was the center of very serious riots in Detroit. For some time after this there was a marked tendency for through motorists to avoid using surface streets where riots had occurred. Fortunately, the streets on the east side of the Freeway south of Davison where the alternate route is were much less affected by riots than those on the west side. Nevertheless, this could also account for some reluctance to use the surface streets. This was reflected in some of the comments received with the questionnaires.

In general, then, sign usage is less than would be expected from the driver interest shown in such information displays as indicated elsewhere. The findings of other researchers of driver opinion may serve to indicate some of the reasons for this other than those cited above which to some extent are peculiar to the Lodge Corridor.

Wachs, in a home-interview survey in the Chicago area, found that drivers on work trips displayed a preference for less congestion and strain in their trip and were less likely to follow complicated routes (61). They also traveled shorter distances on arterial streets. Although not measured directly in the Lodge Corridor, the data tend to support these observations. Sixty-six percent of the Corridor demand is by daily freeway users, most of which at this time of the day are doubtless work to home trips. There is evidence that some drivers enter at ramps other than those judged most convenient for them and the diversion pattern noted in 1965 also indicates that not all drivers minimize their surface street trip to reach the Freeway.

Several researchers have investigated the type of information desired by motorists. Dudek, Messer and Jones surveyed 505 Texas drivers and found the most preferred types of information were the location and length of a congested area (71% of the respondents) and severity of congestion (69%) (26). The majority of respondents would use an alternate route to a freeway only to bypass congestion.

Heathington, Worrall and Hoff surveyed 732 Chicago-area drivers on the information desired by them in a freeway corridor (38). No matter what the level of congestion on the freeway, drivers on the freeway desired relevant traffic information, and if they were confronted with congestion they desired specific information as to whether there was an accident or the like ahead. Second to accident information, these drivers desired speed information slightly in preference to broader descriptors such as "stop and go traffic ahead." Information on projected travel times or simple "delay ahead" indications were not desired. Although the above results apply to on-freeway users, it can be inferred that surface street drivers moving toward a freeway would desire much the same sort of information prior to their entry.

Dudek, Messer and Jones found that motorists would prefer to divert to an alternate route before reaching the freeway rather than when already on the freeway (26). They also found the quantitative descriptor of travel time to be least preferred as information received. Contrary to Heathington's work they also found speed information to be undesired.

The ramp condition information signs, then, provided non-quantitative delay information (ramp congestion) which evidently is one of the less desired pieces of information. However, comparison with the ramp information signs installed in Chicago, which did symbolically display on-freeway conditions, indicated that this additional information did not increase sign usage (42). The results of their survey of public response, using a questionnaire similar to that of this study, indicated that 24% of the motorists understanding the signs would use them as compared to over 40% for the UM signs. Design deficiencies in the Chicago signs noted in Chapter One may have contributed to this, but it does appear that the mere addition of on-freeway information will not necessarily increase sign usage. A later Chicago study on various means for presenting traffic information found that the Chicago signs compared unfavorably with means for specifically informing the driver (variable message signs or via radio) (43). It was concluded that the presentation of symbolic information in the format of the Chicago sign was less effective in aiding the driver in selecting a route.

LONG-TERM EFFECTS OF FREEWAY SURVEILLANCE ON TRAVEL PATTERNS IN THE LODGE CORRIDOR

Long-term travel demand changes can be inferred by comparison of the 1969 origin-destination results with comparable information from the 1965 and 1967 studies. As mentioned in the previous section, the effects of the ramp condition information signs alone cannot be separated from the introduction of ramp metering since this occurred after the 1967 O-D study. The data common to the three studies consists of entrance ramp to exit ramp origin-destination percentages since this is all that is available from the 1967 study by TTI (62). The 1965 study conducted by the staff of the National Proving Ground is well documented and, in fact, was of benefit to several aspects of the 1969 research (45). The 1965 information gives the distances traveled by drivers on the Freeway and any tendency for short trips to be discouraged by ramp metering delay should be detectable.

The three studies are tabulated in Table 26. The 1969 percentages were compiled from the data in Table 21, where those returns with "no answer" were disregarded. The 1967 TTI data did include these responses but this factor was corrected by adjusting the percentages to sum to 100 for each entrance ramp. There is considerable variability

TABLE 26

ENTRANCE AND EXIT RAMPS FOR 1965, 1967 AND 1969 ORIGIN-DESTINATION STUDIES

ENTRANCE RAMP \ EXIT RAMP	DATE	CLAIRMOUNT	CHICAGO	WEBB	GLENDALE	DAVISON EAST	DAVISON WEST	LINWOOD	LIVERNOIS	WYOMING	MEYERS	7 MILE	8 MILE	9 MILE	BEYOND 8 MILE	
WEST GRAND BLVD	1965	0.8	2.2	0.3	0.1	4.1	2.5	1.9	4.6	12.2	16.2	9.6	9.5	NA	36.0	
	1967	0.5	3.2	0.3	0.6	4.1	2.2	1.5	3.3	11.6	12.3	7.8	9.3	NA	43.3	100%
	1969	0.3	1.1	0.8	0.6	2.6	1.4	2.4	3.8	9.5	13.4	7.0	18.6	NA	38.5	
SEWARD	1965	1.4	1.5	0.9	0.2	3.8	3.4	1.7	5.3	13.8	12.2	9.1	10.1	NA	36.6	
	1967	1.6	1.9	0.3	0.3	3.8	3.1	1.6	5.0	9.6	12.5	7.6	12.3	NA	40.4	100%
	1969	0.9	---	---	---	2.5	2.5	3.8	6.0	8.9	13.2	6.4	11.5	NA	44.3	
CHICAGO	1965	---	---	0.3	0.8	4.5	3.4	4.2	7.5	18.4	15.4	13.4	10.3	NA	21.8	
	1967	---	---	0.6	0.6	4.2	1.9	6.4	4.2	16.4	23.5	9.6	10.3	NA	22.3	100%
	1969	---	---	---	---	6.6	3.8	6.6	3.8	10.4	21.8	5.7	13.3	NA	28.0	
WEBB	1965	---	---	---	0.5	2.1	1.6	5.2	4.1	10.8	27.8	10.3	13.9	NA	23.7	
	1967	---	---	---	4.5	2.2	1.5	4.5	5.4	15.1	22.7	6.9	10.6	NA	26.6	100%
	1969	---	---	---	0.6	3.8	---	3.1	1.9	13.2	13.8	10.7	15.1	NA	37.8	
DAVISON	1965	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	1967	---	---	---	---	---	---	4.0	3.8	14.7	14.5	9.0	14.8	NA	39.2	100%
	1969	---	---	---	---	---	---	2.6	3.8	9.8	15.4	8.4	17.0	NA	43.0	
LINWOOD	1965	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	1967	---	---	---	---	---	---	---	3.3	12.1	16.2	9.9	23.1	NA	35.4	100%
	1969	---	---	---	---	---	---	---	4.0	7.5	21.8	5.2	16.1	NA	45.4	
LIVERNOIS	1965	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	1967	---	---	---	---	---	---	---	---	1.8	22.0	14.9	22.6	NA	38.7	100%
	1969	---	---	---	---	---	---	---	---	3.6	11.9	15.5	22.0	NA	47.0	
WYOMING	1965	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
	1967	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	100%
	1969	---	---	---	---	---	---	---	---	---	3.3	6.1	21.6	NA	69.0	

NA---Not Available

Sample Size:		Date	Percent Returned
1965 (NPG) :	2322*	June 8-10, 1965	38.3%
1967 (TTI)**:	NA	Spring, 1967	NA
1969 (UM) :	2316	July 17, 1969	22.8%

* Four ramps only
** 3:00-6:00 p.m. only

in the results of the three studies, part of which doubtlessly can be attributed to demand changes in the four intervening years. There was a reduction in the number of shorter trips between ramps within the section of the Corridor under surveillance. This is particularly evident for Seward ramp origins with destinations up to the Davison exit ramp and from Chicago through to the Linwood exit ramp. Within the Corridor there is a distinct decrease between 1967 and 1969 in short freeway trips starting at the Davison entrance ramp. Trips from the Webb entrance ramp to the nearby Davison westbound exit ramp were almost completely discouraged. Presumably, this was the result of ramp metering at Webb as it is noted that drivers could readily accomplish the same trip objective by traveling north on Hamilton and entering Davison directly. Other instances of short trip discouragement can be found by inspection of Table 27.

For every entrance ramp there has been an increase in the proportion of drivers traveling to the Eight Mile Road exit ramp (Detroit City Limit) and beyond. For exits beyond Eight Mile Road the proportion increased between 1965 and 1967 indicating in general suburban population growth and the decline in Detroit population. Thus, some of the further increases in the proportion of these trips in 1969 must be attributed to these trends. However, at the Chicago and Webb entrance ramps, at least, the effects of freeway control

TABLE 27

RAMP DEMAND PATTERNS FROM 1967 TO 1969

ENTRANCE RAMP	RAMP METERING: 1967 "BEFORE" (127 days)	RAMP METERING: 1967 "AFTER" (13 days)	NO SIGNS 1968 11 Days	NO SIGNS July 1969 4 Days	TTI SIGNS 1968 17 Days	TTI SIGNS May 1969 9 Days	UM SIGNS July 16-25 1969 2 Days	UM SIGNS July 1969 10 Days	UM SIGNS October 1969 16 Days	UM SIGNS November 1969 9 Days
West Grand Boulevard	4215 (39.3)	3755 (38.8)	3270 (32.9)	3345 (32.3)	3170 (31.2)	3714 (33.9)		3164 (32.2)	3410 (32.0)	3720 (34.9)
Seward Avenue	1442 (13.4)	1233 (12.8)	1150 (11.6)	1209 (11.7)	1117 (11.6)	1483 (13.5)		984 (10.0)	925 (8.7)	911 (8.6)
Chicago Boulevard	1394 (13.0)	948 (9.8)	1031 (10.4)	1116 (10.7)	962 (3.5)	1058 (9.7)		1040 (10.6)	914 (8.6)	840 (7.9)
Webb Avenue	736 (6.9)	715 (7.4)	725 (7.3)	779 (7.5)	919 (9.1)	826 (7.5)		821 (8.4)	858 (8.1)	795 (7.5)
Davison Expressway	2921 (27.4)	3017 (31.2)	3772 (37.4)	3906 (37.7)	3941 (38.8)	3886 (35.5)	3819	3813 (38.8)	4540 (42.6)	4460 (41.8)
SUBTOTAL	10708	9668	9948 (100.0)	10355 (100.0)	10169 (100.0)	10967 (100.0)		9822 (100.0)	10647 (100.0)	10726 (100.0)
Linwood Avenue	1565	1428	----	1420		1521		1450	1233	1430
									11880	12156
Livernois Avenue	1165	1653	----	1075		1228		1131		
Wyoming Avenue	----	----	----	1381		1441		1405		
TOTAL	13438	12749		14231		15157		13808		

Other Surveillance Modifications

Ramp Metering Introduced (62)

Relaxed Metering at Davison Ramp (14)

Measures to Reduce False Alarms at Seward, Chicago (14)

New Metering Strategy Based On Allowable Storage (14) programs appear to have accelerated the increasing proportion of such long trips.

Average peak period entrance ramp volumes from 1967 (preceding ramp metering) through November 1969, were compared in a further effort to pinpoint demand changes brought about by various control efforts. Various significant alterations in the surveillance operations are also included to gauge their effect on demand. The nine sets of ramp volumes have in common the volumes of the five ramps from West Grand Boulevard through the Davison Expressway. The total demand for these five ramps fluctuates during the two-and-a-half-year period but in general does not appear to have increased or decreased. However, there are distinctive shifts in this demand among the entrance ramps. Entrance ramp demand has gradually decreased at the three upstream ramps, West Grand Boulevard, Seward and Chicago, mostly at the expense of the Davison Expressway ramp where demand increased over 50% from the levels of 1967.

Before the installation of ramp metering in 1967 West Grand Boulevard was the leading ramp in volume with 39.3% of the demand among the five ramps, with Davison a distant second with 27.4% of the demand as can be seen in Table 26 (62). There were no pronounced changes in ramp demand in the several months after metering was introduced, although the trend toward decreased volumes at the upstream ramps and increased volume at Davison was already manifesting itself. The civil insurrection of 1967 involved this portion of the Lodge Corridor and took place little more than a week after the installation of ramp metering. This event may have had an unsettling effect on ramp users for some time afterwards and seemed to influence some of the comments received with the 1969 questionnaire.

