U.S. Department of Transportation

# Use of Videotape in HOV Lane Surveillance and Enforcement

March 1990

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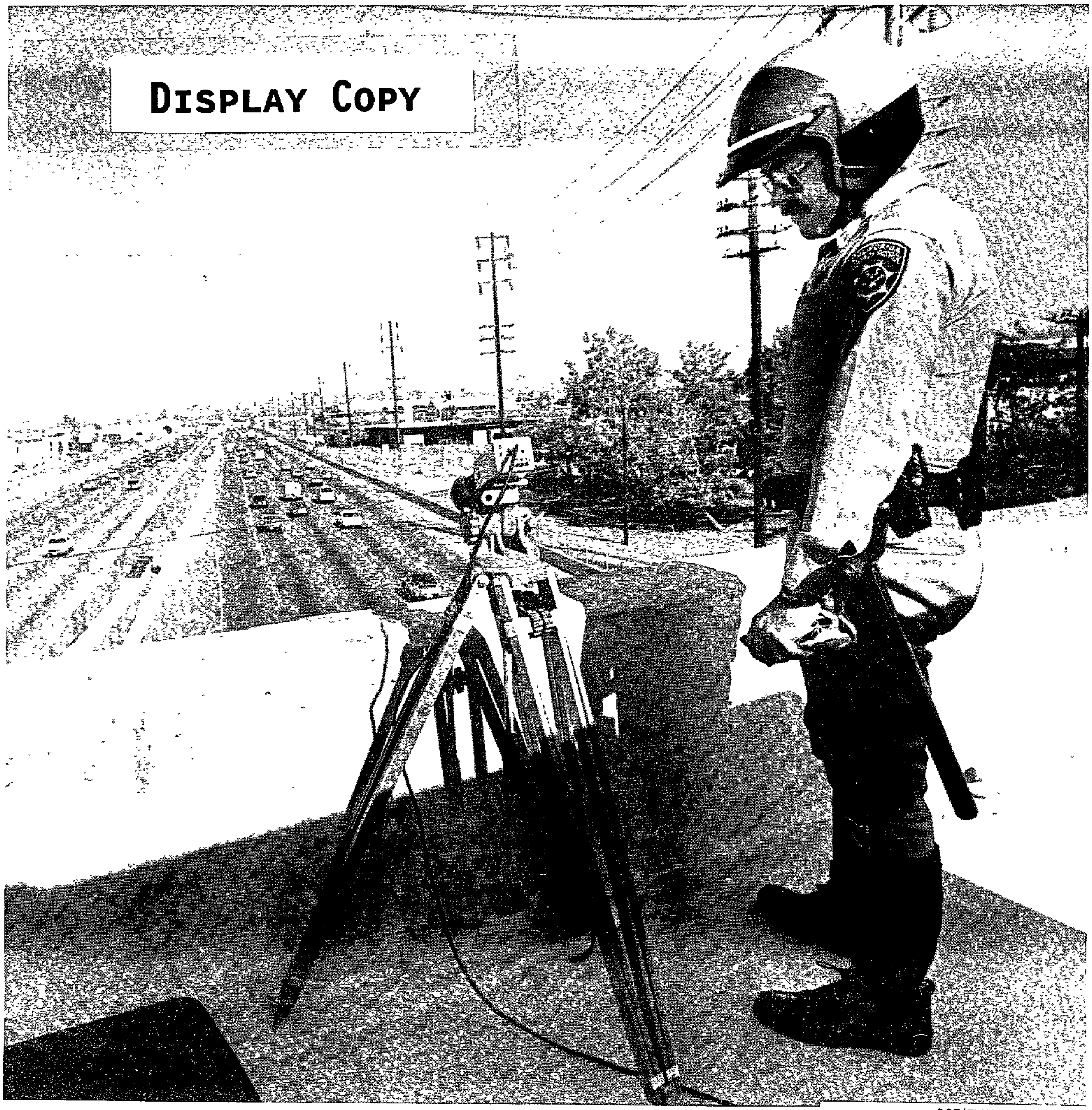

# USE OF VIDEOTAPE

# IN

# HOV LANE

# SURVEILLANCE AND ENFORCEMENT

## FINAL REPORT

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Ken Kaylor
Charles Shade

Submitted to

State of California
Department of Transportation

under Contract 55 G710

D232

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## PREFACE AND ACKNOWLEDGEMENTS

This report covers a six-month study designed to explore the use of vidoetape in HOV lane surveillance and enforcement. The study is an extension of an earlier investigation of the effects of different enforcement strategies and engineering designs on violation rates on California's mainline HOV lanes.

The report has been prepared in the Los Altos, California offices of SYSTAN, Inc. under Contract No. 55 G710 with the California Department of Transportation (CALTRANS). The project was jointly sponsored by the California Highway Patrol (CHP). Mr. Philip Jang, Chief of the HOV Systems Branch of CALTRANS Division of Traffic Operations served as project administrator, while Scott McGowen of CALTRANS acted as the project's technical monitor.

A steering committee comprised of representatives from CALTRANS, the CHP and the Federal Highway Administration (FHWA) was responsible for overall project guidance and for approving the products of major project tasks. In addition to Mr. Jang and Mr. McGowen, other members of the steering committee included: Assistant Chief N.K. Newman of the CHP's Border Division; Mr. Robert Anderson and Mr. Bill Shoemaker of CALTRANS District 4 (San Francisco); Mr. Glen Clinton of the FHWA; Mr. Joe El Harake of CALTRANS District 12 (Orange County); Mr. Ron Klusza of CALTRANS District 7 (Los Angeles); and Lieutenants Ron Phulps and Shawn Watts of the CHP's Long Range Planning Section.

SYSTAN's project manager and principal investigator was Dr. John W. Billheimer. Mr. Eric Lin of SYSTAN assisted with data coordination and analysis. Mr. Ken Kaylor of ATD Inc. was responsible for developing, adapting, and coordinating the camera equipment and monitors used in the study, while Mr. Charles Shade of ATD supervised the field installation and operation of the equipment. Ms. Fran Vella of Phrasmaker Word Processing prepared the Final Report.

Representatives of CALTRANS and the CHP who assisted in coordinating the field tests at the heart of the current study included:

Lt. Mike Howard, CHP (Santa Ana)
Mr. Andrew M. Miceli, CALTRANS (District 7)
Sgt. John Steel, CHP (Santa Ana)
Lt. Ed Whitby, CHP (Westminster)

SYSTAN wishes to thank all those who provided information and insights on the enforcement and operation of California's mainline HOV lanes, and acknowledges full responsibility for the analysis, interpretation, and presentation of the data they provided.

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## 1.O EXECUTIVE SUMMARY

### 1.1 INTRODUCTION

#### 1.1.1 Background

Enforcement of California's HOV lanes currently requires substantial commitments of California Highway Patrol (CHP) personnel and equipment. Personnel costs for enforcing the state's ten mainline HOV lanes alone will exceed $400,000 in 1990. HOV lane enforcement has other costs as well. These include the risks of high-speed pursuit in lanes adjacent to stop-and-go traffic and the deterioration of traffic flow when tickets are issued during peak commute periods.

It has been suggested that using video equipment to assist in HOV lane enforcement could reduce the requirements for patrol officers, increase citation rates, and minimize freeway disruption. The current investigation has been designed to extend past studies of HOV lane enforcement by testing both the feasibility and accuracy of the use of video equipment in HOV lane surveillance.

#### 1.1.2 Objective

The objective of the current study has been to demonstrate and test the use of video equipment in determining vehicle occupancy, documenting violator identity, and aiding enforcement of HOV lanes.

### 1.2 APPROACH

Six days of field tests were undertaken to explore the use of videotape in HOV lane surveillance and enforcement. Three days were devoted to testing the effects of different camera positions, filter adjustments, and monitor displays in the absence of enforcement personnel. Once a promising combination of camera positions and displays had been identified, they were tested with enforcement personnel present on specific HOV lanes in Southern California. Two days of HOV lane tests were undertaken on Los Angeles Route 91, with one day on Orange County Route 55. During these tests, personnel from ATD Inc. set up cameras in different configurations on and under freeway overpasses and established a three-way monitor in a separate video control unit (See Exhibit 1 .1). CHP officers stationed downstream from the video control unit were asked to observe selected video-identified violators to ascertain the actual number of occupants in the vehicle. At the same time, trained CALTRANS observers were stationed on the overpass to provide manual counts of violations. The results of these tests were then analyzed to determine the feasibility, accuracy, and cost-effectiveness of using video cameras in HOV lane surveillance and enforcement.

## 1.3 EXPERIMENTAL FINDINGS

### 1.3.1 Equipment

Field tests showed that it is technologically possible to record several accurate views of vehicles traveling in mainline HOV lanes. Specifications and costs of the equipment needed for videotape surveillance are summarized below.

**Cameras.** Best results are obtained with high speed color cameras capable of achieving exposure times of 1/1000 of a second. A14:1 zoom lens is needed to focus on oncoming vehicles at distances of approximately 1200 feet. Cameras placed at eye-level on the freeway itself should be small and unobtrusive.

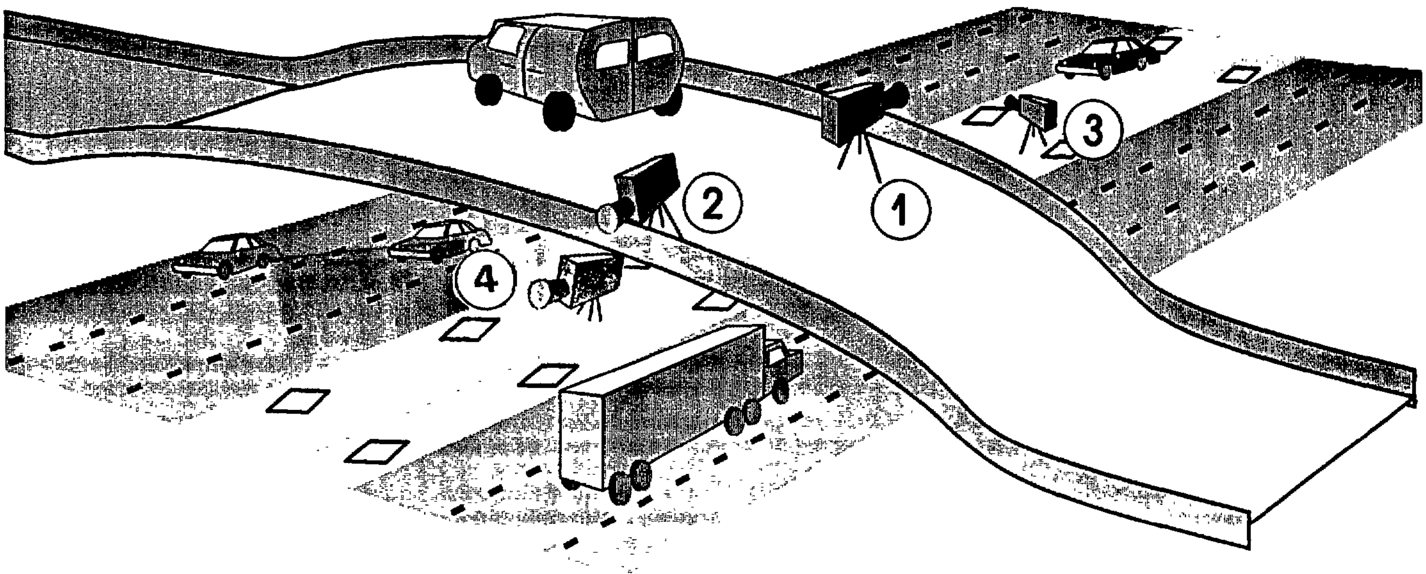
**Auxiliary Equipment.** Two monitors with split screen capability are required in the control van. One monitor provides an on-line review capability, while the other provides a permanent record of all camera views. A special effects generator should be used to make the exact time and location a permanent part of the videotape record.