A year after the metering began, TTI again compiled average ramp volumes in order to establish the patterns existing just prior to their installation of ramp condition information signs in September 1968 (18). By this time, significant shifts in demand had taken place and Davison was now the busiest ramp in the Corridor with 37.4% (Table 27) of the demand at the five ramps. Taking into consideration differences in total demand, it appeared that about 1000 vehicles, nearly 20% of the West Grand Boulevard and Seward ramp demand before metering, had diverted to the Davison ramp. Two different types of ramp metering strategies existed. Single service metering was used at most ramps and bulk service (as many as 13 vehicles at a time) at West Grand Boulevard and Davison (14). The Davison strategy may have appealed to Seward ramp users seeking to minimize ramp delay. Furthermore, in 1967 and 1968 the Davison ramp signal was not turned on until 4:00 p.m., 90 minutes after the signals upstream. It is probable that West Grand Boulevard users were also seeking to reduce ramp delay because, despite the reduced demand there in 1968 and 1969, congestion resulting from ramp queues encroaching upon the adjacent intersection was still a problem (54). However, by this time the increased demand at Davison had created an even worse congestion problem, more critical because ramp queues occasionally intruded upon the through lanes of the Davison Expressway (14).

The short term evaluation of the signs installed by TTI led to their conclusion that their four signs had generated further shifts from the upstream ramps to Davison, although in retrospect this appears to be further evidence of the long-term pattern and not necessarily attributable to the new signs alone (18). At this time the demand pattern during the peak period was also investigated and it was found that much of the increased demand at Davison occurred before the ramp signal was turned on at 4:00 p.m. TTI attributed this increase to the messages displayed on the upstream ramp information signs which would direct drivers to Davison should the upstream ramps be congested (18).

The evaluation of the impact of the UM ramp condition information signs in the summer of 1969 included a compilation of ramp volumes for the conditions of TTI signs in place, no signs at all and the new UM signs in place (Table 27). In

1969 metering operations at Davison, as well as the remaining downstream ramps, were initiated at 2:30 p.m. to conform with the upstream ramps. This did not decrease the demand at Davison.

Several significant surveillance strategy changes were made in the latter half of 1969 and these appear to have had a pronounced effect on ramp demand patterns. In July, congestion problems at Davison forced the relaxation of ramp metering (to a steady green indication) whenever the ramp queue threatened to spill onto the Davison Expressway (Table 27). By October the effects of this were striking, a 19% increase in Davison demand to the point where Davison was carrying over 42% of the total demand at the five ramps. In effect, drivers had discovered an entrance ramp where they could "force" their way onto the Freeway legally. The information signs may have contributed to the increase in demand by directing more upstream vehicles to Davison each time the excess demand was released by the steady green indication.

Also in July of 1969, effective measures were taken to reduce the signal violations at Seward and Chicago and by October the long-term volume decreases at these ramps appear to have accelerated (14). Violations at Seward had been running as high as 40% among entering vehicles. Since this violation rate was reduced to about ten percent, the result would be further delay at Seward and evidently more diversion. The net result for Seward in the 27 months of ramp metering operation from 1967 to November 1969, was a decrease in ramp demand from 1442 vehicles per peak period (13.4% of the five-ramp total) to 911 vehicles (8.6%) for nearly comparable total demand levels. A comparable reduction over this same period was noted for the Chicago entrance ramp.

A new ramp metering strategy based on keeping subsystem freeway storage within acceptable limits for the desired level of service was initiated in late October 1969. In the short term the only demand change of note was a reversal of the long-term decline in demand at West Grand Boulevard. This was attributed to the presence of a lane added downstream of this ramp which would result in more storage capacity being available in that subsystem and thus a less stringent metering rate (14).

The downstream Linwood, Livernois and Wyoming entrance ramps, where volume data were not as complete as for the above five ramps, are also included in Table 27. In general, there do not appear to have been any demand changes at these ramps between 1967 and 1969. As already noted, this can be accounted for because there was little diversion of traffic from the New Center area this far along the alternate route which could have increased the demand. Furthermore, very few drivers at these ramps were found to actually pass the information signs, and thus this would not have an effect on demand except at Wyoming where congestion was seldom indicated anyway.

In conclusion, the implementation of freeway surveillance in the form of ramp metering has had a definite effect on corridor entrance ramp demand patterns. It appears that drivers seek to minimize ramp delay by diverting to the ramps (Webb and Davison) with the least demand or the least stringent ramp metering control. In an effort to eliminate congestion at Davison, significant demand changes resulted which only served to exacerbate the situation. The long-term impact of the ramp condition information signs is less evident than the other surveillance control changes, but it is noted that they can worsen the undesirable demand shifts to Davison. It is apparent that drivers continue to experiment in their search for the most desirable route to the Freeway, and the use of several types of ramp metering strategies with widely varying metering rates does not seem desirable unless the resulting demand shifts are acceptable. In the long run, this is a more effective means for producing demand shifts than ramp information signs which are actually more applicable to uniformly metered ramps since their function is to direct drivers to less congested ramps and hence less congested portions of a freeway rather than to ramps where ramp demand can be satisfied more promptly.

COST EFFECTIVENESS OF THE INFORMATION SIGNS

Ramp demand variations presented in the preceding section demonstrate how additions and modifications in the surveillance control system affect demand patterns. Over a period of months, changes which made isolated entrance ramps more attractive (Davison Expressway) or less attractive (Seward Avenue) or made a set of ramps (installation of ramp metering) less attractive to motorists generated demand changes. Likewise, the addition of the ramp queue condition information signs has generated changes by informing drivers of the presence of uncongested entrance ramps. Since this is the sole purpose of these signs, it was considered appropriate to perform a cost-effectiveness analysis of the benefits to drivers already on the Freeway as a result of demand diversion in the area covered by the signs.

In order to avoid the effects of other surveillance changes noted in Table 27, the ramp volume changes between the period when no signs were in operation in July 1969, and the period in July of new sign operation was selected. Although demand patterns would not be set in this short an interval as drivers become accustomed to the signs and experiment with their use, the data in some sense is a reflection of driver response to the signs. There were slight changes in total demand for the two sets of data, and this was taken into account by adjusting the volumes for the "no sign" data to equal the "new sign" volumes. The before and after volume sets for each ramp were compared and diversion in terms of reduced freeway travel and increased surface street travel were estimated by using the distances between entrance ramps and the equivalent distances along the alternate route. The method and calculations are presented in Table 28. With regard to freeway travel, a total of 1028 vehicle-miles of travel has been diverted at the expense of 1146 additional miles of surface street vehicle miles of travel (assuming the diverted motorists were on trips that would take them along the alternate route until they entered the freeway). This is the net result of diversion from the upstream ramps to the Davison Expressway entrance ramp and farther downstream. The pattern is depicted in Figure 12 where the "no sign" volumes have been corrected. The relaxed metering at Davison may have influenced the increases there although long-term increases will not have taken place as yet. Furthermore, the increased green indications for Davison resulting from less congestion time should have served to promote diversion to this ramp which is born out by the data in Figure 12.

TABLE 28

EFFECTS OF SIGNS ON TRAVEL

ENTRANCE RAMP	CORRECTED "NO" SIGNS (Veh.)	NEW SIGNS (Veh.)	CUMULATIVE DIFFERENCE (Veh.)	FWY. DIST. (Mi.)	FWY. TRAVEL DIVERTED (Veh. Mi.)	SURFACE STREET DIST. (Mi.)	SURFACE ST. TRAVEL INCLUDED (Veh. Mi.)
West Grand Boulevard	3245	3164	- 81	0.3	26	0.40	32
Seward	1173	984	-270	0.9	250	0.85	215
Chicago	1083	1040	-313	0.5	154	0.50	165
Webb	756	821	-248	0.85	211	0.85	213
Davison	3790	3813	-225	1.1	247	0.40	343
Linwood	1378	1450	-153	0.45	65	0.60	96
Livernois	1043	1131	- 65	1.2	75	1.25	82
Wyoming	1340	1405					
TOTAL	13808	13808		5.3	1028	5.85	1146

The diversion of traffic is a possible measure of sign effectiveness but a more suitable measure is a reduction in total travel time. Only an approximate method, however, could be developed to measure this criterion.

Several assumptions are necessary:

(a) The signs cause a diversion of traffic for an average of two hours in a peak period.

(b) During this time the Freeway speed is 30 miles per hour and the alternate route speed is 20 miles per hour without diversion by the signs.

(c) The Freeway is operating at capacity, 100 vehicles per minute, without diversion by the signs.

(d) The alternate route speed is independent of the volume diverted because these vehicles make up only a small fraction of the total volume on the alternate route. The speed is, at least, partially dependent on the traffic signal timings in the Corridor.

(e) There is a linear relationship on the Freeway between speed and density (up to capacity) with free speed (speed at zero density) assumed to be 60 miles per hour.

(f) Traffic volumes are uniform in distance and time throughout the two-hour period.

In two hours, 1146 vehicle-miles were, therefore, diverted. For an alternate route length of 6.6 miles, this is equivalent to a volume of 95 vehicles per hour diverted from the Freeway to the alternate route. The volume on the Freeway is, therefore, reduced to 5905 vehicles per hour.

For the linear speed-density relationship, average freeway speed

$$u_f = u_{fc} \left(1 - \sqrt{(1 - q/q_c)}\right)$$

where u_{fc} = Freeway speed at capacity = 30 miles per hour

q = volume = 5905 veh/hr

q_c = capacity = 6000 veh/hr

Therefore, the removal of 95 veh/hr from the Freeway results in an increase in speed from 30 to 33.7 miles per hour

In two hours, over the Freeway section of 56 miles,

Freeway total travel = 5905 × 5.6 × 2 vehicle miles

= 66,700 vehicle miles

$$\text{Freeway Total travel time} = \frac{\text{total travel}}{u_f}$$

= 1980 vehicle hours

after diversion.

Without diversion, Freeway total travel is 67,200 vehicle-miles and with a speed of 30 miles per hour, the total travel time is 2240 vehicle-hours.

There is, however, an additional travel time of $\frac{1146}{20}$ or 57 vehicle-hours due to diversion to the surface streets.

Therefore, the signs save approximately 200 vehicle-hours in a day's operation. Over a full year this would amount to 40,000 hours.

The capital cost of purchase and installation of the eight signs including the leaflets and supplementary signs amounts to $23,800. There is also a running cost consisting of a power supply cost, telephone line lease and maintenance amounting to approximately $500 per annum. For a ten-year life of the signs, the annual cost is, thus, approximately $2,880.

The marginal cost/effectiveness ratio associated with the eight signs can be roughly estimated to be six cents per vehicle-hour saved. Considering that at five of the entrance ramps only a small proportion of ramp users actually passed a ramp condition information sign and that the full potential of these signs could not have been achieved as a result, this is a conservative estimate of the cost/effectiveness ratio.

CHAPTER FOUR

CONCLUSIONS

ALTERNATE ROUTE SIGN EFFECTIVENESS

The research described in the first three chapters was divided into two stages: the design and location of a set of eight dynamic ramp queue condition information signs and the evaluation of the effectiveness of these signs. The signs were located along an alternate route extending the entire length of the most congested section of the northbound Lodge Freeway during the evening peak period. The signs replaced four similar signs installed on a part of the route by the Texas Transportation Institute in late 1968. The sign positions are adjacent to the entrance ramps where there is a service drive and in other positions in advance of appropriate cross streets for access to the Freeway.

All but one of the corresponding entrance ramps are metered. The operation of a metering system appears to be a necessary condition for the satisfactory performance of the information signs. The metering produces a queue of vehicles on the ramp when there is high demand for a ramp as determined by a queue detector at the head of each ramp.

The studies of visibility, legibility, driver comprehension and driver response showed that the new signs were more easily seen, read and understood than the original signs. Thus, a driver not familiar with the corridor should have a good chance of understanding the signs on first sighting them. The questionnaire confirmed that the signs were understood by 68% of the respondents. The improvement in the proportion of correct responses by test subjects at successive signs indicated that a learning effect is present as drivers become more familiar with the signs, although this could not be verified with the questionnaire data on frequency of ramp usage. The fact that drivers previously receiving information about the signs also understood them better demonstrates the usefulness and importance of the public relations campaign surrounding their installation. It is important that the signs be relatively self-explanatory, for despite television and newspaper publicity and the handing out of explanatory leaflets at the entrance ramps the day the signs were put into operation, only half the responding ramp users the day the questionnaire was handed out a month later recalled having previously received information.

The questionnaire showed that about 66% of ramp users were daily users, but that daily users were less inclined to use the signs than motorists who occasionally used the Freeway. This may have been a result of their experimenting with the alternate route and finding the longer trip time less satisfactory than tolerating ramp delay or failure from their point of view to find an uncongested ramp. There were equipment failures in 1969 that may have contributed to the loss of faith in the system by motorists. Questionnaire comments also indicated some reluctance to travel on the surface streets in the corridor, the scene of the 1967 civil insurrection.

Overall, 41% of the questionnaire respondents claimed to use the signs. Actual diversion results as determined from license plate studies by message state on each sign were inconsistent. Diversion at West Grand Boulevard when the sign indicated congestion there was about two percent compared to over 32% at the nearby Seward entrance ramp. At these two ramps the drivers could see freeway and ramp queue conditions and this would be a factor in their decision to enter the ramp.

There was no continuous service drive at the downstream ramps. The signs were located along an alternate route consisting of nearby surface streets. It was found that as few as six percent of the ramp users actually passed a sign on their way to the ramp, an inevitable result of the alternate route being oriented to a single surface street route. However, the signs did appear to generate some diversion, at least as far as the Davison Expressway entrance ramp. Also, drivers were more reluctant to enter if the signs indicated "red" for congestion when the ramp was out of sight than if the ramp was visible. North of the Davison Expressway, the Lodge Freeway follows a westward alignment for several miles and the alternate route consists of several different segments. Drivers from the southern end of the corridor were very reluctant to travel the alternate route beyond Davison, although ramp users further north appeared to be just as willing to divert as at the other ramps. The alternate route does not appear to be an attractive substitute for those drivers with trips longer than the length of the Freeway under surveillance.

The studies of sign effectiveness also show that the signs seem to have reduced the proportion of shorter freeway trips (entering a metered ramp and exiting before Meyers Road exit) from the 1967 level. This has probably been brought about by motorists seeing and obeying red ramp displays. In the questionnaire study, 27% of the respondents said they would abandon the Freeway upon seeing an all-red display.

An analysis of the marginal cost of the system indicated that it is cost-effective; the cost per one vehicle-hour of travel time saved through improved freeway conditions is six cents.

For application to any other freeway corridor with metered on-ramps, signs of similar design should be equally effective.

It would be desirable to place signs on all approaches to on-ramps and to clearly mark the alternate route or routes. There should also be a sustained and continuing public information effort.

SUGGESTED RESEARCH

Recent surveys of driver desires for further real-time information on traffic operations demonstrate the validity of the research effort contained in this report. It is interesting to note that, as was the case in Chicago, driver interest as shown by their responses to questions could not be translated into consistent travel pattern changes measured in the field. However, this research has demonstrated that ramp queue condition information signs are used by many drivers and perhaps would be greater used if such systems were more prevalent and extensive in scope.

Some of the inconsistent or incomplete results contained in this report can be attributed to the limited funds available, particularly in terms of the number of signs installed. Based on the experience gained through this project, the following observations on research methodology are made.

For the driver behavior study one or more miniature signs could have been constructed for subject test viewing in a simulation laboratory. At this stage, if a deficiency in the design of the signs had become apparent, the temporary signs could have been altered and further tests made so that the optimal results could have been obtained from the signs installed in the field. Field testing of driver behavior, however, does maintain the advantage of testing on actual roads with prevailing traffic conditions and should definitely be pursued. The laboratory test requires special equipment but, if this is available, both types of tests should be performed to fully evaluate both the sign design and the signs after their installation in the field.

With regard to the license plate study, difference in sign state has been shown to be of little significance with the exception of first ramp, red or green. Interesting results might have been demonstrated, however, if all ramps and signs could have been observed simultaneously.

The overall evaluation of the signs was carried out without data on the increase in surface street travel time with increase in volume. The collection of this data would not normally be justified to evaluate the information signs alone but should be used if available. Also, the ramp queue lengths were not known but, with relocation of the queue detector, better information on queue lengths could be obtained.

Finally, further research is desirable in both the content of information and amount of information presented to the driver. The former was beyond the scope of this study, but in matters directly pertinent to the ramp information signs the question remains as to how many ramps should be displayed on an individual sign. This is of considerable importance in a computer-operated system since each ramp name costs $10 per month or less for communications and an element of output from the computer. Also, demand warrants should be developed with which to justify the placement of a sign in locations where there is no continuous frontage road.

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PART TWO

APPENDIX A

DESCRIPTION OF EQUIPMENT USED FOR DATA ACQUISITION AND SURVEILLANCE CONTROL

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DESCRIPTION OF EQUIPMENT USED FOR DATA ACQUISITION AND SURVEILLANCE CONTROL

Introduction and System Logic

Dynamic or real-time traffic control is accomplished by means of a "feedback" system. This system must measure the level of traffic flow, identify and process the data and assess the data in order to control the in-field information devices so that they reflect actual traffic conditions. This process is continual and overlapping. The feedback control process is depicted in Figure A-1.

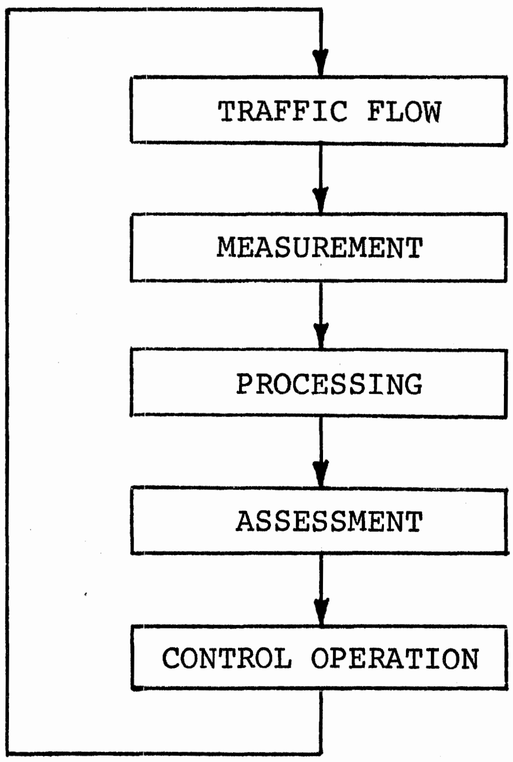

FIGURE A-1

BLOCK DIAGRAM SHOWING REAL-TIME SYSTEM LOGIC

The traffic flow data is measured for a large area within the Freeway Corridor (see detector locations in Figure 1) and are received at the Control Center continuously during the 2:30 to 6:30 p.m. afternoon peak period. Since the measured data is considerable, and the time permitted for processing is short, an electronic digital computing system is essential.

The processing and assessment functions are managed by the computer system. As the field complex grows in size the computer system can match this growth by appropriate increases in its capabilities. Also, as new traffic flow theories are developed, or as older ones are improved, the assessment function can be updated. This is accomplished through programming changes. Thus, while the computer system is essential to compile and assess the vast quantities of data involved in a real-time freeway control system, it also has the desirable feature of being flexible enough to develop with the control system.

Discussion of Traffic Control and Information System Component

The measurement and control operations are performed by field and office equipment. The physical components of the full traffic control and information system are shown in Figure A-2. (The reader should refer to Appendix B of A Freeway Corridor Surveillance, Information and Control System (18) for further information on equipment.) The traffic detectors are the major source of flow measurement input in

BLOCK DIAGRAM OF PHYSICAL COMPONENTS OF TRAFFIC CONTROL AND INFORMATION SYSTEM

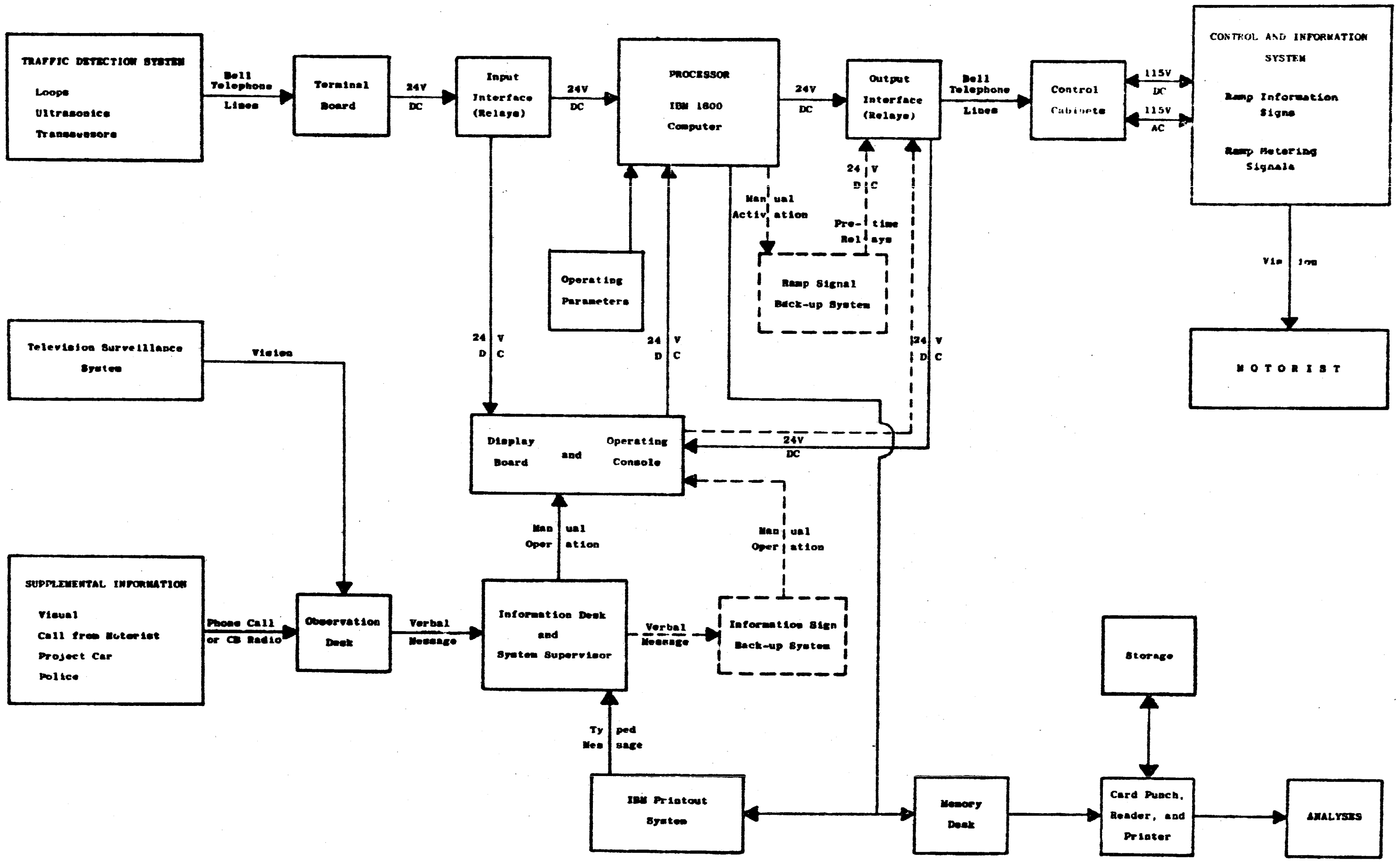

FIGURE A-2

the system. These detectors are of three types: loop, ultrasonic, and transsensor. The loop detectors are used on all ramps to detect vehicle presence and to record volumes and on various surface streets in the Lodge Corridor to record volumes. The transsensor detectors are also used as count detectors on surface streets, while the ultrasonic detectors are positioned over each freeway lane by mounting them on the railing of each roadway or pedestrian overpass within the study area. Ultrasonic detectors are also utilized at the on-ramps to measure the existence of a queue (at one ramp, Chicago, a loop detector is used).