Polarizing filters help to solve problems with glare from shiny cars and windshields, although they reduce the light-gathering capability of the cameras. Infra-red cameras and light sources can be used to document license plates after dark by videotaping the rear license plates of departing cars. However, it does not appear feasible to videotape oncoming vehicles under conditions of darkness or low visibility. Results are not clear and the infra-red light source can distract oncoming drivers.

**EXHIBIT 1.1**

**TYPICAL FIELD TEST SET-UP AND MONITOR OUTPUT**

1. Oncoming View
2. License View from Bridge
3. Driver's Eye Level View
4. License View from Roadway




**Camera Positions.** For real-time decision making, viewers seemed to prefer a monitor display showing three views of the suspect vehicles: (1) An oncoming view; (2) A view of the license plate; and (3) An oblique view downward into the passenger seat (camera positions 1, 2, and 3 in Exhibit 1 1). When decisions regarding vehicle occupancy can be delayed for a more leisurely review away from the freeway, the most useful monitor display appears to be the one providing the most information--that is, four views of the suspect vehicle. To provide these four views, an eye-level camera (Camera 4 in Exhibit 1.1) should be added to the three-camera display.

Cost. The cost of purchasing a fully outfitted van carrying four color cameras and the required monitors and auxiliary equipment is estimated to be $108,000. This includes the cost of the van itself and California sales tax. The van must be attended at all times by two experienced operators, since frequent camera adjustments are required to deal with glare and changes in ambient lighting. The services of a van and experienced operators can be leased for roughly $5,000 per peak commute period.

### 1.3.2 Accuracy

**Buffer Violations.** Buffer violators, those drivers who enter or leave the HOV lane illegally by crossing the double yellow line where lane changing is not allowed, were easily identified by the camera recording oncoming traffic. Violator sightings were unambiguous, and the license plates of those drivers entering the lane are recorded by the video surveillance system.

**Occupancy Violations.** Videotape reviewers cannot currently identify the number of vehicle occupants with enough certainty to support citations for HOV lane occupancy violations. In early tests with three cameras located on an overpass, subsequent videotape review produced a false alarm rate of 21%. That is, 21% of those vehicles identified as violators by videotape reviewers which had been checked by officers on site actually had the required number of occupants. In later tests with the third camera moved to the freeway itself, the false alarm rate rose to 51%. The chief cause of false alarms appeared to be small children and sleeping adults located out of the view of all three cameras.

**Ambiguous Observations.** Ambient lighting conditions, glare, and such vehicle design features as tinted windows, headrests, windshield posts, and high windows also made it difficult to interpret the number of videotaped vehicle occupants consistently. Videotape reviewers reported that these conditions made it impossible to estimate the occupancy of 11.4% of the vehicles passing by the video cameras. Even allowing for these uncertainties, individual reviewers differed widely in their attempts to document vehicle occupancy levels. These differences suggest that tape reviewers must be well-trained to ensure that certain conditions (i.e., glare) do not trigger false alarms and that ambiguous views are treated consistently by all reviewers.

**Roadside Occupancy Counts.** It is difficult to draw general conclusions regarding the accuracy of roadside counters from the observations of a small number of crews, since it is possible that the observations of different roadside observers will vary as greatly as those of different videotape reviewers. It appears, however, that roadside counters tend to overstate the number of HOV lane violators. In addition, one set of counters clearly understated the number of 3+ vehicles passing the observation point (this was the highest number of occupants required by their count sheets). Another set of counters using different count sheets apparently overstated the number of 6+ vehicles. Their count sheets included a space for 6+ vans, which they filled by assuming that most of the vans passing their observation point had six or more occupants.

It appears that videotape, with the opportunity it affords for rewinding and reviewing questionable vehicles, has the capability of supporting more accurate occupancy counts than those provided by roadside observers who must make decisions on the spot about cars moving past at 50 or 60 miles per hour.

### 1.3.3 Potential Applications

Although it is technologically possible to record a series of accurate views of vehicles traveling in mainline HOV lanes, no combination of recorded views currently provides enough information to support prosecution for occupancy violators. Even so, videotape surveillance of HOV lanes can provide useful information for a variety of other purposes. These include:

1. **Support for on-line enforcement.** In cases where there are no refuge areas adjacent to mainline HOV lanes, videotape surveillance provides a means of alerting officers stationed downstream from the cameras to the presence of oncoming violators.

2. **Support for remote ticketing.** Although videotape by itself does not appear to be accurate enough to provide a basis for citations, the combination of videotape and an observing officer could conceivably provide the accuracy needed for a system of mailed warnings and citations. If a system of mailed warnings or citations

can be installed, the officer would not have to pursue violators, and a videotape record of driver, occupancy, and license plate would be available for court hearings. Such a system would be more cost-effective than the current system of freeway pursuit and roadside citing, and will reduce the congestion caused by rubbernecking.

3. **Performance Monitoring.** There are several applications in which videotape surveillance appears to provide a marked improvement over current practice. These include:

   (a) **Freeway monitoring** to document vehicle type and occupancy over time;

   (b) **HOV lane monitoring** to document occupancy and violation rates as an aid for enforcement planning; and

   (c) **Project evaluation** to document the impact of HOV lanes and other carpool incentives on occupancy rates.

The cost of videotaping HOV lane activity is more than double the cost of monitoring operations manually. However, videotape provides more accurate records, a consistent data base, and a permanent, verifiable record of traffic activity. It also provides information on the vehicle mix, traffic speed, and the license plates of carpoolers and suspected violators.

### 1.3.4 Public Reaction

In a state in which radar cannot legally be used to enforce speed laws on state freeways, videotape surveillance of HOV lanes has significant legislative and public relations implications. These implications are beyond the scope of the current study. However, two pieces of information related to the current study may shed some light on the potential reactions of the public and the media to the possibility of videotape surveillance.

**Focus Group Reactions.** In a previous study (Billheimer, 1990) focus group participants were asked their opinions of a ticket-by-mail system supported by video surveillance. This possibility generated heated discussion, and driver opinion split dramatically, but evenly, on the desirability of videotape surveillance and tickets-by-mail. Opponents cited “big-brotherism” while proponents argued that freeway ticketing caused significant traffic slowdowns. Most drivers agreed that the public would have to be educated regarding the need both for HOV lanes and mail-out citations if such a procedure were to succeed.

**Press Coverage.** The field tests undertaken during the current study attracted the attention of the Los Angeles media and resulted in a limited amount of press coverage. Articles in the Los Angeles Times and Ontario Daily Report/Progress Bulletin were both balanced and informative. To the extent that these stories can be viewed as an indication of press and public reaction to the use of videotape in HOV lane enforcement, there was no suggestion that CALTRANS and the CHP would be exposed to a massive public outcry if videotape proves to be technologically and legally feasible as an enforcement tool. Furthermore, it can be assumed that the articles themselves made potential HOV lane violators in the Los Angeles area more cautious.

## 1.4 CONCLUSIONS

### 1.4.1 Enforcement

- Videocameras operating alone cannot currently identify the number of vehicle occupants with enough certainty to support citations for HOV lane occupancy violations. While certain HOV lane infractions, such as illegal buffer crossings, can be identified unambiguously and the license plates of violators can be recorded accurately, the rate of false alarms encountered in using videotape records to document occupancy violations is much too high to support enforcement actions. The chief problem encountered involves the size and positioning of vehicle occupants. Small children and sleeping adults can regularly escape the camera's eye.

  Other problems encountered in attempting to document vehicle occupancy through video surveillance included glare, ambient lighting conditions, vehicle size and position, tinted windows, and sight-obscuring headrests and windshield posts. These other problems, however, do not appear to be insurmountable. Some (i.e. glare and ambient lighting) can be solved technologically through the use of filters and continuous camera adjustments. Others simply lead to indeterminate occupant counts which would not trigger a citation. In any case, these problems are not the kind which lead to the mis-identification of violators. They may cause some violators to escape detection, but they should not produce false alarms so long as the videotape is carefully interpreted.

- Video cameras operating in conjunction with officer observation may provide sufficient accuracy to support mail-out citations for HOV lane occupancy violations. An officer stationed downstream from the video cameras is in a position to verify the occupancy of vehicles which appear suspect to observers monitoring camera output. If a system of mail-out warnings or citations can be installed, this officer would not have to pursue violators, and a videotape record of driver, occupancy, and license plate will be available for court hearings. This system is not foolproof, since the roadside officer may fail to see a small child missed by the video monitor, but it appears to have considerable promise. Moreover, the presence of an observing officer may remove some of the "Big Brother is watching" stigma from the use of videotape.

  Analysis suggests that a combined system of video recording, officer observation, and citations-by-mail is far more cost-effective than the current system of freeway pursuit and roadside citing. The combined video/observation system should be able to produce the same number of tickets for less than one-third the cost of special overtime assignments to roadside enforcement. Furthermore, by eliminating the need to pursue and cite violators during rush hour, the combined system improves the safety of both officers and drivers and reduces the congestion caused by rubbernecking.

- The use of videotape as a real-time on-line enforcement aid appears to be limited to those locations lacking a median shoulder or enforcement area where an officer can be posted for observation purposes.

  The use of videotape as an aid in enforcement activities requiring officer pursuit and on-line citations appears to be somewhat limited. An officer stationed beside an HOV lane in an enforcement area is in a better position to observe violators than an officer stationed in the control van watching a video monitor. Furthermore, the roadside presence of an officer in an enforcement area can have a cautionary effect on drivers. Either officer can radio ahead to pursuit units.

  The only locations where an officer in the videotape van might be better able to assist on-line enforcement than an officer on the freeway would be those locations where there is no refuge area adjacent to the HOV lane. If there is no median shoulder or enforcement area where an officer can be situated for enforcement purposes (as in the case, for example, on Marin 101), video-assisted enforcement stops might be considered as an option.

### 6.1.2 Surveillance

- Individual interoretation of occupancy levels by both roadside observers and videotaoe reviewers varies widelv with the individual and the instrument used. Evidence suggests that roadside observers overstate occupancy violations. While some observers understated the number of vehicles with three or more occupants, others using different count sheets overstated the number of high occupancy vans carrying six or more people.

- Videotape provides a freewav monitoring tool which is ootentiailv more consistent and accurate than existing techniques for documenting vehicle occupancv. In addition, videotape provides a permanent, verifiable record of the vehicle mix, traffic speeds, and the license plates of violators and carpoolers.

## 1.5 RECOMMENDATIONS

In view of the improved accuracy of videotape surveillance and the potential promise of videotape as an enforcement tool if used in conjunction with officer observation, it is recommended that CALTRANS and the CHP take the following steps to explore further the potential uses of videotape in HOV lane surveillance and enforcement.

- Test the relative accuracy of a four-camera set-up in conjunction with an observing officer. Further field tests should be undertaken to explore the relative accuracy of a four camera set-up in a freeway setting. As in past field tests, a downstream officer should verify the occupancy of suspect vehicles. However, as an additional check on the accuracy of the officer/videotape combination, motor officers should be available to pursue and cite vehicles identified as violators by both the videotape observers and the verifying officer.

- Test the impact of mailed warnings on violation rates. Video surveillance should be used in conjunction with a roadside officer to monitor several days of HOV lane operations. Written warnings should be mailed to the registered owners of vehicles identified as violators by both the videotape monitors and roadside officers. The impact of this activity on HOV lane violations should be documented through subsequent videotape surveillance and follow-up surveys. Media support for the demonstration should be enlisted through a carefully designed program of public information.

- Explore the use of videotape on ramp meter bypass lanes. The current study has tested and demonstrated the use of videotape in documenting violation activity on mainline HOV lanes. Similar tests should be undertaken on ramp meter bypass lanes.

- Continue to explore the legislative/legal ramifications of mail-out citations. The CHP should continue to explore the necessary legislative and legal steps necessary to support the use of tickets-by-mail for HOV lane infractions.