Installation of each of these types of detectors presented no problems. Freeway traffic was not disrupted by the installation of the ultrasonic detectors as they were placed on bridges over the Freeway. Some ramp and single-lane surface street blockage was necessary for the in-roadway installation of the loop and transsensor detectors. This work, however, necessitated only simple "saw cuts" in the pavement and was generally performed during the weekend when traffic volumes were lower. All detector installation work was accomplished by the Wayne County Road Commission.

Electrical power used at each of the sites was provided by either the Public Lighting Commission (a City of Detroit agency which produces power for City services) or the Detroit

Edison Company. In all cases, power was tapped from existing lines belonging to one of these sources and run to the installation site. All lines were strung overhead and attached to existing poles.

The information detected by this equipment is conveyed to the Control Center by means of leased Michigan Bell Telephone lines. This service is tapped at the closest available location by the Telephone Company and is routed to the field equipment. In the special case of the southern portion of the Lodge Freeway, the communication lines are contained in a multi-conductor cable that traverses the median of the Freeway. The office ends of these lines are located at the Control Center and terminate on a terminal board supplied by the Telephone Company. Signals conveyed by the communication lines feed into an interface consisting of electric relays (24 volts, DC) and then to the computer. Here the information is processed and assessed in light of operating parameters previously programmed into the system. These parameters, or threshold values, consist of maximum metering rates, minimum metering rates, queue lengths for each ramp, occupancy levels necessary to change sign states and capacity values for each freeway subsection.

After the processing and assessment, and if appropriate, a call is made for a control function. In these cases the appropriate command is sent to the field through a second relay interface and a second set of leased communication lines.

The control and information systems consist of ramp information signs and ramp metering signals which are controlled by computer command. Relays are used in the field installations to effect the control operation. These are housed in control cabinets where the power and communication lines are terminated.

Information is then presented to the motorist through the normal viewing process. By nature of the placement and positioning of the information and control equipment, the information is properly contained within the driver's field of vision.

In summary, the "main line" process described above consists of: traffic flow measurement (detectors); receipt of data (communication lines); processing (computer); command output (communication lines); and control function (signs and signals). This "main line" process is supported by other input information, as well as being subject to manual overrides by the system supervisor.

Supplemental System Components

The supplemental input information is basically provided by the television surveillance system. As part of the National Proving Ground phase of research on the Lodge Freeway, fourteen TV cameras were installed on overpasses. By way of monitors in the Control Center, these cameras provide a continuous view of the Freeway (including on- and off-ramps). In addition, other information is provided by project vehicles that are in the field performing studies or maintenance tasks, by police who call in reporting various conditions of interest, by a call from a motorist or by visual inspection (viewing out the windows at the Control Center).

Another source of supplemental information is the direct typewriter output from the computer. This listing provides data on field equipment that may not be operating properly. Thus a detector station may become inoperative and, because of a system override control, the metering rate at the on-ramp will be fixed rather than based on real-time calculations. The typewriter output provides this type of auxiliary information to personnel at the observation desk who then pass it on to the system supervisor. The supervisor may then utilize manual overrides if necessary. These manual overrides consist of switching the display on a sign from one state to another or altering the metering rate or strategy.

These very same procedures (manually switching signs and ramp signal rates) are employed on days experiments are taking place. Thus, the system supervisor has the capability to override the system at will. Knowledge provided by the typewriter and other sources can also prompt the supervisor to dispatch personnel to repair reportedly damaged equipment.

An important component of the physical traffic control and information system consists of the backup equipment. Both the ramp signal and information sign features have back-up units. In the case of the ramp metering signals this consists of a time-delay relay for each ramp. The appropriate delay is pre-set for each individual ramp based on historical data. This system automatically comes on if the computer becomes inoperative. Therefore, when a vehicle is detected to be waiting at the red light, the time-delay relay begins cycling and the motorist receives a green signal. The difference between backup and normal operations is that the backup system operates on a fixed-time basis while normal operations are based on real-time conditions.

The backup system for the ramp information signs consists of manually switching sign messages. Through past experience, these signs can be changed to correspond generally to demand. Thus, the first sign in the system will be turned red as congestion starts to build, a short time later the next one, and so forth until all signs are red during the heaviest part of the peak period. The reverse of this procedure is employed as the peak period advances toward 6:30 p.m. These changes are, of course, modified if conditions dictate.

All of the previously described features (except the ramp metering backup system) are visually displayed on a board located at the Control Center. Superimposed on a complete map of the Lodge Freeway Corridor are all the field detectors, each represented by a small light. Thus, each time a vehicle is detected, whether on the Freeway, on a ramp or on the surface streets, the corresponding light will flash. The state of each of the eight ramp signals is displayed by a bank of red and green lights, while the current information sign displays are shown by either a red (congested) or a green (uncongested) light.

The display board is used generally to help explain to visitors the operation of the system. It also serves as an excellent check on how the field equipment is operating. This can be illustrated by an example concerning ramp metering. By watching the representation of a particular ramp on the display board you can "see" a vehicle present itself at the signal when the presence detector light becomes illuminated. That the signal is red can be confirmed by looking at the current signal display for that ramp. The cycle, which begins when a vehicle is detected, can be timed with the aid of the second hand on an ordinary watch. The light for the ramp metering signal will then turn green on the display board (and simultaneously in the field), and after a reaction period, the vehicle can be "seen" to proceed down the ramp as the light for the downstream detector flashes. It can be confirmed that the signal returned to red by checking its counterpart on the display board. An actual field check is, of course, the best way to determine if equipment is operating correctly and viewing the display board should not be considered a substitute for it. However, it can serve as a supplemental source of information.

The last component of the system involves the collection of data for future off-line analysis. During the entire peak period all input and output information is stored on computer memory disks. At the end of each day these data are converted to punched computer cards. The cards are labeled and saved for later analysis. The system computer is used for this purpose.

Description of Ramp Information Signs

The installation of the eight ramp information signs was of prime importance during this phase of research. As stated above, these variable message signs are controlled by commands from the Control Center (originating either from the computer or manually). Each sign is capable of presenting a variety of messages depending on commands from the Control Center.

Each sign has a metal frame and back while the front consists of plexiglass panels. Legends on the panels show ramp names, the word "enter" opposite each ramp name and the alternate route in the form of a series of arrows. These panels are illuminated from behind by internal red and green neon tubing. Thus, the signs are capable of producing a number of different message combinations (eight for those signs with information on three ramps). Figure 4 in Chapter One indicates possible variations in sign state for a typical sign.

Electrical Circuitry for Ramp Information Signs

The electrical circuitry for control of the variable ramp information signs is shown in Figure A-3. Four relays (power, A, B, and C) accomplish the task of switching the signs to the proper display to reflect current conditions.

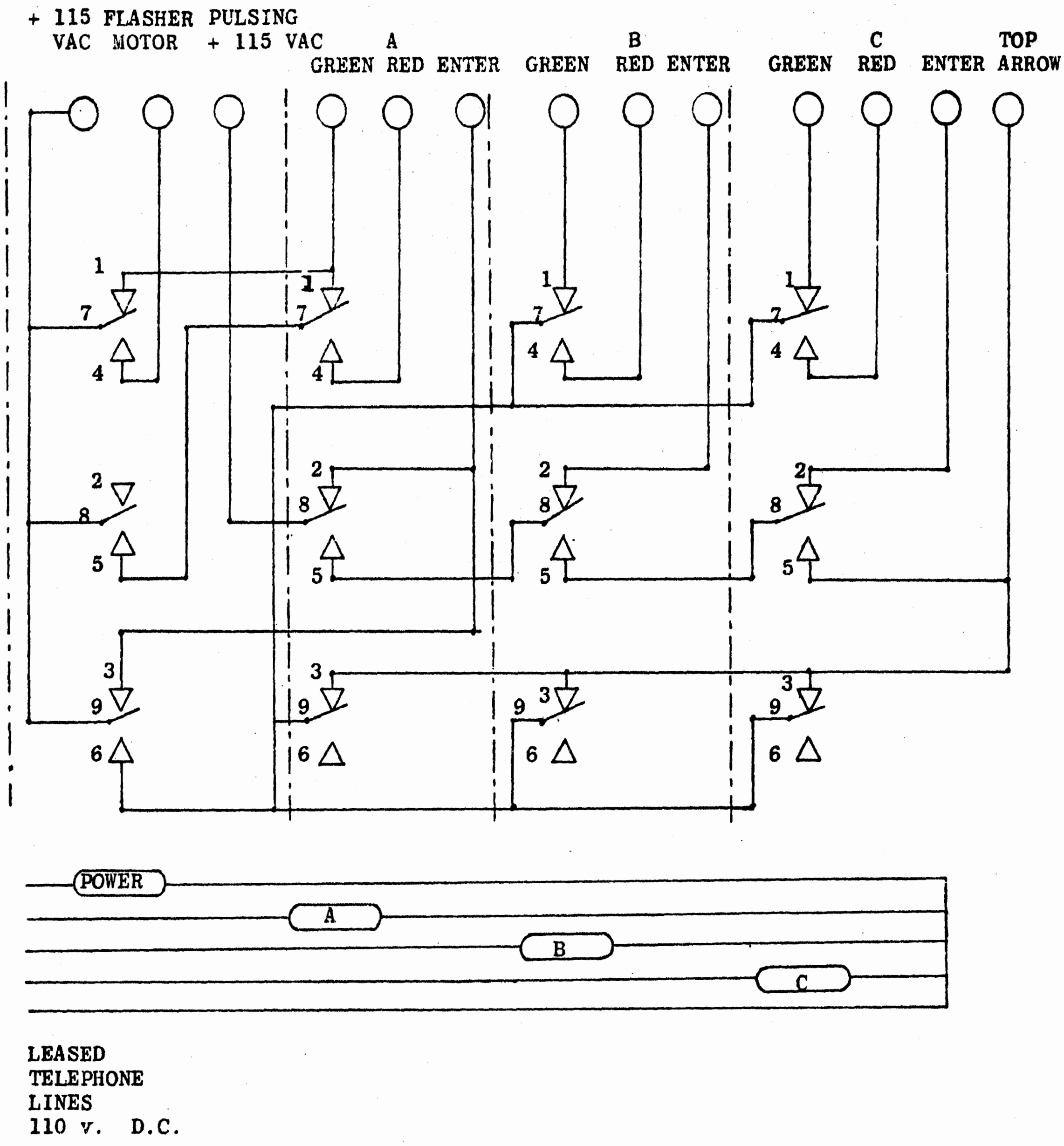

FIGURE A-3

ELECTRICAL CIRCUITRY FOR INFORMATION SIGNS

The relays are of the three-pole, double-throw type. For each relay, terminals 1, 2, and 3 are the normal or "green" position. Upon activation of switches 7, 8, and 9, the poles are thrown to terminals 4, 5, and 6.

The relays are connected to the Control Center by means of leased telephone lines using a power supply of 110 volts, D.C. The power relay is also connected to a 115 volt, A.C. supply and when activated, switch 7 connects the power to the flashing motor instead of green for the "A" relay - first ramp. This turns on the other ramp names corresponding to the "B" and "C" relays and also the frontage road arrow at the top of the sign through switch 9. The message "ENTER" would flash beside the first ramp if there were no congestion.

If any of the three relays, A, B, or C, are activated, switch 7 will be thrown thus changing the ramp name color from green to red. The flashing motor flashes the first ramp name in green, but if all three are red, the top arrow flashes.

The signals for all the changes are transmitted by means of the leased telephone lines.

APPENDIX B

PUBLIC RELATIONS

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PUBLIC RELATIONS

One important consideration in the proper functioning of any driver information system is a correct understanding by its intended recipients of the meanings of the messages being conveyed. In addition, where experiments are being conducted on the street system which may be a cause of temporary delay or inconvenience to homeward-bound motorists, it is essential to minimize public annoyance by the widest possible dissemination of information about the general methods and the intended goals of these experiments. The potential for adverse public reaction is exemplified by the letter to "Action Line" in the Detroit Free Press, Figure B-1, concerning the ramp metering operation published soon after The University of Michigan took over the Lodge Freeway facility.