- Continue to explore the uses of advanced videotape technology in HOV lane surveillance and enforcement. Two additional avenues of investigation identified through the current research include:

    1. The use of micro-cameras installed in the helmets of motorcycle officers; and

    2. The use of low level infrared lighting installed at freeway level to document the occupancy of departing vehicles under conditions of darkness or low visibility.

# 2.0 INTRODUCTION

## 2.1 BACKGROUND

Enforcement of California's mainline HOV lanes currently requires a substantial commitment on the part of the California Highway Patrol. A recent SYSTAN study (Billheimer, 1990) estimated that the personnel costs required to enforce the mainline HOV lanes in place in January 1990 exceeded $400,000 per year. HOV lane enforcement has other costs as well. Heavy enforcement during peak commute periods, when violations are heaviest, leads to rubbernecking which can cause traffic flow to deteriorate.

It has been suggested that using video equipment to assist in HOV surveillance and enforcement could reduce the requirements for patrol officers, increase citation rates, and minimize freeway disruption. It is also possible that a videotape of HOV lane activities could improve the accuracy of occupancy counts, provide a permanent record of violations, document the identity of violators, and supply a basis for mail-out warnings or citations. Manufacturers of video equipment claim that it is possible to videotape both the license plates and the windows of vehicles using HOV lanes, even when those vehicles are traveling at rapid rates of speed. What is less well understood is the ability of the video camera to document with certainty the exact number of vehicle occupants. The current investigation is designed to extend past studies of HOV lane enforcement by testing both the feasibility and accuracy of the use of video equipment in HOV lane surveillance.

## 2.2 OBJECTIVE

The current investigation has been designed to demonstrate and test the use of video equipment in determining vehicle occupancy, documenting violator identity, and aiding enforcement of HOV lanes.

## 2.3 SCOPE

As many as four high-speed color video cameras operating from a special mobile video unit were used in the demonstration. This equipment was installed by Advanced Technology Division (ATD), and was adjusted to detect vehicle occupancy. Preliminary experiments tested the effect of different camera positions, filter adjustments, and monitor displays. Once a promising combination of camera positions and displays was identified, they were tested in specific HOV lanes in Southern California. During the tests, trained observers were stationed at the roadside to provide manual counts of violations at the same time that the video equipment was recording. In addition, CHP officers stationed downstream from the mobile video unit were asked to observe selected video-identified violators to ascertain the actual number of occupants in the vehicle and possibly issue a citation. The results of these tests were then analyzed to determine the feasibility, accuracy, and cost effectiveness of using video cameras in HOV lane surveillance and enforcement.

## 2.4 SCHEDULE OF FIELD TRIALS

A schedule of the field trials undertaken in the current study appears in Exhibit 2.1. Chapter Three details the demonstration activities undertaken during these trials, while Chapter Four analyzes test results and lists the lessons learned from the field demonstrations. Chapter Five discusses potential applications of video technology in HOV lane surveillance and enforcement. Chapter Six outlines recommendations resulting from the current study.

**EXHIBIT 2.1**

**SCHEDULE OF FIELD TRIALS**

| DATE | ROADWAY | LOCATION | EQUIPMENT | TEST PERSONNEL | PURPOSE OF TEST |
|---|---|---|---|---|---|
| 8/22/89 | Simi Valley Roadway | Winnetka Overcrossing | Mobile van with four high-speed color video cameras; two monitors; two 3/4" recorders | Three technicians | Test alternative camera positions, filter and lens settings, and monitor displays |
| 10/19/89 | LA 91 HOV Lane | Wilmington Ave. Overcrossing | Mobile van with three high-speed color video cameras; two monitors; two 3/4 recorders; time generator | Three technicians; Two motor officers; One patrol officer | Test alternative camera positions; use of video in on-line enforcement; accuracy of video sightings |
| 11/12/89 | Simi Valley Freeway | Winnetka Overcrossing | Mobile van with three high-speed cameras; one micro-camera; one monitor; one 3/4" recorder | Three technicians | Test alternative lens and filter settings; camera levels; and placement techniques for freeway-level camera |
| 12/14/89 | DeSoto Avenue | Intersection of DeSoto and Victory | Micro-camera, monitor and recorder | Two technicians | Test filter, lens and alternative heights for freeway-level camera |
| 12/19/89 | LA 91 HOV Lane | Wilmington Ave. Overcrossing | Mobile van with three high-speed color video cameras; one micro-camera; two monitors: two 3/4" recorders | Three technicians; Two motor officers; One patrol officer; Two vehicle counters | Test alternative camera positions; use of video in on-line enforcement; accuracy of video sightings |
| 1/4/90 | OR 55 HOV Lane | Warner Avenue Overcrossing | Mobile van with three high-speed color video cameras; one micro-camera; two monitors; two 3/4" recorders; time generator | Three technicians; Three motor officers; Two vehicle counters | Test alternative camera positions; lens and filter settings; accuracy of video sightings; comparability of manual and video occupancy counts |

## 3.0 FIELD TESTS

This section describes the field tests undertaken to test the use of videotape in HOV lane surveillance and enforcement. Each test is described, findings from the field demonstrations and subsequent analyses are documented, and results are summarized.

### 3.1 INITIAL CAMERA TEST

The initial test of the use of video equipment in HOV lane surveillance took place on the Winnetka Road overcrossing overlooking the Simi Valley Freeway on August 22, 1989. The test was designed to explore alternative lens settings, camera positions, and monitor displays. Although there is no HOV lane on the Simi Valley Freeway, the Winnetka Road overpass is unused and provided a good setting for experimenting with a variety of camera positions trained on vehicles in the number-one lane.

#### 3.1.1 Test Eauioment

A mobile video van was employed in the tests. This unit included four high-speed video cameras operated from a control console having a split screen capability. An infra-red camera and light source were also available. Two 3/4" video recording units were used in conjunction with two monitors to provide simultaneous playback and recording capability. A motor-generator supplied AC power for all of the equipment. The relative positions of the four cameras and the control van are diagrammed in Exhibit 3.1.

#### 3.1.2 Test Sequence

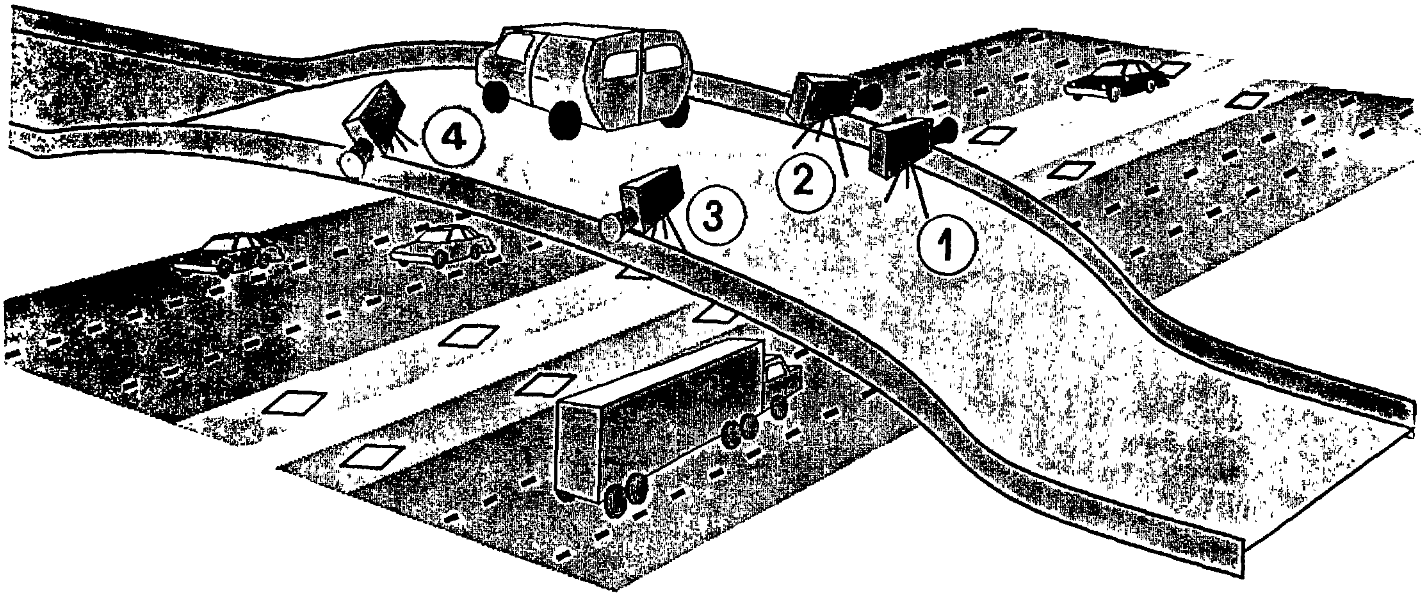
**infra-Red Test.** The ATD crew began setting up equipment at approximately 4:00 a.m. in order to test the feasibility of obtaining videotape records under conditions of darkness and poor visibility. An infra-red camera and light source were used during this phase of the test.

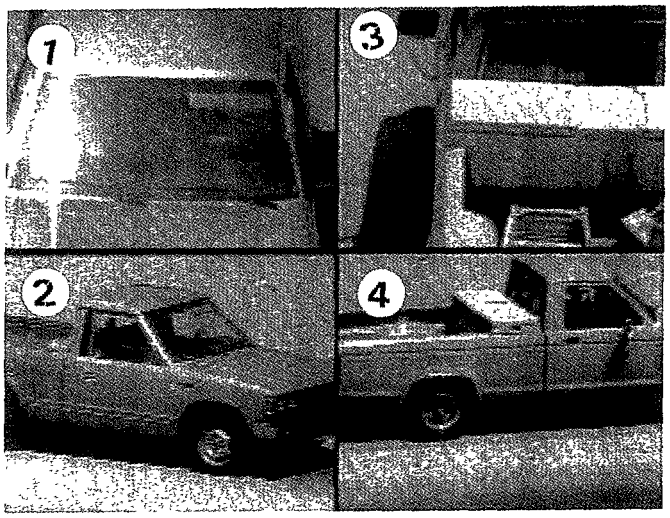
**Three-Camera Test.** When daylight permitted, four cameras were set up to record occupancy and license plate information simultaneously (see Exhibit 3.1). Three cameras were initially deployed as follows:

EXHIBIT 3.1

# INITIAL SET-UP

1. Oncoming View
2. Oblique Oncoming View
3. License View
4. Oblique Departing View



**Camera 1:** One high-speed video camera was positioned on the overpass facing oncoming traffic to provide an oncoming view of vehicles traveling in the number 1 lane and their license plates.

**Camera 2**: A second high-speed camera was placed on the same side of the overpass to provide an oblique view of vehicles in the number one lane. The angle of this camera was varied from $90^{\circ}$ (right angles to the freeway) to $45^{\circ}$ in order to determine the most advantageous position.

**Camera 3**: A third high-speed camera was placed on the opposite side of the overpass facing the rear of the vehicles traveling in the number one lane. This camera provided a view of the rear window of the car as well as license plate data.

Information from all three cameras was displayed simultaneously in a split-screen format on a single monitor. Sample split-screen displays appear in Exhibit 3.2. In addition, a separate monitor recorded the license plate images provided by Camera 3. Camera positions were adjusted to determine the most advantageous positioning, and a variety of split-screen presentations were tested to determine the configurations best suited for observing vehicle occupancy.

**Four-Camera Test.** A fourth camera was ultimately added to the three-camera configuration described above in order to provide an oblique view of the rear of vehicles after they had passed by the observation post. Views from all four cameras were displayed in four quadrants of a split screen monitor, and the position of the fourth camera was adjusted to provide the most advantageous position.