Inquiries or comments from individuals or media representatives received prompt attention from qualified project personnel, or where appropriate, were referred to officials of governmental agencies such as the Detroit Department of Streets and Traffic. In the particular case of the ramp congestion mentioned in the letter reproduced in Figure B-1, studies had already been planned to alleviate traffic

Detroit Free Press
March 31, 1969

Action Line
Dial 222-6464

Action Line solves problems, gets answers, cuts red tape, stands up for your rights. Write Action Line, Box 881, Detroit, Mich. 48231. Or dial 222-6464 between 8:30 a.m. and 4:30 p.m. Monday through Friday. Please include your name, address and telephone number.

What idiotic highway planners put those traffic lights midway down the Lodge freeway entrance ramps? All they do is create congestion on streets leading to the freeway. It's just one more dumb expense the taxpayer gets socked for. — S. J., Detroit.

At least Detroit taxpayers aren't getting socked for it all. Stretch of the Lodge from the Ford to Davison is a national proving grounds. The $300,000 cost of running the research project — ramp lights, closed circuit TV, overhead lane signals — is shared by all 50 states. This year the overhead signs were turned off "for economy reasons." Detroit traffic director Alger F. Malo admits the ramp lights, installed in 1967, have caused back-up problems, particularly on Grand Boulevard. Department is considering installing detectors in the road which could trigger the "go" light and move traffic when cars start piling up.

FIGURE B-1

ADVERSE PUBLIC COMMENT TO RAMP METERING

back-ups and were subsequently carried out (14). These studies were also explained to another individual who wrote a carefully considered letter on the ramp metering to the Detroit Department of Streets and Traffic.

The project made use of the professional public relations personnel at the Highway Safety Research Institute to plan public information programs and help in obtaining the cooperation of the news media. The three areas of public relations concern were the various governmental agencies with interests in this research and in Lodge Corridor operation, the motorists who used the corridor for travel, and the residents in the corridor area.

In the latter case, the function of the ramp information signs was to divert traffic away from the Freeway onto parallel surface streets, some of which were residential. It was anticipated that problems might arise with local residents protesting the increased traffic diversion or possibly the delays they incurred at the metered ramps when suburban residents and downtown workers were given "unrestricted" access to the Freeway. Such problems did not arise but the conflict in the use of residential streets as arterials surfaced early in 1969 when the City of Highland Park contemplated the installation of four-way stop signs at many intersections along two important north-south arterials in the Lodge Corridor, Second and Third Avenues (Figure B-2).

DETROIT FREE PRESS
Thursday, March 6, '69 7-F

City Fears Rerouting Of Traffic

BY DON LENHAUSEN
Free Press Staff Writer

Highland Park's plans for converting Second and Third into residential streets could cause chaotic congestion in Detroit, a Streets and Traffic Department official said Wednesday.

Highland Park intends to begin restricting traffic on the two major arteries by installing four-way stop signs every few blocks.

Northbound Second and southbound Third later would be converted to two-way traffic, then eventually blocked off. Highland Park officials believe the plan will be put into effect this year, possibly beginning in three months.

* * *

THE EFFECT on the north-south corridor through Detroit "is going to be chaos unless someting practical and feasible is worked out," according to Stanford Gross, Detroit traffic-operations engineer.

Officials said the two streets each carry about 20,000 cars daily in Detroit, and 25,000 along the two-mile long sections in Highland Park.

Highland Park officials say that cutting traffic will help protect the residential character of the area through which the streets pass.

Gross said Highland Park's plan would involve considerably more than simply rerouting traffic to Woodward, Hamilton and other major north-south streets.

"How are we going to get the cars over to the other streets?" he said. "Clairmount, Chicago Blvd. and others are heavily traveled now. People already are complaining about them. By dumping additional traffic on to them, they'll get bogged down even more."

Also, he said, the other north-south streets will be seriously affected.

"This thing is a chain reaction," he said.

* * *

GROSS SAID his department and Highland Park officials had discussed the plan "very briefly" last fall but that there was no indication at that time that it might be put into effect this soon.

Highland Park officials said they had intended to talk further with Detroit streets and traffic people once they had a better idea of when the plan would be put into effect.

FIGURE B-2

CITY OF HIGHLAND PARK PLANS TO DISCOURAGE THROUGH TRAFFIC ON TWO MAJOR LODGE FREEWAY CORRIDOR ARTERIALS

Highland Park is located just east of the Lodge Freeway from near Chicago Boulevard to McNichols Road (Figure 1). The possible loss of these two arterials and the resulting diversion of traffic to other streets constituted a considerable threat to efforts to use these streets as alternative routes for freeway users in the Lodge Corridor.

Highland Park never implemented these changes, but the evident conflict in interests between the cities of Highland Park and Detroit emphasized the continuing need for mutual coordination and communication where traffic engineering modifications were contemplated. For these reasons, the research staff of the Lodge Project endeavored to maintain close contacts with officials of both cities and kept both cities informed of proposed changes in the Lodge Corridor and their overall impact on traffic operations.

Although the Detroit Department of Streets and Traffic and the Highland Park Public Works Department were the two governmental agencies most directly involved with the research work, contacts were also necessary with other agencies, both public and private, involved in various aspects of this work. These agencies included the police departments of the above two cities, the Public Lighting Commission of Detroit (who installed the ramp information signs), the Wayne County Road Commission, the Michigan Department of

State Highways and the Traffic Safety Association of Detroit. Satisfactory relations were maintained with officials of all these agencies.

Since research efforts, and notably the new ramp condition information signs, were directed at the individual motorists, public relations efforts were considered of nearly equal importance with technical planning. Unless the drivers who come in contact with any innovative traffic device understand not only the operation but also the purpose behind such a device, they will be unable, and perhaps unwilling, to comply with its instructions. In a situation in which the aims of the research involve a change in driver behavior, the effectiveness of the project may depend on the public relations campaign. With these considerations in mind, the initial operation of all new equipment installed in the Freeway Corridor was accompanied by appropriate public information activity.

A concerted publicity campaign was begun several weeks before the installation of the ramp information signs. On May 15, 1969, the news media were informed that the new signs would be installed in a few weeks. The purpose of the new signs was explained in a press release (Figure B-3) and background information on the project was provided.

NEWS . . . FROM THE UNIVERSITY OF MICHIGAN

NEWS SERVICE, 6014 ADMINISTRATION BUILDING ANN ARBOR, MICHIGAN 48104

May 15, 1969 (38)
Contact: Chuck Wixom
Phone: 764-6504

FOR IMMEDIATE RELEASE

ATTENTION NEWS DESKS: This is sent mainly as an advisory, although you may, of course, use it if you wish. A news conference to demonstrate the operation of the new Lodge Freeway frontage road information signs will be held as soon as installation procedures will permit. The most probable time and place for the news conference are at the Herman Keifer Proving Ground Headquarters in about two weeks.

Northbound motorists on the John C. Lodge Freeway will get more and clearer information soon, when eight new frontage road information signs are installed.

The eight will replace four now in use and provide four more in new locations.

Replacements will be made at ramp locations at West Grand Boulevard, Seward, Chicago, and Webb. Signs will be newly placed at the Davision service drive, Linwood, Livernois, and Wyoming. This will extend the ramp information system from its present 3.2 miles to about 6 miles on the Lodge Freeway.

The purpose of the signs is to suggest to northbound motorists a single clear route to the freeway. The old signs were considered ambiguous because they did not specify a single route.

The new signs will also be more legible than the old ones. They will be larger and more distinctly lettered.

The function of the signs is just about the same. Sensors on ramps will detect traffic density, sending information to the computer at the National Proving Ground for Freeway Surveillance and Control headquarters at Herman Kiefer Hospital. An IBM 1800 computer controls the ramp information signs.

(more)

FIGURE B-3

PRESS RELEASE ANNOUNCING FORTHCOMING INSTALLATION OF RAMP CONDITION INFORMATION SIGNS

The freeway information signs will operate between 2:30 p.m. and 6:30 p.m. as at present.

Installation of the signs will be made by the Detroit Public Lighting Commission and the city of Highland Park. Completion of the installation is expected by mid-May.

The signs are part of the project of the National Proving Ground for Freeway Surveillance and Control. Goal of the project is to find ways to ease congestion on combined freeway and surface street systems that are overtaxed at rush hours but adequate through the rest of the day.

The project includes the television surveillance system and the entrance ramp signals.

The Highway Safety Research Institute of The University of Michigan has been executing the contract for the study since November of last year. The previous contractor was the Texas Transportation Institute, which began work on the ramp signaling system in January 1967.

The project is carried out with the cooperation of several governmental units: the Detroit Department of Streets and Traffic, the Michigan Department of State Highways, the City of Highland Park, the Wayne County Road Commission, and U-M.

The project is part of the National Cooperative Highway Research Program, administered by the Highway Research Board of the National Academy of Sciences-National Academy of Engineering. Support for the NCHRP comes from the American Association of State Highway Officials and the U. S. Bureau of Public Roads.

##########

(R2, Det R & TV; 24 sp. 10 to Wixom) bjw

FIGURE B-3

(CONTINUED)

A Tuesday, June 3, 1969, was selected as the first day of operation of the ramp condition information signs in order that a press conference could be held the day before. Leaflets explaining the purpose of the new signs and the alternate route concept were prepared with the cooperation of the Traffic Safety Association of Detroit (Plate B-1). They were to be passed out to as many drivers as possible at the eight metered ramps and Wyoming during the metering hours of 2:30 to 6:30 p.m. Consideration was also given to distributing leaflets at major sources of traffic using these ramps such as the office complex in the New Center area served by the West Grand Boulevard ramp and the industrial areas in the northern half of the corridor. The limited availability of personnel rendered this infeasible, although the existing inter-office communications network at the General Motors Building in the New Center area was used to advantage in sending leaflets to these offices.

PLATE B-1 (opposite page)

LEAFLET DESCRIBING RAMP
INFORMATION SIGNS

New Signs And Alternate Routes To Aid Northbound Drivers

- ▲ The Alternate Route Provides A Quick Way Home During Rush Hours.
- ▲ By Using The Alternate Route To By-Pass Crowded Portions Of The Freeway, You Escape Congestion At The Entrance Ramps.
- ▲ Each New Sign Tells You The Best Point To Enter The Freeway In Order To Avoid Heavy Traffic And Delays In Reaching Home.

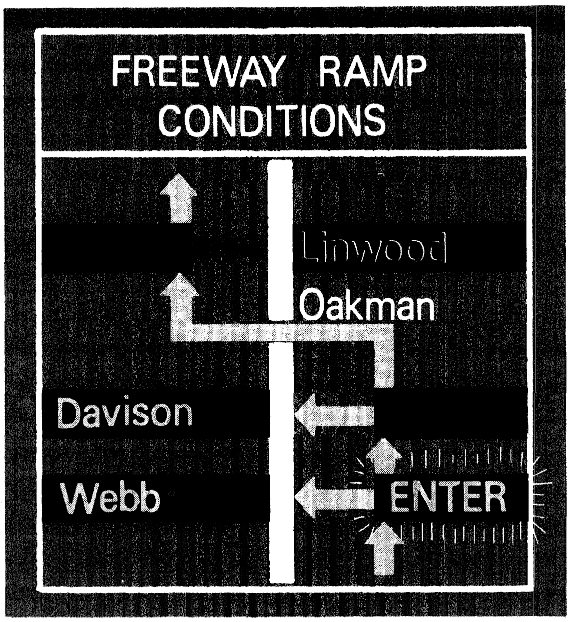
SIGNS WITH A MEANING FOR YOU

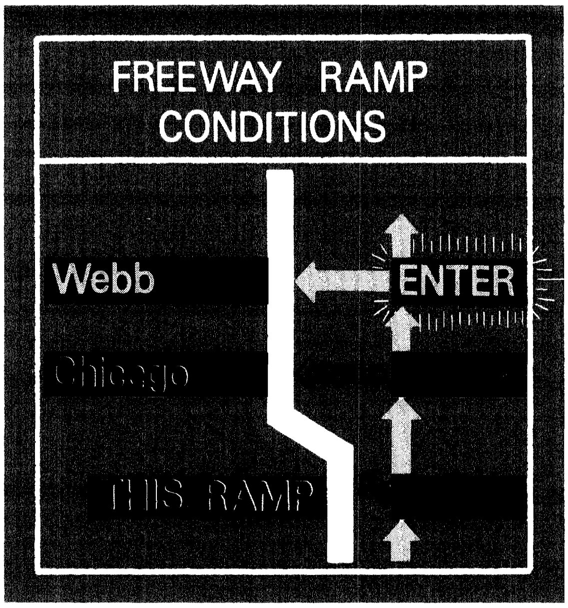
The new signs give information on traffic conditions on the nearest entrance ramp and the two ramps immediately following. The conditions are indicated:

ENTER (flashing green) – **Enter Freeway at this ramp.**
GREEN – **Conditions here are not congested.**
FLASHING GREEN – **Continue along alternate route.**
RED – This ramp is congested.