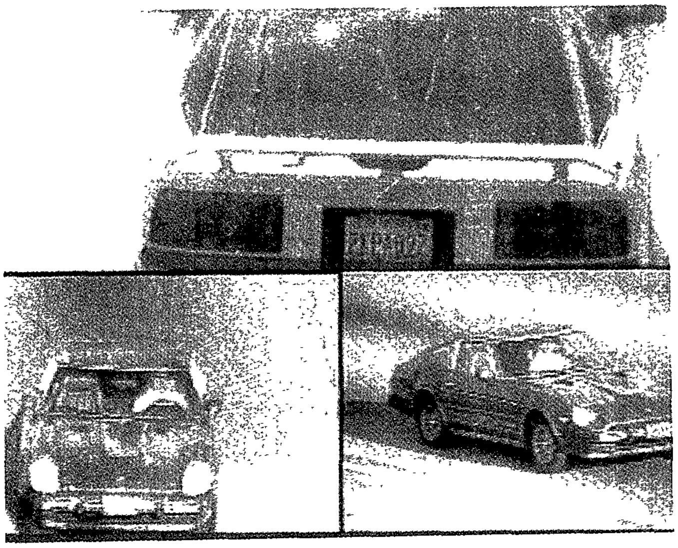
### 3.1.3 Post-Test Analysis

**Sample Videotape.** A sample videotape was prepared from the footage recorded at the Winnetka Road overcrossing to facilitate the evaluation of different camera angles and monitor displays. The sample tape included fourteen different TV monitor displays involving a combination of camera angles. The fourteen displays were characterized as follows:

1. Single camera, rear view
2. Single camera, front view
3. Single camera, rear view
4. Single camera, side view (R to L)
5. Single camera, side view (L to R)
6. Single camera, rear angle
7. Three cameras, rear view vesticle (Display B in Exhibit 3.2)
8. Three cameras, rear view horizontal (Display A in Attachment B)
9. Four cameras, black and white front view
10. Four camera (Display C in Attachment B)
11. Single camera, front view
12. Single camera, side view
13. Single camera, rear view (dark)
14. Four cameras, synchronized view

## EXHIBIT 3.2

## SAMPLE VIDEO MONITOR OUTPUT



**(A) THREE-CAMERA DISPLAY**

1. Rear View of Departing Vehicle
2. Front View of Oncoming Vehicle
3. Oblique View of Oncoming Vehicle

**(B) THREE-CAMERA DISPLAY**

1. Rear View of Departing Vehicle
2. Front View of Oncoming Vehicle
3. Oblique View of Oncoming Vehicle

**(C) FOUR-CAMERA DISPLAY**

1. Front View of Oncoming Vehicle
2. Oblique View of Oncoming Vehicle
3. Rear View of Departing Vehicle
4. Side View of Departing Vehicle

**Procedure.** To test viewer reactions to the sample videotape, a standard form was prepared that identified vehicles by description (license numbers where available, size and color otherwise) and tape location. Five raters were asked to view the tape and assess the occupancy of each vehicle and determine whether the driver was wearing a seat belt. Occupancy choices were 1, 2, 2+, 3, 3+ and "unknown." Seat belt use was identified as "yes," "no," or "?".

A maximum of 25 cars were rated in each of the fourteen sample displays. In all, a total of 232 cars were identified specifically on the rating sheet. All but one rater was able to locate all of the vehicles identified on the sheet. All of the raters reported that they had no particular difficulty with the process.

Raters were provided with stop-motion and rewind controls and allowed to take as much time as they wished in identifying vehicles. They were instructed to make sure that they reviewed all views of a vehicle in the multiple camera displays before completing the rating. The amount of time raters took to review and record their responses to 232 vehicles ranged from one hour and thirty minutes to three hours and fifteen minutes.

Appendix A summarizes the five rater evaluations for each of the fourteenn displays. A review of this information and observation of the rating process suggests that:

- Vehicle ocupancy was easier to observe than seatbelt use;
- No single display produced unanimity of results among raters;
- Single-occupant vehicles were easiest to identify;
- In considering the multi-camera displays, raters tended to prefer three-camera displays to four-camera displays, since they felt the views provided in the four-way split were too small;
- The various displays produced wide variations in rater consistency. Raters provided the most consistent responses to the three-camera and four-camera displays (#8 and #9). The least consistent responses were obtained in rear-view shots (#l and #3), right-angle shots (#12), and the synchronized four-way shot (#14).

Raters were asked to comment on the advantages and disadvantages of each alternative, but few had specific comments. By the time they had finished their task, the individual displays had run together in their minds.

### 3.1.4 Preliminary Findings

The field tests and subsequent tape review led to the following tentative conclusions.

1. **After-Dark Videotaping.** Although it is possible to videotape license plates from the rear using an infra-red camera and light sources, it does not appear feasible to document occupancy under conditions of darkness or low visibility. Results are not clear and the light source can be a distraction to oncoming drivers.

2. **Playback Necessity.** Under real-time viewing conditions, it is usually necessary to play back the videotape to make sure that a vehicle suspected of violating HOV requirements actually has too few occupants. The playback/conformation action can take from 30 seconds to one minute, so that any officers responding to broadcast descriptions of violators will have to be at least one to two miles downstream from the taping site.

3. **Number of Cameras.** During the field test, the four-camera set-up appeared to provide the most useful information on vehicle occupancy. However, viewers reviewing the tape after the fact preferred the three-camera setup, feeling that the images provided in the four-way split were too small.

4. **Camera Angles.** During the initial trial, it appeared that the camera facing the oncoming vehicles (Camera 1 in Exhibit 3.1) should be set at a shallow angle (with the horizon) to keep vehicles in the frame as long as possible. The oblique camera (Camera 2) should be aimed to cover the same field of vision as the camera facing traffic directly. In this way, the two views of the vehicle (head on and oblique) appear simultaneously on the split screen, providing a visual cue to the monitor viewer. As a practical matter, the amount of occupancy information provided by the oblique camera appeared to increase as the angle between the camera and the roadway decreased (i.e. as the camera was aimed farther down the roadway). Very little useful information was transmitted when the camera was set at right angles to the roadway.

   The two cameras trained on the rear of departing cars should be focused at sharper angles to the freeway to provide clearer license plate definition. As with the forward-facing camera, the oblique camera (Camera 4 in Exhibit 3.1) should be trained on the same segment of freeway as the camera directly over the departing cars (Camera 3).

5. **Missed Observations.** Although the four-camera system provided conclusive occupancy information on most vehicles, car design, camera angles, glare, tinted windshields, changing light conditions and a variety of other problems made it impossible to obtain occupancy information on 100% of the vehicles videotaped.

6. **Simultaneous Display.** Although it is possible to acquire video equipment capable of introducing an on-line time delay in the monitoring system so that all four images of a single vehicle are displayed simultaneously, the expense of this equipment (currently estimated at roughly $50,000) does not appear to be justified. Furthermore, the on-line delay would have to be adjusted constantly as vehicle speeds change. The on-site observer will have to review the tape under most circumstances, and can quickly review the separate images produced by the two forward-facing cameras and the two rear-facing cameras. Any requirement for simultaneous hard-copy records can be manufactured in the studio after the initial data have been recorded.

7. **License Plate Documentation.** License plates can be captured with sufficient accuracy on the quarter-screen display of the multiple-image monitor. They need not have a separate dedicated full-screen monitor.

## 3.2 INITIAL ENFORCEMENT TEST

On October 19, the first of a series of tests using CHP officers and on-line video displays to identify possible violators was undertaken. The test took place at the Wilmington Avenue overpass overlooking the eastbound HOV lane on LA 91. As the demonstration was initially set up, a single officer in the control van monitored the video display and radioed descriptions of suspected violators ahead to two motor officers. The two motor officers verified the number of occupants in the vehicle and, at their discretion, issued citations to drivers violating the HOV lane's occupancy requirements.

### 3.2.1 Demonstration Set Up

**Equipment.** Three cameras were set up on the Wilmington Avenue overcrossing and linked to two video monitors in the observation van. The location of the camera is diagrammed in Exhibit 3.3. Two cameras focused on oncoming traffic in the HOV lane, while the third camera recorded license plates of departing vehicles. One of the monitors in the van provided an on-going, time indexed record of the three camera views. Exhibit 3.4 shows the three views displayed on the monitor. The second monitor provided the viewing officer with a stop-action and review capability which made it possible to replay and reexamine the images of suspected violators before making a final decision on the number of occupants.

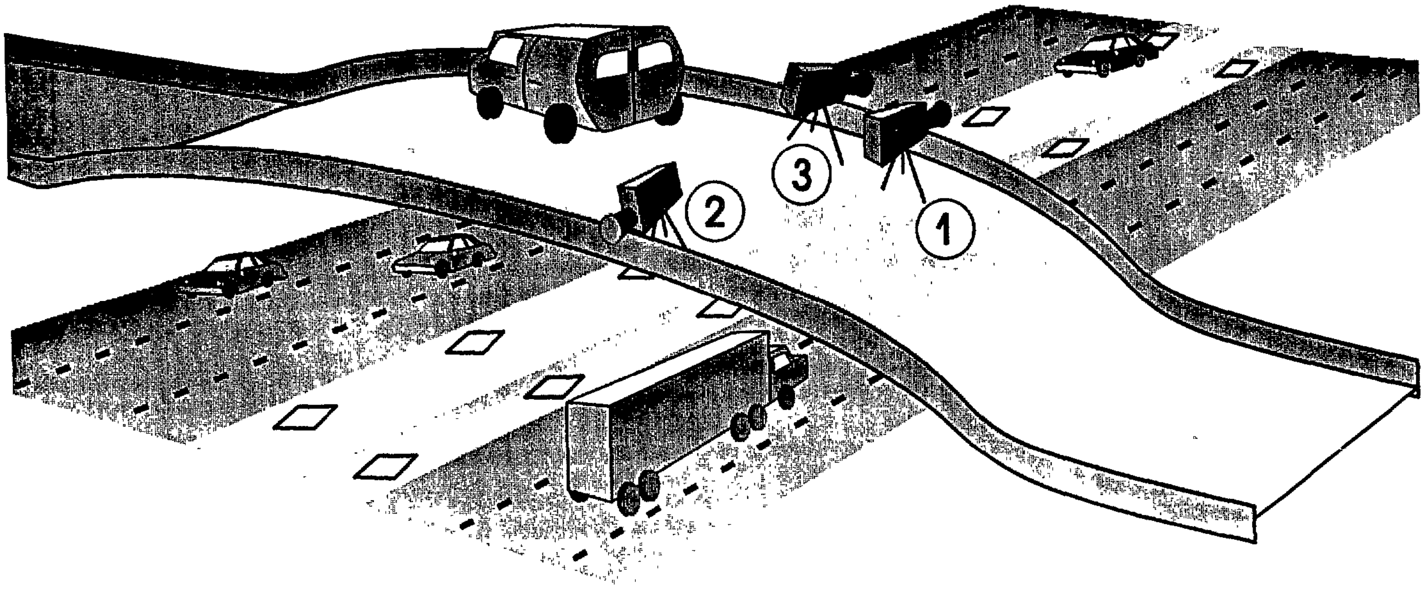
**Officer Participation.** The video equipment was in place and running by 12:00 noon. At that time two motor officers took up positions at onramps roughly one-and-a-half miles downstream from Wilmington Avenue. A third officer was stationed in the observation van and given a brief run-down on equipment operations. The three officers then experimented with the tool during the relatively light midday traffic. When the observing officer spotted a potential violator, she would review the tape, note the license number, and radio the vehicle description ahead to the two motor officers, who would pursue the suspect and verify the violation. Even during the light midday traffic, some suspected violators went unverified if the motor officers were busy pursuing previous calls.