EXAMPLE 1: You are driving north along Hamilton Avenue approaching Webb Avenue and want to enter the Freeway. The name of the street, Webb, and its arrow are both illuminated in green. The ENTER sign next to Webb is also flashing in green. You can expect to enter the Freeway via the Webb ramp with little or no delay.

All the ramps shown on the sign will be shown in RED if the ramps are congested and you may be delayed in entering at any of these points. The arrow at the top of the sign will then be *flashing in green* directing you to proceed farther along the alternate route to find the best point for entering the Freeway.





EXAMPLE 2: You are driving north along the East Lodge Service Drive approaching Seward Avenue. You want to enter the Freeway by the Seward ramp. You see, however, that this ramp and its arrow are illuminated in red – an indication of congestion on the ramp. The green arrow tells you to proceed past the Chicago Boulevard ramp which is also congested (notice the red street name and red arrow) to the Webb Avenue ramp, which is clear as shown by the flashing green ENTER sign, green street name, and green arrow. Here you should be able to enter the Lodge Freeway with little or no delay.

There Is Another Way

The alternate route provides a quick way home during rush hours.

Eight new ramp condition information signs will begin operation on the ramp-metering segment of the northbound John C. Lodge Freeway Tuesday, June 3, 1969. These signs *(See reverse side.)* will inform northbound motorists of traffic conditions on the nearest entrance ramp and the two ramps immediately following. They advise drivers either to enter the Lodge Freeway by the nearest ramp or to proceed farther along the *alternate route* to a ramp where there is less congestion and easier access.

One way to improve traffic conditions for the individual motorist without building new highways is to suggest that he use existing street systems. Many of these systems provide satisfactory routes but are not currently being used to their full capacity, especially during rush hours.

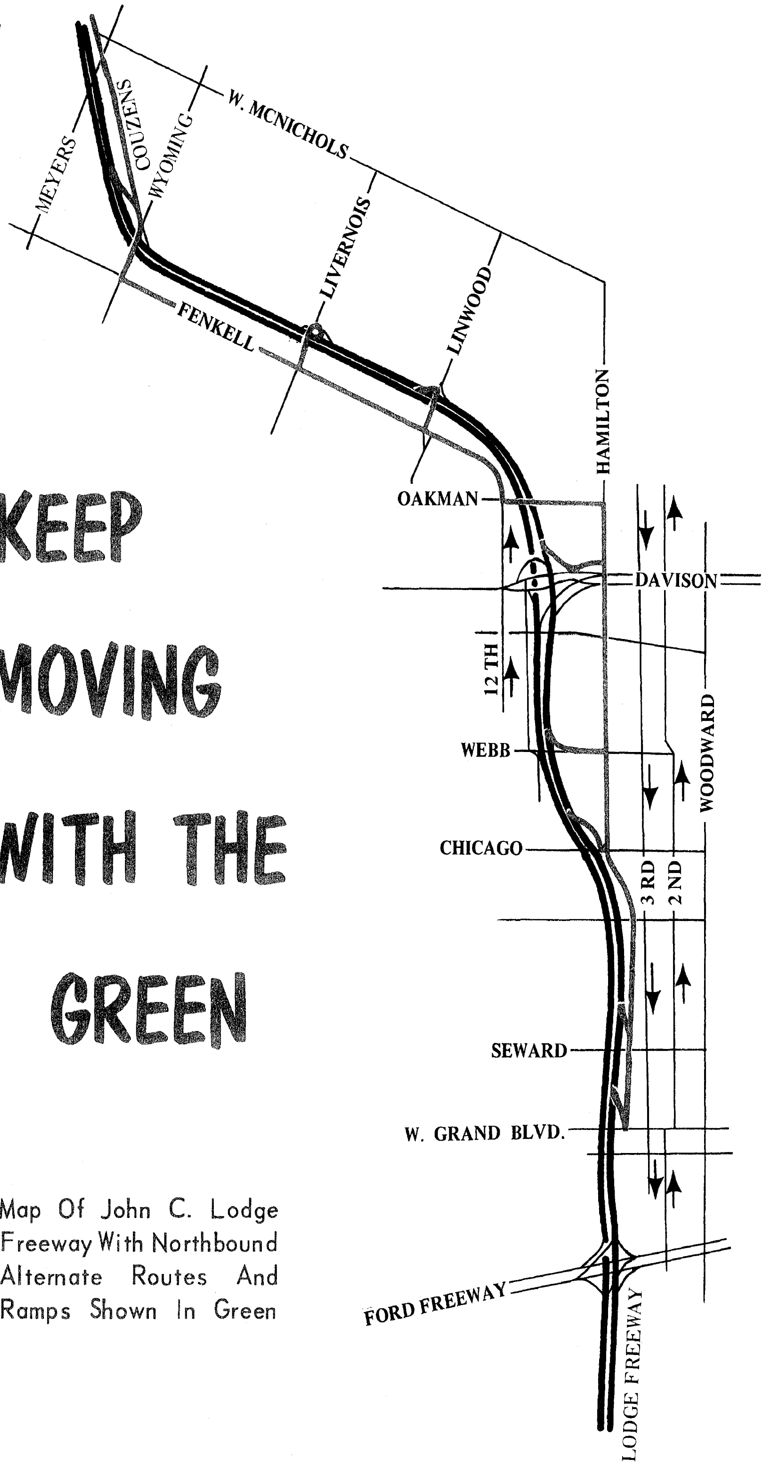
Each sign tells you the best point to enter the Freeway in order to avoid heavy traffic and delays in reaching home.

During 1969, the northbound Lodge Freeway Corridor will provide a testing ground to determine whether motorists will change their route habits when provided with reliable, up-to-the-minute information on attractive *alternate routes*. This information is based on computerized processing of traffic flow data continually gathered from more than fifty locations within the Freeway Corridor.

By using the alternate route to by-pass crowded portions of the Freeway, you escape congestion at the entrance ramps.

The *alternate route* suggested here runs parallel to the Lodge Freeway as indicated by the *green line* on the map. This route provides a helpful alternative to freeway travel by lessening travel time and delays due to congestion on entrance ramps. Also, traffic diverted to the *alternate route* will relieve the burden presently carried by the freeway and help everyone to get home earlier.

KEEP MOVING WITH THE GREEN



Map Of John C. Lodge Freeway With Northbound Alternate Routes And Ramps Shown In Green

The new freeway ramp signs are the first of a series of innovations designed to assist the motorist in route selection by providing information on Freeway Corridor traffic conditions, and are used in conjunction with the ramp-metering signals and television surveillance of accidents during afternoon rush-hour traffic.

The project is being carried out by The University of Michigan under contract with the Highway Research Board and in cooperation with the Michigan Department of State Highways, the Wayne County Road Commission, the City of Detroit, and the City of Highland Park.

Prepared By The Traffic Safety Association Of Detroit For The University of Michigan Highway Safety Research Institute

An advance briefing was held May 20th at the Department of Streets and Traffic in Detroit. The purpose of this meeting was to inform the various agencies participating in the Lodge Project, including the Detroit Police Department, that the signs were to become operational. It was important to keep the police informed as they were required at the West Grand Boulevard sign to protect news photographers and also at the other leaflet distribution sites to assure smooth traffic operations.

On June 2nd, the day before four of the signs began operation, a press conference was held at the Howard Johnson New Center Motor Lodge in Detroit. All area news media were sent written invitations. Dr. Donald E. Cleveland, Principal Investigator for the Lodge Project, Alger F. Malo, Director of the Detroit Department of Streets and Traffic and Harold H. Cooper, Chairman of the Project Operating Committee, spoke to the reporters. Also present were Edward Wujcik, Director of the Highland Park Department of Public Works, Donald Orne, Michigan Department of State Highways, Oscar Gunderson, Assistant County Engineer of the Wayne County Road Commission and Anthony Freed, Detroit Department of Streets and Traffic.

The conference was attended by reporters from the three Detroit network television stations and the two major daily newspapers and by a public relations representative of the General Motors Corporation. Reporters were given a press release (Figure B-4) and copies of the explanatory leaflet for motorists. These materials were also delivered to major Detroit-area radio stations. Following the press conference, those in attendance were given a tour of the Control Center and were shown the West Grand Boulevard sign in operation. The sign was controlled manually to enable photographs and video tapes for television news programs to be made.

Coverage of the new signs appeared in the Tuesday editions of both the Detroit Free Press and Detroit News (Figure B-5). (Photographs of the West Grand Boulevard sign accompanied both articles but are not reproduced in Figure B-5.) Operation of the sign was shown during the Monday evening news telecasts of the three network stations accompanied by an interview with the Principal Investigator. The signs were also mentioned on several radio stations and in the Monday New Center News newsletter (Figure B-6). The newsletter used the project's press release of May 27th for their copy.

On the afternoon of June 2, the leaflets explaining the alternate route system and the operation of the signs were distributed to motorists at the eight ramps. The distribution took place from 2:30 p.m. to 6:30 p.m., the period of ramp metering and the regular operation of the signs. Two people

NEWS... FROM THE UNIVERSITY OF MICHIGAN

NEWS SERVICE, 6014 ADMINISTRATION BUILDING ANN ARBOR, MICHIGAN 48104

Contact: Chuck Wixom
Phone: 764-6504
June 2, 1969

FOR IMMEDIATE RELEASE

Eight new freeway ramp condition signs will go into operation in the John C. Lodge Freeway Corridor on Tuesday, June 3, at 2:30 p.m. Dr. Donald E. Cleveland, principal investigator of the research group working on the Lodge, explained the purpose of the signs at a press conference Monday (June 2) at Howard Johnson's New Center Motor Lodge.

By giving information on ramp congestion at three successive entrance ramps, the signs help northbound motorists select the quickest route to the freeway. The signs advise drivers either to enter the freeway by the nearest ramp or to proceed farther along the alternate route (a series of surface streets running parallel to the freeway) to a less congested ramp. (The map on the attached leaflet shows the alternate route, a six-mile section extending northwest from Grand Boulevard to Wyoming.)

The eight new signs replace four ramp information signs now in use and provide information at four new locations. The replacement signs are located on the Lodge Service Drive near West Grand Boulevard and Seward, and on Hamilton near Chicago and Webb. New sign locations are on Hamilton near the Davison Service Drive, on Fenkell near Linwood and Livernois, and on Couzens Drive near Wyoming.

The new signs suggest to northbound motorists a single less congested route to the freeway. In addition, their larger and more distinct lettering gives them improved legibility.

The information given the motorists is accurate and up-to-the minute. Electronic detectors at the entrance ramps measure waiting line length

FIGURE B-4

PRESS RELEASE ON INAUGURATION OF
RAMP CONDITION INFORMATION SIGNS

and automatically send the information over lines leased from Michigan Bell to an IBM 1800 computer at the Control Center at Herman Kiefer Hospital. Here, the computer instantaneously processes the data and determines the message to be flashed on each sign.

The ramp condition information signs will operate on weekdays from 2:30 to 6:30 p.m., when freeway traffic is the heaviest. They work in conjunction with detectors at more than fifty locations in the freeway corridor, existing ramp metering signals and television surveillance to reduce congestion and delays.

Traffic diverted from the congested entrance ramps can be easily handled by the alternate route. These streets, at present, carry considerably fewer cars than their capacity. Not only do motorists using the alternate route save time, but with the freeway's burden reduced, everyone gets home quicker.

The eight new signs are being installed as part of a research project studying ways to improve freeway corridor travel. This phase focuses on the driver -- will he change his route habits when provided with reliable, timely information on attractive alternate routes? The research is being conducted by The University of Michigan Highway Safety Research Institute under a contract from the Highway Research Board of the National Academy of Sciences.

Harold Cooper, engineer of traffic and safety for the Michigan Department of State Highways and chairman of the operating committee of local highway agencies, introduced Dr. Cleveland and opened the conference. Alger F. Malo, director of the Detroit Department of Streets and Traffic; Oscar Gunderson, assistant county highway engineer of the Wayne County Road Commission; and Edward Wujcik, Highland Park director of public works, were also present. All these agencies play important roles in the Lodge project.