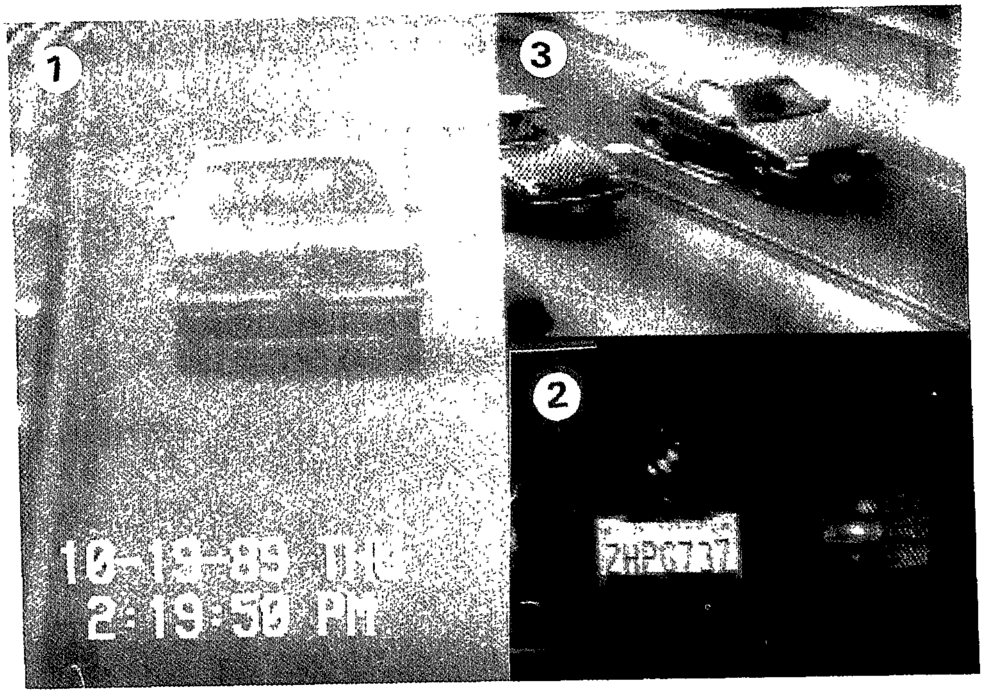
EXHIBIT 3.3

INITIAL ENFORCEMENT SET-UP

Three Cameras On Bridge

1. **Oncoming View**
2. **License View**
3. **Oblique View**



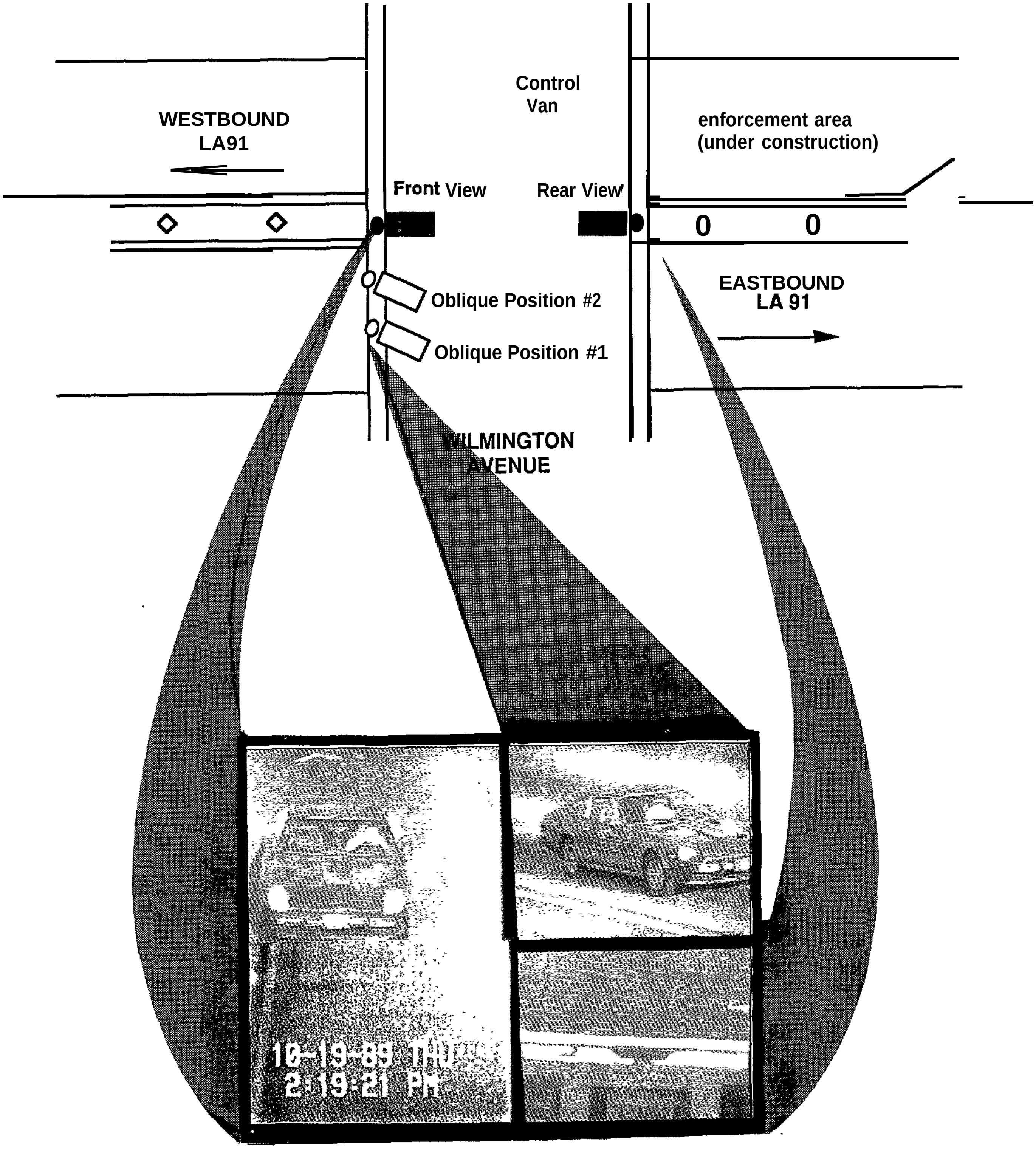



**EXHIBIT 3.4**

**MONITOR DISPLAY**
**INITIAL ENFORCEMENT TESTS**

At 2:00 p.m. the CHP shifts changed, and a new set of officers replaced the initial participants. The incoming officer quickly learned videotape operations, and the new team of officers was in place by 2:19.

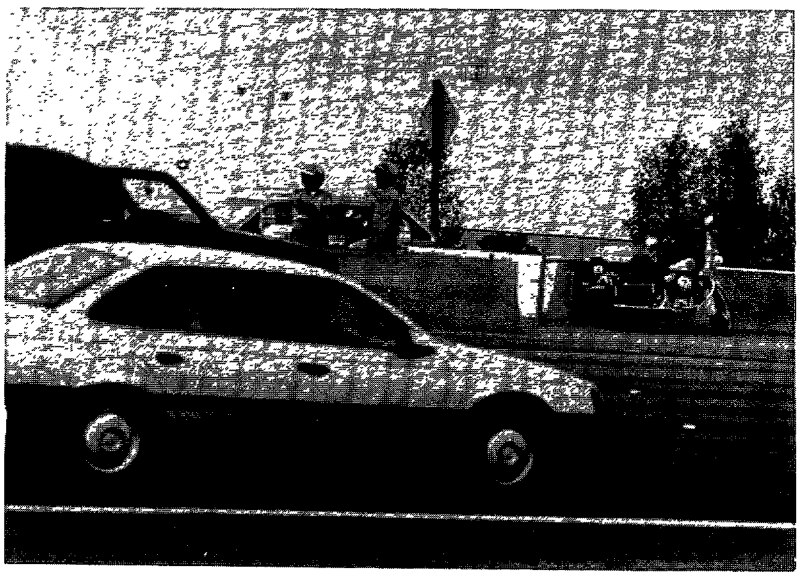
As the evening commuter traffic built up, it became increasingly difficult for motor officers to pursue violators from positions near freeway ramps. When it became apparent that more and more suspects were escaping unverified, the officers repositioned themselves at an enforcement area being constructed about 1500 feet downstream from the observation point. (See Exhibit 3.5.) From this stationary position next to the HOV lane, they were able to observe most of the suspected violators identified by the officer viewing the videotape.

### 3.2.2 Analvsis of Results

**Field Test Findings.** A summary of the traffic observations made by the second team of officers during the evening commute period appears below:

| TIME | SUSPECTED VIOLATORS OBSERVED | VIOLATOR DESCRIPTIONS SENT | VIOLATOR DESCRIPTION ACKNOWLEDGED | VERIFICATION RESULTS | | |
|---|---|---|---|---|---|---|
| | | | | VIOLATOR VERIFIED | SUSPECT NOT A VIOLATOR | UNABLE TO OBSERVE SUSPECT |
| INITIAL TIME 2:15-3:25 (Motor officers pursuing) | 12 | 12 | 11 | 1 | 5 | 5 |
| OFFICERS REPOSITIONED 3:30-4:20 (Motor officers stationary in enforcement area) | 29 | 29 | 28 | 18 | 10 | 0 |
| CAMERA REPOSITIONED 4:29-5:00 (Motor officers stationary) | 18 | 18 | 16 | 8 | 6 | 2 |
| TOTAL | 59 | 59 | 55 | 27 | 21 | 7 |

**VAN AND REAR-VIEW CAMERA**



**OFFICERS IN ENFORCEMENT AREA**

**EXHIBIT 3.5**

## VIDEOTAPE DEMONSTRATION PHOTOS

Motor officers were able to observe 48 of the 59 (81%) suspected violators whose descriptions were broadcast by the observing officers. Of the suspects actually observed, 27 of 48 (56%) were verified as violators. However visual observation at freeway level showed that 44% of the suspects turned out to have the required number of occupants. This rate of false alarms is far too high for any mail-out warning scheme. However, the rate represented the results of a first trial, and several adjustments were identified to improve future accuracy.

Both of the officers assigned to the van were able to master the use of the video monitor quickly and with no difficulty. At first, both tended to try to review the tape on potential violators before the violator had passed by the third (rear-view) camera, but this tendency was quickly remedied.

The position of the oblique camera was adjusted at 4:30 p.m. to provide a more direct view downward view into the passenger seat of the oncoming vehicles. The observing officer felt that this view "...improved things 110%" but it did not noticeably reduce the false alarm rate.

**Data Reduction**. In order to check the relative accuracy of the officers making decisions during peak commuting hours against the accuracy of office workers reviewing the videotape under more relaxed conditions, office personnel subsequently screened the October 19 tape record for the hour between 3:30 p.m. and 4:30 p.m., classifying vehicle occupancies. The occupancy records documented by reviewers during that period are listed below.

| LA 91: 10/19/89 Vehicle Occupancy 3:30 p.m. to 4:30 p.m. | 1 | 2 | 3 | 3+ | Can't Tell | Total |
|---|---|---|---|---|---|---|
| Number | 86 | 947 | 111 | 45 | 58 | 1247 |
| Percent | 6.9% | 75.9% | 8.9% | 3.6% | 4.7% | 100% |

Thus the office reviewers counted 86 violators during the one-hour period, a violation rate of 6.9%. Over the same period, the CHP officer viewing the videotape on the scene had identified 29 potential violators. When field officers assigned to the freeway checked these 29 vehicles, they found that 19 actually were violators, while 10 had at least two occupants. This represented a success rate of 66%.

Only fourteen of the twenty-nine vehicles verified by officers at the time of the field trial were identified as potential violators by the office reviewers. Of these, eleven vehicles had been identified as actual violators, while three had the required number of occupants, even though they escaped the camera's eyes. This represented a success rate of 79% for the office reviewers.

As would be expected, reviewers identified more potential violators than the officer on the scene, who needed to make decisions in real time and was often reviewing videotape or conferring with field officers as other violators passed before the camera. It is also not too surprising that the office reviewers, who enjoyed the luxury of unlimited screening time, had a higher percentage of accuracy (79% vs. 66%) than the field officer. Because of the relatively small sample size this higher accuracy percentage is not statistically significant (at the 5% significance level).

### 3.2.3 Preliminary Findings

The following preliminary conclusions and observations were made following the initial videotape/enforcement demonstration on LA 91. These observations and findings would be tested further in subsequent demonstration runs.

1. **Real-Time Enforcement Efficacy.** The use of videotape as a real-time enforcement aid appeared to be somewhat limited. The officer in the van radioed descriptions of more potential violators than the two motor officers could apprehend, but he could easily have made the same observations from a roadside enforcement area, where his presence might have had a cautionary effect on drivers. The only locations where an officer in the videotape van might be better able to assist on-line enforcement than an officer on the freeway would be those locations where there is no refuge area adjacent to the HOV lane. If there is no median shoulder or enforcement area where an officer can be situated for enforcement purposes, video-assisted enforcement stops might make more sense. The Marin 101 HOV lane is a good example of such a location. In the previous test of enforcement tactics on Marin 101, it was virtually impossible to find an adjacent location where a motor officer could safely observe traffic (Billheimer, 1990).

2. **Camera Positioning.** The ability of officers stationed beside the HOV lane to sight violators that escaped detection by the overcrossing camera suggested that an unobtrusive freeway-level micro-camera might be used to good advantage in HOV lane surveillance.

3. **Technical Difficulties.** A few technical problems were noted which would be corrected in future runs.

   - At certain times of day, windshield glare prevented viewers from observing the number of vehicle occupants. On future runs, polarized filters would be used to combat this effect.

- Different lengths of cable leads from the control van made it difficult to synchronize the color and images provided by the three cameras. On future runs, cable leads would be reconfigured to balance line resistance and minimize this problem.

## 3.3 EYE-LEVEL CAMERA TESTS

Since officers in the enforcement area alongside the HOV lane on LA 91 were able to detect occupancy violations with more success than cameras and observers stationed on overpasses above the HOV lane, ATD undertook the development of a camera that could record the same view as that seen by the roadside officers. Since this camera would be located alongside the HOV lane, it was essential that it be unobtrusive enough to avoid distracting passing drivers. To that end, they developed a micro-camera and mount capable of being installed on the median divider.

### 3.3.1 Field Testing

Three field tests were made to develop, test, and demonstrate the roadside micro-camera.

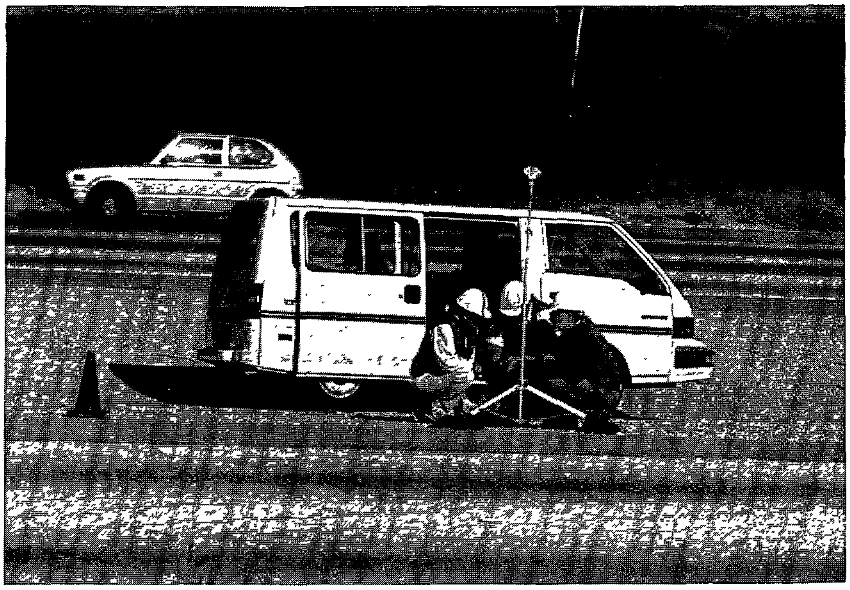
(1) On December 12, 1989, ATD tested the installation of a micro-camera along the Simi Valley freeway at the Winnetka overcrossing. Various camera levels were tested, and best results were obtained from a camera position slightly higher than the car roof, angled downward to provide a view of the passenger seat and right rear seat. Exhibit 3.6-A shows the camera-tripod arrangement tested on the Simi Valley Freeway.

(2) On December 14, 1989, ATD tested the use of polarized filters in conjunction with the micro-camera. The test was conducted on DeSoto Avenue near ATD headquarters, and resulted in the development of a tiny filter capable of reducing the effect of glare when the micro-camera is recording.

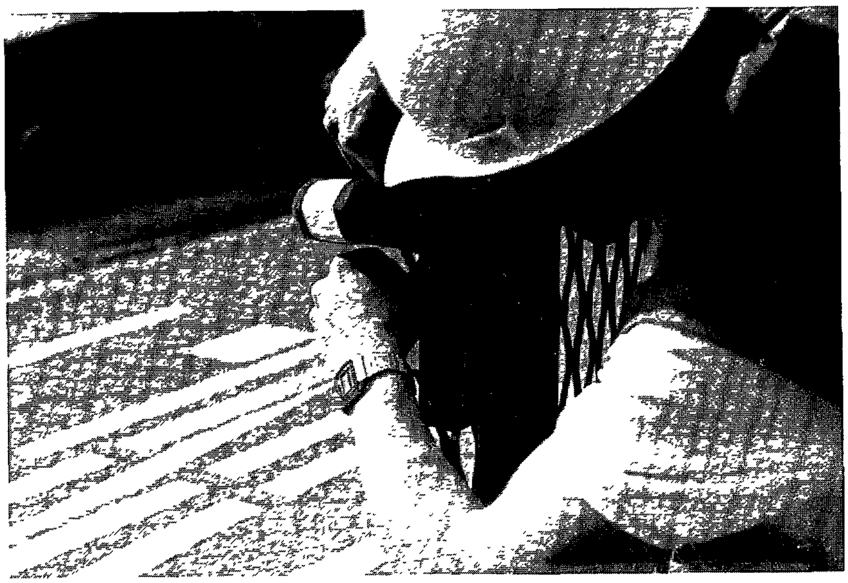
(3) On December 19, 1989, the team tested the eye-level micro-camera on LA 91 with CHP officers present to review the videotape and verify violations on the freeway itself. Exhibit 3.6-B shows the micro-camera installation on a fence post rising from the LA 91 center divider, while Exhibit 3.7 shows the relative positions of the three cameras used in the demonstration. Two experienced CALTRANS freeway observers were also on hand to count vehicle occupants from the bridge level and provide a basis for comparing manual and videotape counts.

## EXHIBIT 3.6

## TESTS OF EYE-LEVEL MICRO-CAMERA



**B-1 Testing Eye-Level Microcamera on Simi Valley Freeway**

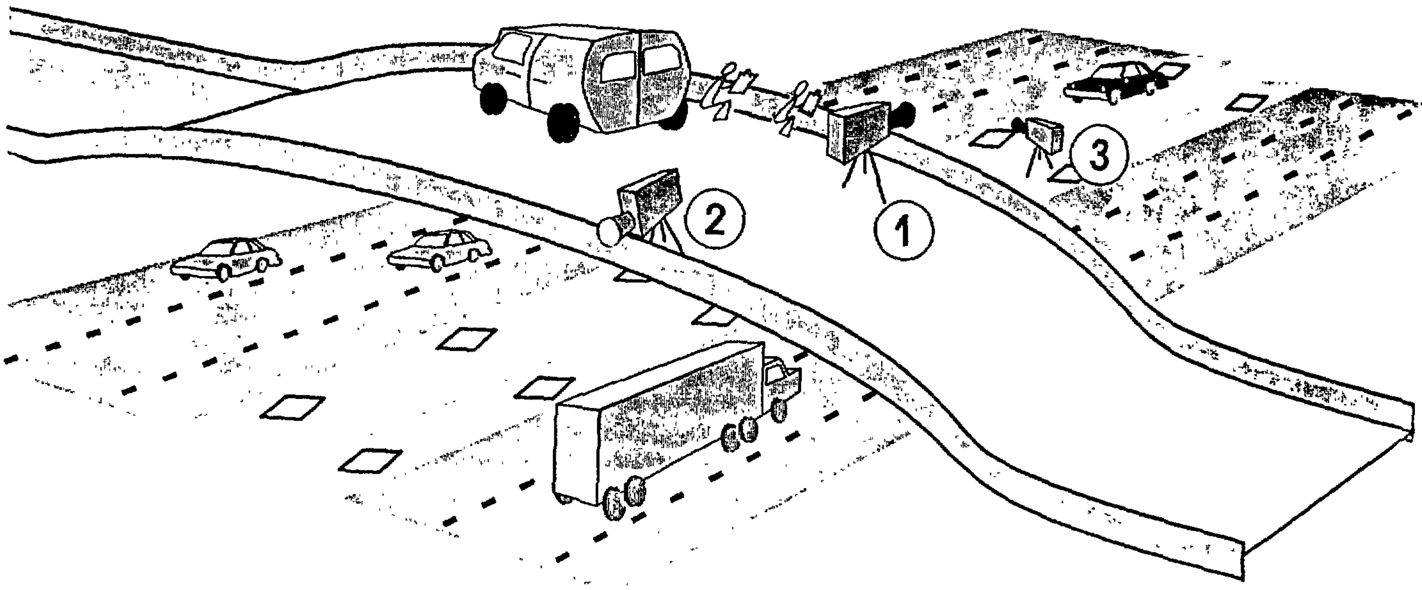


**B-2 Installing Eye-Level Microcamera on LA Route 91**

**EXHIBIT 3.7**

Two Bridge Cameras And Eye-Level Camera

1. Oncoming View
2. License View
3. Drivers Eye Level View




### 3.3.2 Test Results

**Camera Functioning.** The primary purpose of the series of tests undertaken in December 1989 was to develop and demonstrate a micro-camera suitable for roadside installation. From this technological standpoint, the tests were successful. The micro-camera was small enough to avoid distracting drivers and still provide useful information to the control van monitor. Exhibit 3.8 shows one of the views provided by the eye-level micro-camera. The camera provided a good view of rear-seat occupants, particularly those in the right rear passenger seat. Occupants in the left rear seat whose heads were below window level might still escape detection. Depending on car design and shutter-timing, riders in the passenger seat next to the driver could be obscured by the windshield post.

**Enforcement Support.** Attempts to document the accuracy of the three-camera set up on LA 91 on December 19 were marred by several problems.

1. Shortly after the cameras were in place, a truck overturned at the freeway ramp linking eastbound LA 91 to southbound LA 710. This accident occurred downstream from the test overpass, and the participating officers were called away to deal with the emergency.
2. When the officers returned, they experienced problems establishing a communications frequency separate from the Westminster area's dispatch frequency.
3. The license plate camera failed intermittently, as did a replacement camera.
4. The control van monitor was not fitted with a timer unit, making it difficult to document ongoing activities for future reference.

All officers had returned and established a working communication channel by 4:00 p.m., and were able to verify suspect violations for a half-hour, before it became too dark to proceed. Unfortunately, the intermittent failure of the license plate camera made it difficult to undertake a subsequent analysis of the tape to compare reviewer observations with on-line verifications.

### 3.3.3 Observations

**On-Line Accuracy.** The officer viewing the monitor in the van tended to rely on a single camera view, the view of oncoming traffic provided by Camera #1, in determining whether or not a vehicle was a violator. He rarely experimented with the monitor controls to get the

**EXHIBIT 3.8**

**SAMPLE VIEW FROM EYE-LEVEL CAMERA**

benefits of the eye-level camera. This may have been because the motor officers observing traffic were located in an enforcement area only 1500 feet downstream from the overcrossing, so that decisions had to be made rapidly. During the period between 4:00 p.m. and 4:30, the officer in the control van radioed the descriptions of 24 suspected violators to the motor officers downstream. Eight of these 24 suspects were found to have the required number of passengers, eight were identified as violators, and eight were not located.* Of the sixteen suspects verified by close-up observation, therefore, only 50% turned out to be actual violators. This high false-alarm rate can't be taken as a comment on the accuracy of the eye-level camera, however, since in most cases the van officer did not wait to consult the eye-level camera before radioing suspect descriptions.