Motorists using the northbound freeway will receive hand-outs with detailed explanations of the operation and purpose of the new signs. The hand-outs will be distributed Monday at the eight ramp locations where the new signs have been installed.

# # # # # # # # #

FIGURE B-4

(CONTINUED)

Detroit Free Press

THE SECOND FRONT PAGE

Page 3. Section A Tuesday, June 3, 1969

Computerized Signs to Help Guide Lodge Drivers

BY ROBERTA MACKEY
Free Press Staff Writer

Northbound motorists who want to enter the Lodge Freeway between W. Grand Blvd. and W. McNichols will have a new set of signs to guide them Tuesday.

From 2:30 to 6:30 p.m. each day, the signs will indicate whether the nearest ramp is congested, whether the next two ramps are crowded or clear, and whether it would be better to follow an alternate route of surface streets.

All the motorist has to do is learn to keep one eye on the road ahead and one eye on the sign long enough to figure out what the computer that controls it wants him to do.

THE SIGNS are part of a research project to determine whether the weary homeward bound drive can change his habits when he is given up-to-date, reliable information about his route.

A University of Michigan research team designed the new system, and Dr. Donald E. Cleveland, the chief investigator, said Monday that it doesn't have to work perfectly to be a success.

Even if a limited number of cars can be diverted to surface streets, Dr. Cleveland said, some ramp congestion will be relieved, "and everybody will get home faster."

Each sign is bisected by a white line which indicates the freeway. To the left of the white line are three labels, beginning at the bottom with "This Exit" and working northward with the names of the next two exits.

To the right is a path of northbound arrows which stands for the alternate surface route. Another set of arrows angles off from this toward the exit labels, and opposite each of these is a panel which can flash the word "enter" at appropriate times.

The motorist should do all right if he keeps in mind that red means "stop" and green means "go."

When the green "enter" flahses, he will be advised to enter the freeway at the entrance indicated opposite, also in green.

If a given ramp is congested, its name, and the arrow pointing to it, will be lighted in red, telling the driver to proceed on the alternate route until he comes to a "green" entrance.

Turn to Page 8A, Column 3

FIGURE B-5

NEWSPAPER COVERAGE THE DAY RAMP INFORMATION SIGNS BECAME OPERATIONAL

Computer Signs To Guide Drivers

Continued from Page 3A

He can tell from the sign whether the next entrance or the one after it is clear. If all three ramps are congested, the green arrow at the top of the alternate route line will flash, telling him to keep going that way.

THE SURFACE route closely parallels the freeway, following the service drive to W. Chicago Blvd., continuing [illegible], there on Hamilton to Oakman, where there is a sharp left turn. Following Oakman across the freeway, and after a short stretch on Twelfth, the route angles to the northwest on Fenkell to Wyoming, where it re-crosses the freeway to connect with James Couzens and follows that highway to W. McNichols.

"We are not asking anybody to sacrifice himself for the benefit of the other motorist," Dr. Cleveland said. "If the ramps are congested it is to his own advantage to stay off them."

Alger F. Malo, Detroit director of streets and traffic, said, "Our basic interests is in whether we can get the motorist to co-operate by reminding him that there is unused capacity on the surface streets.

"This is the only way to move traffic. We can't build expressways on every street."

He said some new street signs had been erected and lanes have been painted on some streets to guide drivers through the system. Some on-street parking was also eliminated.

Motorists entering the Lodge Monday afternoon were given handbills explaining the new system, and they will have until 2:30 p.m. Tuesday to do their homework. As Harold Cooper, traffic and safety engineer for the State Highway Department, observed Monday, "These are not simple signs. The message doesn't leap out at you."

Cooper is chairman of the committee of local agencies involved in the project, which will cost something just under $350,000 for a year's research.

The signs are located on the Lodge service drive near Grand Blvd., and Webb; on Hamilton near the Davison service drive; on Fenkell, near Linwood and Livernois, and on Couzens Drive, near Wyoming.

More than 50 detectors along the freeway corridor, ramp metering signals and television cameras will flash information to the computer center in Herman Kiefer Hospital which will control the new signs.

14-A—THE DETROIT NEWS—Tuesday, June 3, 1969

Lodge ramp signs to flash 'go' or 'no'

By JOHN GILL
Detroit News Staff Writer

Eight experimental signs, designed to indicate traffic conditions, will go into operation at 2:30 p.m. today on the Lodge Freeway north of West Grand Boulevard.

The new signs will flash green lights and a signal "Enter" if traffic conditions are not too congested for motorists to drive onto the Lodge.

If congestion is heavy the signs will flash a red light telling drivers to stay on the service drive and try another ramp. Each sign will indicate if a motorists should enter the freeway on the next of two ramps.

THE SIGNS, all on the northbound side of the freeway, are located at:

The Lodge service drive near West Grand Boulevard; Lodge service drive at Seward; Hamilton at Chicago; Hamilton at Webb; Hamilton at Davison; Fenkell at Linwood; Fenkell at Livernois, and James Couzens at Wyoming.

Each of the signs carry three ramp names, the one the driver is approaching and the next two. A green or red light will be lit alongside each ramp name.

If all the lights are red, this will warn the motorist that better time can be made on surface streets than on the freeway.

THE INFORMATION GIVEN drivers is up-to-the-minute.

Electronic computers at the entrance ramps measure waiting line length and automatically relay the information over telephone lines to a computer center at Herman Kiefer Hospital.

The computer instantaneously processes the data and determines the message to be flashed on each sign.

The ramp condition signs will operate on weekdays from 2:30 p.m. to 6:30 p.m. when freeway traffic is heaviest.

FIGURE B-5

(CONTINUED)

GM CENTER **new center news** FISHER CENTER
MONDAY MORNING
FIRST IN THE HEART OF DETROIT
THIRTY-SEVENTH YEAR DETROIT, MICHIGAN, MONDAY, JUNE 2, 1969 NUMBER 1898

Lodge Freeway Gets New Signs

The news briefing on the Lodge Freeway signing change will be held from 9 a.m. to 12 noon on Monday (June 2) at Howard Johnson's New Center Motor Lodge on West Grand Blvd., in the Boulevard Room South.

Details of the operation of the new signs and their purpose will be given at the news conference by Dr. Donald E. Cleveland of the University of Michigan Highway Safety Research Institute. Dr. Cleveland directs the project, which is sponsored by the Highway Research Board.

Purpose of the signing change is to give motorists using the north-bound Lodge Freeway information about traffic conditions ahead to help them select the quickest route.

Representatives of the other agencies cooperating on the project will also be present. These include the Detroit Department of Streets and Traffic, the Wayne County Road Commission, the Detroit Police Department, the City of Highland Park, and the State Highway Department.

It is intended that the new signs become operational on the northbound Lodge Freeway on June 3 at 2:30 p.m.

FIGURE B-6

NEW CENTER NEWSLETTER COVERAGE OF NEW RAMP CONDITION INFORMATION SIGNS wearing orange vests and one policeman were stationed at each ramp. The policeman was present in case problems arose from congestion caused by queued vehicles waiting to receive the leaflet. (At Wyoming, an unmetered ramp, an advance warning sign informed drivers of the need to stop on the ramp to pick up the leaflet.) An estimated 10,600 motorists, 90% of those entering the ramps that day, accepted the leaflet.

Some leaflets were also passed out at a large parking lot adjacent to the West Grand Boulevard ramp when extra personnel were available. Vehicles leaving the parking lot entered the northbound frontage road just north of this entrance ramp. Also, leaflets were attached to the June 2nd General Motors Daily News Summary distributed to 135 offices in the New Center area (Figure B-7).

News coverage of the initial operation of the new signs was accurate and thorough. This may be attributed to the press conference which gave the reporters an opportunity to speak individually with Dr. Cleveland, Mr. Malo and Mr. Cooper.

Several aspects of public relations were learned from this press conference. The reporters came only after an additional phone call the morning of the conference. It was decided that the written invitation should be accompanied by

GENERAL MOTORS CORPORATION

June 6, 1969

Dr. Donald E. Cleveland
Principal Investigator
Highway Safety Research Institute
220 East Huron
Ann Arbor, Michigan 48108

Dear Dr. Cleveland:

Attached is a copy of our June 2 Daily News Summary containing the explanation of the Lodge Freeway Alternate Routing System.

The summary was distributed to 135 offices in the General Motors Building. I am certain the freeway information proved helpful to those of us who travel the Lodge each working day.

I was pleased to attend your news conference, and stand ready to assist you in the future.

Very truly yours,

Gregory J. Harrell
Public Relations Staff

GJH/mt
Enc.

General Motors Building 3044 West Grand Boulevard Detroit, Michigan 48202

FIGURE B-7

DISTRIBUTION OF EXPLANATORY LEAFLETS TO GENERAL MOTORS OFFICES IN THE NEW CENTER a call to the City Editor or a specific contact. Then, a follow-up call should be made at 8:00 a.m. the morning of the conference.

Secondly, a meeting scheduled for 10:00 or 11:00 a.m. is preferable to one at 9:00 a.m. Newsmen must often meet morning deadlines before 10:00 a.m. Even though the conference was to be held at 9:00 a.m., most reporters did not come until later. Another factor to be considered in scheduling is holidays or other special events. The meeting took place the Monday after Memorial Day when the attention of news media was diverted to weekend events. Conflicts such as this should be avoided.

Another way to improve coverage and guarantee accuracy of information may be to supply advance television and radio tapes. Inquiries to The University of Michigan News Service indicated that these tapes could be obtained through them at moderate cost.

Public relations efforts regarding the new signs were continued where appropriate. A press release was issued when the signs were temporarily turned off to resolve several problems encountered in their initial operation (Figure B-8).

In order to evaluate driver response to the new signs, a questionnaire (Plate 1) was written, again with the cooperation of the Traffic Safety Association of

NEWS . . . FROM THE UNIVERSITY OF MICHIGAN

NEWS SERVICE, 6014 ADMINISTRATION BUILDING ANN ARBOR, MICHIGAN 48104

July 3, 1969 (11)
Contact: Chris Carey
Phone: 764-7260

FOR IMMEDIATE RELEASE

The new electronically controlled signs which tell motorists the condition of eight northbound ramps on the John C. Lodge Freeway will be turned off next week (July 7-11).

They will go back on again at 2:30 p.m. Monday, July 14, in time for that day's evening rush hour. The temporary shutdown is to permit checking the equipment.

The signs are at the ramps at West Grand Blvd., Seward, Chicago, Webb, Davison, Oakman, Linwood, and Livernois. They were installed in early June as part of a research project conducted by the University of Michigan and various city, state, and federal agencies.

By providing up-to-the-minute information about traffic conditions on the freeway ramps, the signs enable motorists to choose the fastest route home.

# # # # # # # #

(50 special) ssb

PRESS RELEASE ANNOUNCING TEMPORARY SHUT-DOWN OF RAMP INFORMATION SIGNS

Detroit Free Press
July 16, 1969

Xway Computer Survey Planned

Sixteen orange-vested workers will be handing out questionnaires Thursday to motorists entering the Lodge Freeway.

The questionnaires are designed to help evaluate the new traffic-control system recently installed at eight ramps along the expressway.

The system has television cameras along the expressway which monitor traffic and feed information into a computer. The computer regulates signs along Lodge service ramps, which indicate to motorists whether they should enter the freeway at one exit or use the service drive to the next one.

Although the new system was installed over a month ago, it has not been operating properly. Various bugs in the computer hookup had to be ironed out but now, according to Dr. Donald Cleveland, project manager, it's ready to go.

Cleveland and his team from the University of Michigan hope the information obtained from the survey will help perfect the complicated system.

NEWSPAPER COVERAGE OF QUESTIONNAIRE DISTRIBUTION

FIGURE B-8

FOLLOW-UP PUBLICITY ON CONTINUED OPERATION OF RAMP INFORMATION SIGNS

Detroit. They were printed on a form which could be folded and gummed to form an envelope. Return postage was pre-paid to further encourage their return. Staff personnel in public relations and human factors at the Highway Safety Research Institute were consulted to help in the design of the questionnaire so that it would not confuse or intimidate those who received it. Respondents were assured that all answers were to be treated confidentially.