**Counter Accuracy** During the same 4:00 to 4:30 period that the van officer identified 24 suspect violators, CALTRANS observers positioned on the overpass counted 32 violations. While CALTRANS counters observed every vehicle, the van officer sometimes took time to rewind the tape and take a second look at a suspect vehicle. Hence it is not surprising that the observers would count more violators than the van officer. However, the fact that only half of the suspects identified by the van officer turned out to be violators suggested that the observers may also be overstating the actual number of violators. This possibility would be further tested in the final videotape demonstration.

## 3.4 FINAL ENFORCEMENT TEST

The final test of videotape technology in enforcement took place on January 4, 1990 at the Warner Avenue overcrossing on OR 55.

### 3.4.1 Demonstration Set-Up

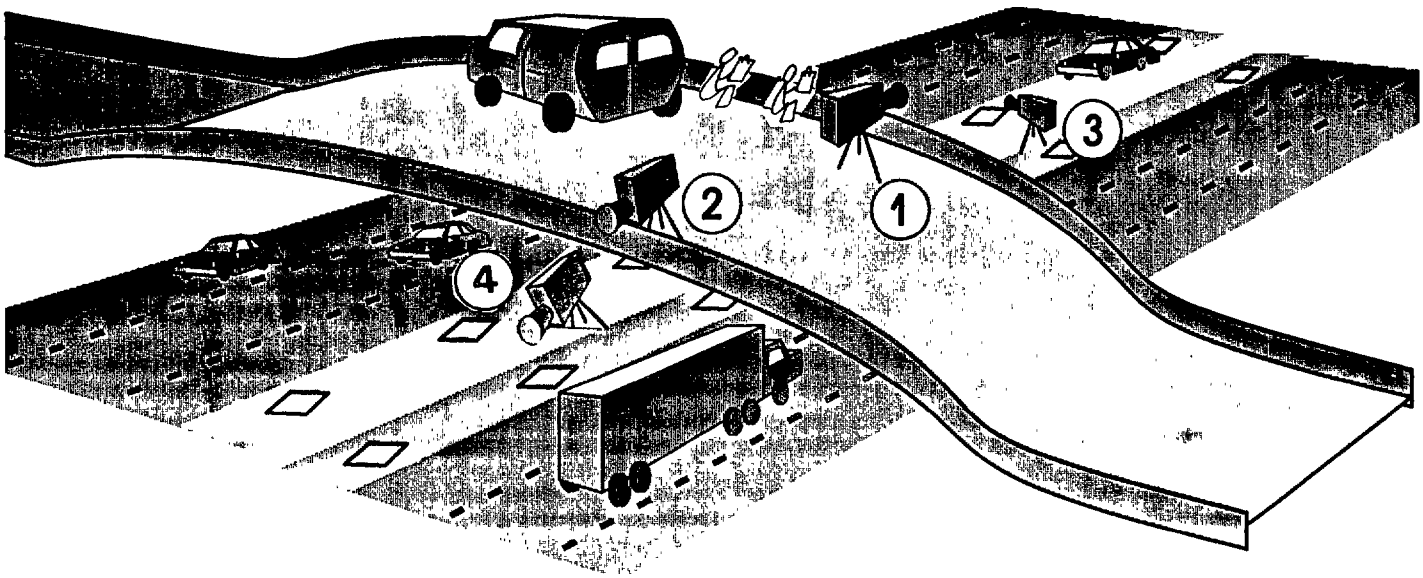
**Cameras.** Exhibit 3.9 shows the locations of the four cameras used in the demonstration. The cameras were installed and ready for use at 2:00 p.m. Between 2:00 p.m. and 4:00 p.m. three camera views were fed to the monitor: The oncoming scene recorded by Camera 1 of Exhibit 3.9, license plate data revealed by Camera 2, and an eye level view of passing

* Reasons for the lack of verifications varied. Some suspects bailed out of the lane when the downstream officers came into view. In other cases, the suspect description arrived too late, after the vehicle had already passed the enforcement area.

**EXHIBIT 3.9**

**FINAL SET-UP**

1. Oncoming View
2. License View from Bridge
3. Driver's Eye Level View
4. License View from Roadway




traffic provided by Camera 3. At four o'clock, Camera 4 was switched into the system to provide a freeway-level record of license plate information, replacing that of Camera 2. The views of Cameras 3 and 4 were synchronized to provide a simultaneous image of a car's interior and its license plate.

**Enforcement.** Three motor officers from the Santa Ana office were assigned to assist with the demonstrations. At two o'clock, the three officers took up positions at an enforcement area about 2,000 feet downstream from the overcrossing. Between two and three-thirty, the officers verified the occupancy levels of vehicles identified as potential violators by an ATD employee seated in the control van. At 3:30 one of the officers took over in the control van. Whereas the ATD employee was more adept at reviewing the tape to determine the license numbers of potential violators, the officer was better able to describe the suspect vehicles from their profiles ("Check out the white Camaro") and communicate his descriptions to his fellow officers.

Between 3:45 and 4:00, the officers left the enforcement area to cover an accident which occurred just downstream from the Warner Avenue overcrossing. There was no way to verify the occupancies of potential violators during this period. Aside from this single instance, however, the demonstration went smoothly.

### 3.4.2 Analysis of Results

**Field Test Findings.** A summary of the traffic observations made by the van occupants and field officers during the OR 55 demonstration appears on the following page:

| TIME/ START/END/ VAN OBSERVER | SUSPECTED VIOLATORS OBSERVED | VIOLATOR DESCRIPTIONS ACKNOWLEDGED | VERIFICATION RESULTS | | | ADDITIONAL VIOLATORS SPOTTED BY FWY. OFFICERS | TOTAL VIOLATORS |
|---|---|---|---|---|---|---|---|
| | | | VIOLATOR VERIFIED | SUSPECT NOT A VIOLATOR | UNABLE TO OBSERVE SUSPECT | | |
| 2:15-2:30/C<br>2:30-2:45/C<br>2:45-3:00/C | 6<br>8<br>7 | 5<br>5<br>6 | 3<br>3<br>3 | 2<br>2<br>3 | 1<br>3<br>1 | 0<br>1<br>0 | 3<br>4<br>3 |
| 3:00-3:15/C<br>3:15-3:30/C<br>3:30-3:45/C<br>Officers Called Away at 3:45 | 4<br>2<br>3 | 4<br>2<br>3 | 2<br>1<br>0 | 2<br>1<br>3 | 0<br>0<br>0 | 2<br>1<br>0 | 4<br>2<br>0 |
| 4:00-4:15/O<br>4:15-4:30/O<br>4:30-4:45/O<br>4:45-5:00/O | 3<br>2<br>9<br>9 | 3<br>2<br>9<br>8 | 1<br>0<br>4<br>2 | 2<br>2<br>5<br>6 | 0<br>0<br>0<br>1 | 1<br>4<br>1<br>2 | 2<br>4<br>5<br>4 |
| | 53 | 47 | 19 | 28 | 5 | 12 | 31 |

*C = Civilian Observer in Van
0 = Police Officer in Van

During the demonstration, field officers verified the occupancy of forty-seven vehicles identified as suspects by the van occupants. Of these forty-seven vehicles, nineteen (40.4%) turned out to be violators, while twenty-eight (59.6%) had the required number of occupants. These field results should not necessarily be used to gauge the accuracy of the video monitoring system, since the van occupants were under pressure to call out the identity of suspect vehicles before they passed the field officers 2,000 feet downstream. As a result, they sometimes identified suspects from the first view seen (the view provided by the single, head-on camera) without checking other views.

In this regard, the performance of the two observers was remarkably different. The monitoring observer in the van from 2:15 to 3:30 was a civilian employee of ATD familiar with the playback system and its controls. He was much more likely to check the view from the eye-level camera before alerting the field officers to the presence of a possible violator. On the other hand, the motor officer who took over at 3:30 was more likely to single out a potential violator on the strength of a single view from the head-on cameras. The relative accuracy of the two observers reflects their difference in approach: Of the twenty-two suspects identified by the civilian observer, twelve (54.5%) actually turned out to be violators. In the case of the second observer, only seven of twenty-five suspects (28%) were found to be violators.

The on-line performance of both observers could undoubtedly have been improved if the enforcement area used as an observation post by the field officers had been further downstream. Both van operators were rushed to identify potential violators before they had passed the observation post.*

**Data Reduction: Accuracy.** In order to check the ability of reviewers to identify violators using the videotape alone, five observers reviewed different segments of the videotape and identify occupancy violators. Each observer was instructed in the use of the monitor and asked to identify those vehicles which they felt should receive citations for occupancy violations based solely on the videotape evidence.

The results of the review are summarized below:

| Observer Number | Time Period | Violator Suspects Identified | Vehicles Checked In Field | Violator Verified | Suspect Not a Violator | False Alarm Rate |
|---|---|---|---|---|---|---|
| 1 | 2:18-3:45 | 15 | 4 | 3 | 1 | 25% |
| | 4:05-4:30 | 2 | 1 | 1 | 0 | 0% |
| 2 | 2:18-3:45 | 89 | 19 | 9 | 10 | 52.6% |
| 3 | 2:48-3:20 | 22 | 5 | 2 | 3 | 60% |
| | 4:30-5:00 | 27 | 9 | 4 | 5 | 55.6% |
| 4 | 2:45-3:00 | 18 | 5 | 2 | 3 | 60% |
| 5 | 3:00-3:20 | 3 | 0 | 0 | 0 | 0% |
| TOTAL | | 176 | 43 | 21 | 22 | 51.2% |

* The selection of monitor views may also have contributed to the tendency of the van operators to rely on a single image in identifying violators. During the first enforcement test on LA 91, the second image presented in the van was an oblique shot of the passenger seats taken from the overcrossing. This image followed the initial oncoming shot closely in time and the van officers tended to wait for it before judging a vehicle occupancy. The eye-level view of suspects did not appear on the screen until roughly seven seconds after the first view of the vehicle had disappeared, and the van observers appeared to be less likely to wait for this delayed view.

Forty-three of the 176 suspect vehicles identified by the videotape reviewers had been checked by field officers at the time the videotape was made. When these vehicles were compared with the officer reports, 22, or 51.2% were found to have the required number of occupants. Thus the false alarm rate for the eye-level camera was actually greater than that experienced with the bridge-level camera. Although the sample sizes were not large enough to be statistically significant, the high error rate suggests conclusively that videotape cannot currently be used as the sole means of identifying violators for enforcement purposes.

Data Reduction: Occupancy Counts. To obtain further insights into the relative accuracy of videotaped occupancy counts, three observers were asked to monitor videotapes of three different fifteen-minute periods of HOV lane activity, and record the number of occupants of each vehicle passing by the camera during each period. The occupancy counts recorded by each of the three videotape viewers are tabulated along with counts made by roadside observers in Exhibit 3.10.

The tabulations of Exhibit 3.10 show that the occupancy counts recorded by the three videotape viewers not only differ from those recorded by the roadside observer, but also from each other. Videotape observer #1 recorded occupancy rates that were consistently higher than those recorded by the roadside counter, while videotape observer # recorded consistently lower occupancy rates.* A three-way analysis of variance showed that the observers differed significantly among themselves in two key judgments: 1) identification of violators; and 2) identification of vehicles with three or more occupants.