The questionnaires were distributed on Thursday, July 17, 1969, in a manner similar to the distribution of the explanatory leaflet. Advance notice of their distribution was sent to the Detroit News, the Detroit Free Press, the three network television stations and several radio stations. The Free Press article is reproduced in Figure B-8. The questionnaire was also mentioned by the News and the television and radio stations. In addition, the Principal Investigator was interviewed by radio station WWJ.

The distribution of the questionnaire was accomplished in a satisfactory manner. Continuing the efforts to foster public good-will toward the research, questions written by respondents on their questionnaires were answered by mail.

The final question (number 10) in the questionnaire provided an opportunity to evaluate the public relations effort. It was found that the percentage of respondents who had previously received information about the signs was 48%. The percentages by entrance ramp as determined from data presented in Table B-1 are given in the following tabulation:

ENTRANCE RAMP	PERCENT OF RESPONDENTS WHO HAD PREVIOUSLY RECEIVED INFORMATION ON THE NEW SIGNS
West Grand Boulevard	52.7
Seward	52.4
Chicago	49.6
Webb	49.1
Davison	42.8
Linwood	44.0
Livernois	46.3
Wyoming	41.4
OVERALL	47.9

The somewhat higher percentages at the first four ramps are assumed to reflect the greater proportion of work trips generated by the New Center area. Publicity contained in the two newsletters circulated to offices in this area guaranteed a greater opportunity to reach the freeway user.

TABLE B-1

NUMBER OF RESPONDENTS ENTERING AT EACH ON-RAMP
HAVING PREVIOUSLY RECEIVED INFORMATION ABOUT THE SIGNS
(SOURCE: ENTRY RAMP, Q.10)

ON-RAMP	PREVIOUSLY RECEIVED INFORMATION		
	Yes	No	Total Responses
West Grand Boulevard	350	315	665
Seward	124	113	237
Chicago	108	110	218
Webb	83	86	169
Davison	230	307	537
Linwood	84	107	191
Livernois	81	94	175
Wyoming	94	128	227
TOTAL	1158	1261	2419

For those who had previous information, the following tabulation presents the source of that information:

INFORMATION SOURCE	PERCENT OF RESPONDENTS WHO HAD RECEIVED INFORMATION ABOUT THE SIGNS
Explanatory Leaflet	55.3
Newspaper	37.5
Television	24.7
Radio	9.3
Other	2.4

The total percentage exceeds 100% since many respondents received information from several sources. The leaflet was the most important source of information at every entrance ramp as indicated in Table B-2. Considering that over 66% of the ramp users are daily users, it is concluded that the distribution of leaflets directly at the ramps is the most effective method for reaching the freeway user. However, it appears that even a publicity campaign on the fairly broad level described above has reached only half of the ramp users despite the fact that the signs had been in operation for one month. It is thus important that such new, innovative traffic devices also be relatively self-explanatory to assure understanding and compliance by the entire driver population.

TABLE B-2

NUMBER OF RESPONDENTS ENTERING AT EACH ON-RAMP RECEIVING INFORMATION ABOUT THE SIGNS FROM EACH SOURCE*
(SOURCE: ENTRY RAMP, Q. 10)

ON-RAMP	SOURCE OF INFORMATION					
	TV	Radio	Newspaper	Leaflet	Other	Total
West Grand Boulevard	100	36	144	173	11	464
Seward	32	16	41	70	2	161
Chicago	30	3	43	58	3	137
Webb	14	6	32	49	2	103
Davison	53	20	85	124	5	287
Linwood	18	9	31	55	2	115
Livernois	21	11	26	45	0	103
Wyoming	18	7	32	66	3	126
Total Responses	286	108	434	640	28	1496

*Only those respondents stating they received information (Table B-1) are considered in this analysis. The above total is greater than the total answering "yes" in Table B-1 as a respondent may have received information from more than one source.

APPENDIX C

INSTRUCTIONS TO TEST SUBJECTS IN THE STUDY OF DRIVER RESPONSE TO THE RAMP CONDITION INFORMATION SIGNS

APPENDIX C

INSTRUCTIONS TO TEST SUBJECTS IN THE STUDY OF DRIVER RESPONSE TO THE RAMP CONDITION INFORMATION SIGNS

INSTRUCTIONS TO SUBJECTS OF SIGN VISIBILITY AND LOGIBILITY STUDY

During this experiment you will be asked to drive on the John C. Lodge service road paying attention to notice several ramp information signs. Here is a picture of what you will be looking for (show slide). Notice that several messages may appear on the sign. Please indicate by saying "NOW" when you first see the sign and again when you are able to read the message. I will record the distance from the sign at which you make each response.

Naturally you should follow all normal safe driving procedures since we will be in traffic throughout the experiment.

Questions?

INSTRUCTIONS TO SUBJECTS OF SIGN COMPREHENSION AND MESSAGE OBEDIENCE STUDY

This is a test of your ability to read and understand traffic regulatory and information signals under normal traffic conditions. I will direct you to a service road along the John C. Lodge Freeway at which point you should try to enter the Freeway by the earliest possible entrance ramp without violating any traffic regulatory signals. The service road will follow the Freeway at all times. In any case, you will have numerous opportunities to enter the Freeway. Besides these directions, I will give you no further information concerning the entrance ramps or the Freeway.

To repeat, it is imperative that you follow all traffic and information signals while attempting to enter the Freeway, keeping in mind that I cannot help you once we get on the service drive.

Questions?

APPENDIX D

SPECIFICATIONS FOR THE SUPPLY OF EIGHT INTERNALLY ILLUMINATED FRONTAGE ROAD INFORMATION SIGNS

APPENDIX D

SPECIFICATIONS FOR THE SUPPLY OF EIGHT INTERNALLY ILLUMINATED FRONTAGE ROAD INFORMATION SIGNS

Purpose

The signs shall be used for the purpose of advising a motorist on the frontage road to the John C. Lodge Freeway, Detroit, as to the traffic conditions on the various ramps which he might use to enter the Freeway. The following specifications generally apply to all eight signs. Where a specific sign is referred to, it is given the name of the nearest cross street with an adjoining on-ramp to the Freeway. For example, the West Grand Boulevard sign is the one near the ramp which, in turn, adjoins West Grand Boulevard.

Operation

The face of the signs shall display schematically the location of various ramps, together with a legend identifying the ramps by street name. Both the schematic route locations and the legend shall be illuminated internally such that a red or green color may be displayed except where otherwise indicated on the attached drawings. Where flashing operation is required, the flashing shall occur at a rate of not less than thirty (30) nor more than forty (40) times per minute. The illuminated period of each flash shall be not less than 70% and not more than 80% of the total cycle.

The colors shall be reasonably homogeneous throughout the area to be illuminated and shall be of sufficient intensity to produce a legible indication at a minimum distance of one hundred and fifty (150) feet in direct sunlight, with provision for a reduction in intensity by remote control.

Construction

The signs shall be constructed as shown on drawings 1, 2, and 3 enclosed with this specification*. The control circuitry for switching the sections of the sign will be provided by The University of Michigan. The length and width of the signs shall be as shown on the enclosed drawings, and the thickness shall be no greater than necessary to provide an adequate housing, allowing a space of one (1) foot by four (4) inches by four (4) inches for the switching chassis of the West Grand Boulevard, Seward, Chicago, and Wyoming signs. Any type of material may be used in the construction; however, the finished product must be generally sturdy, weatherproof, and neat in appearance.

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*Blueprints were provided to each prospective bidder. These are not included in this report as the details are fully discussed above and figures within the text of this report adequately depict the final design of the signs.

Sign Faces

The sign faces shall be flat, with no exposed illumination sources. Interstate standard non-reflectorized green color shall be used for the background. However, a black background shall be used for the illuminated panels. The section representing the Freeway and the lettering in "Freeway Ramp Conditions" shall be overlaid in reflectorized white. A one (1) inch reflectorized white border shall also be overlaid. All transparent material used in the sign face shall be equivalent in strength and impact resistance to 3/16 inch plexiglass. All lettering used in connection with the legend shall be four (4) inch Series D (Michigan Department of State Highways Standard Lettering Manual) except for ramp and street names. These shall be standard lower case with the initial capital letter four (4) inch Series E and all stroke widths reduced by 10%. Reduced spacing between letters may be necessary to fit the legend into the panel. The completed sign face shall present a legible, attractive, and generally professional appearance.

Mounting

All signs shall be provided with the necessary hardware for direct attachment to existing wooden poles or octagonal steel standards, and shall attach to the standards such that the loading is as nearly longitudinal as possible. The installation will be undertaken by The University of Michigan or its agents.

The present signs will be removed by The University of Michigan or its agents for alteration and the manufacturer shall state the maximum length of time required for the alteration of the signs.

Serviceability and Maintenance

It is not intended to develop a permanent operational piece of hardware, but rather to test an operational concept in communication with the motorist.

Strict specifications regarding serviceability and maintenance will, therefore, not be imposed; however, the manufacturer shall state the following:

1. Operating temperature range;
2. Anticipated life of light sources;
3. Anticipated useful life of the entire unit;
4. Power consumption;
5. Ease of access to internal area for maintenance;
6. General quality of components;
7. Requirements for electrical grounding; and
8. Any other features which are likely to affect serviceability as an operational device.

Electrical Requirements

The signs shall be designed to operate on 115 volt, 60 cycle, single phase alternating current, unless prior approval is obtained for a change in this requirement. All components shall be approved by Underwriters Laboratories. For the Livernois, Linwood, Davison, and Webb signs, a cable housing the wiring should extend twelve (12) feet from the exterior of the sign for connection to the switchboard. All units shall be designed to eliminate the danger of electric shock under normal operation.

Delivery

Delivery must be completed within five (5) weeks of notification of acceptance of the manufacturer's offer. The quoted price shall include delivery and unloading at the Public Lighting Commission, 174 East Atwater, Detroit, Michigan, or other location in the City of Detroit specified by The University of Michigan.

Guarantee

The supplier shall guarantee satisfactory performance of the units (excluding physical damage) for a period of six (6) months from the date of delivery.

In the event of physical damage to a sign, the manufacturer is asked to quote a labor cost (per hour) and a transport cost (per call) to return immediately to Detroit to repair the sign. Replacement materials would be supplied by the manufacturer at current retail prices less sales tax.

Bids

The manufacturer shall quote a price for the supply of the signs as specified and address the bid to The University of Michigan Purchasing Department (attention Mr. R. J. Wisler) but mail it to Professor Donald E. Cleveland, Department of Civil Engineering, University of Michigan, Ann Arbor, Michigan, 48104. The bid must be received no later than 5:00 p.m. , February 27, 1969.

APPENDIX E

PROJECT STATEMENT

APPENDIX E

"Excerpts From"

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Highway Research Board
National Academy of Sciences-National Research Council

FY '67

Project Statement

Research Project Title:

Optimizing Freeway Corridor Operations Through Traffic Surveillance, Communication, and Control

General Problem Area:

Special Projects

Research Problem Statement:

To meet present and future traffic demands, the combined freeway and surface street system must operate more efficiently. Freeways through heavily developed areas have limited right-of-way which prevents, on an economic basis, their reconstruction for increased capacity. Practical measures for increasing operational efficiency of these facilities through heavily traveled corridors should be developed by judicious application of traffic surveillance, communication, and control.

Urban freeways comprise a major portion of the traffic-carrying capacity of the total vehicular route system in American cities. It is believed that surveillance, communication, and control of traffic on freeways as well as on the supplemental street systems can be improved, resulting in better service to the motoring public as a whole.

It is desired to apply the best traffic surveillance, communication, and control techniques in a typical urban freeway corridor and to study the results. Innovations that may be expected to enhance the operational efficiency should be explored.

The National Proving Ground for Freeway Surveillance Control and Electronic Traffic Aids located on the John C. Lodge Freeway in Detroit has been extensively equipped for freeway surveillance, and this freeway and the adjacent corridor is designated as the study site to develop and evaluate improved surveillance, communication, and control techniques.

Objectives:

1. Determine method(s) for increasing the effectiveness of the system which involves the freeway and the adjacent surface street network within the corridor. Evaluate the methods on the study site with or without the use of additional hardware.

2. Recommend equipment configurations (that is, type and location) for the improved system which will represent the optimum balance in cost-effectiveness.