Because of the marked differences in the results obtained from the three different videotape observers, it is difficult to draw any general conclusions regarding the relative accuracy of videotape vs. roadside observations in documenting vehicle occupancy. A careful check of the tape suggests that the roadside observers consistently understated the number of vehicles with

* The first observer displayed a tendency to understate violations and produce a relatively high number of 3+ vehicle sightings. She was reluctant to label a vehicle as a violator until she had carefully examined all three views of the vehicle, and searched each view thoroughly for evidence of a third passenger. Observer number 3 went through the videotape more quickly, requiring less evidence to label a suspected violator and spending less time searching for additional passengers. During the third fifteen-minute time period, where the sun's angle darkened the view from the eye-level camera, the tendencies of these two observers were magnified. Observer number 1 recorded only one violator during the period. She couldn't be sure there wasn't a second occupant out of her view. Observer number 3 found 26 possible violations during this same period, but only two vehicles with three or more occupants. Without the eye-level camera, he couldn't identify a third occupant with sufficient certainty.

## EXHIBIT 3.10

## OCCUPANCY COUNT COMPARISONS

| Time Period | Buses | Motorcycles | Vehicle Occupancy | | | | | Computation | |
|---|---|---|---|---|---|---|---|---|---|
| | I/2 Full | | 1 | 2 | 3+ | Don't Know | Total | Violation Rate | Occupancy Rate |
| 2:45-3:15 | | | | | | | | | |
| COUNTER | 1 | 6 | 10 | 242 | 21 | 0 | 280 | 3.57% | 2.10 |
| Observer | 2 | 7 | 7 | 203 | 50 | 20 | 289 | 2.60% | 2.32 |
| Observer 2 | 1 | 7 | 26 | 160 | 40 | 27 | 261 | 8.45% | 2.17 |
| Observer 3 | 1 | 7 | 21 | 188 | 10 | 39 | 266 | 9.25% | 2.00 |
| 3:00-3:15 | | | | | | | | | |
| COUNTER | 0 | 11 | 11 | 234 | 10 | 0 | 266 | 4.14% | 1.97 |
| Observer 1 | 0 | 10 | 4 | 159 | 38 | 9 | 220 | 1.90% | 2.20 |
| Observer 2 | 0 | 9 | 18 | 159 | 27 | 20 | 233 | 7.84% | 2.06 |
| Observer 3 | 0 | 9 | 8 | 170 | 15 | 21 | 233 | 3.91% | 1.93 |
| 4:15-4:30* | | | | | | | | | |
| COUNTER | 1 | 9 | 7 | 218 | 23 | 0 | 258 | 2.71% | 2.12 |
| Observer 1 | 1 | 6 | 1 | 139 | 27 | 43 | 217 | 0.57% | 2.27 |
| Observer 2 | 1 | 5 | 16 | 160 | 22 | 22 | 226 | 11.11% | 2.12 |
| Observer 3 | 2 | 6 | 26 | 128 | 2 | 44 | 208 | 15.85% | 1.97 |

*During this time period, the angle of the sun was such that the eye-level camera provided very few views inside passing vehicles.

three or more occupants, and therefore, presumably understated occupancy levels. This finding is not surprising, since it is easy to overlook some occupants and roadside observers must make instantaneous judgments without the benefit of the replay knob available to videotape viewers. Given the differences observed among videotape viewers, however, it is dangerous to extend this observation from the specific CALTRANS observers watching traffic on January 4 to the more general class of roadside observers. It is possible that another set of roadside observers might have overstated the number of vehicles with three or more occupants.* If there is one lesson to be learned from these comparisons, it is that different observers can produce widely different estimates of the occupancy levels of the same flow of vehicles. Consequently, when reviewing trends in traffic observations, sudden jumps in violation rates or occupancy levels should, be viewed with some skepticism if different observers were responsible for successive counts.

### 3.4.3 Preliminary Findings

**Camera Posltlonlng.** Dropping the license plate camera to freeway level was viewed as a positive move at the time, since it synchronized the views from two of the cameras and took some of the guesswork out of the on-line review process. However, office personnel using the tape to identify violators preferred the license plate view generated by the overhead camera, since it often provided a view into the backseat of the vehicle as well.

**Verification of Manual Counts.** During the last two videotape demonstrations (December 19 on LA 91 and January 4 on OR 55), CALTRANS provided personnel who counted

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* This actually appears to have happened during the December 19 field test on LA 91. There CALTRANS counters from Division 7 used different forms from those used by the Division 12 counters observing OR 55. The headings on the two count sheets are reproduced below:

District 7 (LA 91):

| 1 | 2 | 3 | 4 | 5 | 6+ | 6+ Vans | M/C | Full Bus | (112 Bus | 1/4 Bus | Empty Bus |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |

District 12 (OR 55):

| I/2 Bus | Full | Bus | M/C | 1 | 2 | 3+ |
|---|---|---|---|---|---|---|
| | | | | | | |

The availability of a counting slot for 6+ vans in the district 7 count sheets resulted in many entries being made in that category. A review of the videotape for that day suggested that many vans were being classified as 6+ occupants when it was impossible to see inside the van or when a van actually had far fewer than six occupants. In this case, therefore, the roadside observers undoubtedly overstated actual occupancy rates on LA 91. There is no way of knowing whether this tendency extends beyond the count crew assigned to the videotape field test. The current study was not designed to explore the accuracy of count crews in detail. However, the limited findings suggest that CALTRANS should standardize its count forms, train counters carefully, and check for differences among individual counters.

occupancy rates from their normal positions on the overcrossing. Two counters were available on both occasions. Preliminary results suggest that manual counts made from overcrossings may overstate the number of HOV lane violators.

The table below compares manual counts with the observations of roadside officers tallying violators downstream from the overcrossing.

| FREEWAY: | O R | L A |
|---|---|---|
| TIME PERIOD: | 1415 to 1530 | 1600 to 1630 |
| VIOLATIONS OBSERVED BY COUNTERS | 38 | 32 |
| SUSPECTED VIOLATIONS OBSERVED BY MONITOR VIEWER | 27 | 24 |
| ■ Violations Verified | 12 | 8 |
| Legitimate Vehicles | 10 | 8 |
| ■ Vehicle Not Sighted | 5 | 8 |
| ADDITIONAL VIOLATIONS SPOTTED BY FIELD OFFICERS | 4 | 0 |
| TOTAL VERIFIED VIOLATIONS | 16 | 8 |

In both cases, the viewer in the control van registered fewer suspected violators than the observers on the bridge. This is not surprising, since the van viewer had the ability to rewind the tape and take a second look at a suspect vehicle. Sometimes violators drove by while this review was taking place. However, the downstream officers were instructed to report on all violators they saw passing them, whether or not the viewer in the control van had alerted them to check a particular vehicle.

Only 50% of the suspect vehicles actually checked by the officers stationed beside the LA 91 HOV lane turned out to be violators. In the case of OR 55, 54.5% of the suspects identified by the monitor operator were violators. As noted, these figures should not necessarily be used to gauge the accuracy of the video monitoring system, since the van occupants were under pressure to call out the identity of suspect vehicles before the vehicles passed the police officers downstream. However, the results do indicate that manual counts probably overstate the actual violation rate, perhaps even doubling it.*

While theoretically interesting, this knowledge may have little practical impact. Even if suspects turn out not to be violators (usually because there is a child out of the view of the camera and the CALTRANS counters), the fact that they look like violators can affect the public perception of the HOV lane.

HOV lane critics have accused CALTRANS in the past of understating actual violation rates. These critics are not likely to believe that the rates have actually been overstated, particularly when many vehicles which are actually legal Carpools look like violators. In this regard, one of the positive aspects of the use of videotape in HOV lane surveillance is that it provides a permanent record of HOV lane activity. Critics who doubt reported violation rates can be provided with copies of the relevant tape as a rebuttal.

**Unambiguous Violator Identification: Buffer Violations.** Although many suspected occupancy violations identified on videotape turned out to be false alarms, one type of violator could be unambiguously identified one hundred percent of the time. This was the buffer violator who entered the HOV lane illegally by crossing the double yellow line at a place where lane changing was not allowed. Exhibit 3.11 shows an example of one such violator.

Buffer violators can be easily identified, even when fast-forwarding through the videotape. So long as the violators are entering the lane (rather than leaving it), moreover, the appearance of the driver and the license plate of the vehicle will be recorded by the video surveillance system.

**Accuracy and ambiguity: Missing Children.** Infants or children hidden from the camera's view were the most common causes of violator misidentification by videotape viewers. Exhibit 3.12 shows three views of a taxi cab videotaped in the OR 55 HOV lane on January 4. The

* In all, the freeway officers on LA 91 saw eight violators in the same span of time that the counters tallied thirty-two. On OR 55, the freeway officers saw sixteen violators while the counters tallied thirty-eight. Heisenberg's principle affects these findings to a certain extent, since some violators left the lane when they saw officers in the enforcement area. However, when the violators were first under the scrutiny of the van occupants and the CALTRANS counters, they were well out of range of the officers in the enforcement area. The fact that the field officers found that only half of the suspects identified by the van occupants were actually violators, coupled with the relative number of sightings reported by the van observers and bridge counters, suggests strongly that the counters on the bridge were no more accurate than the observers in the control van.

**EXHIBIT 3.11**

**MONITOR VIEW OF BUFFER VIOLATOR**

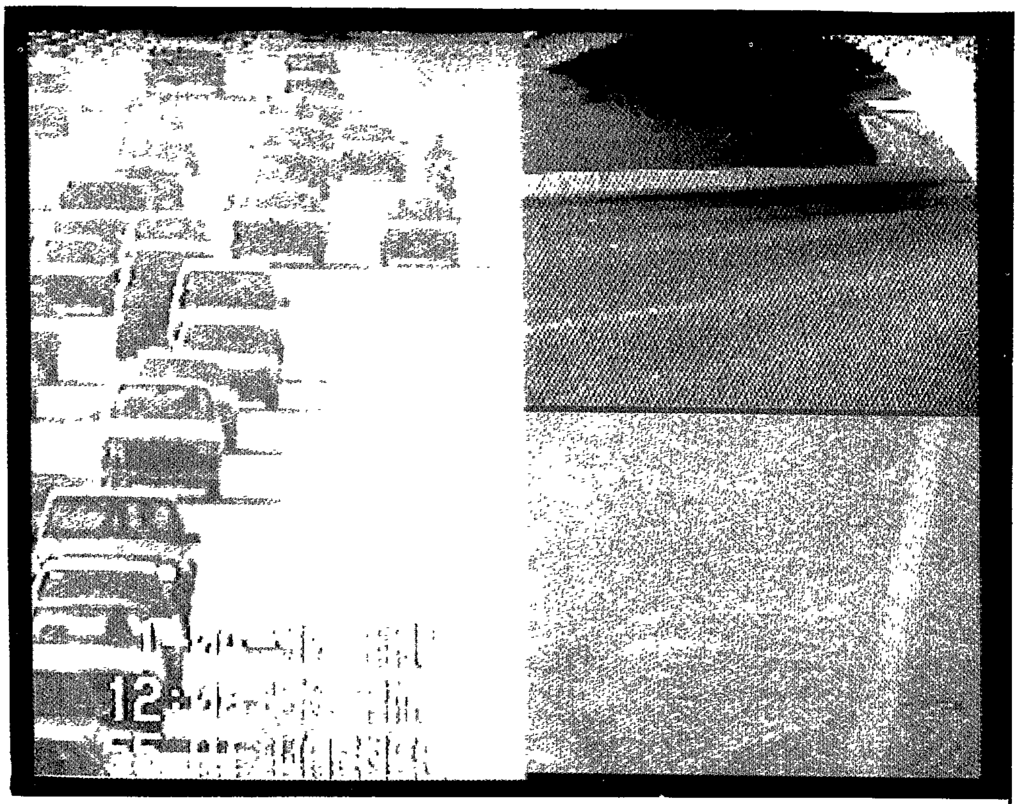


**EXHIBIT 3.12**

**MONITOR VIEWS OF SUSPECTED VIOLATOR WITH UNDETECTED CHILD**

**(Yellow Cab #51)**

**ONCOMING VIEW**


**SIDE VIEW**

**LICENSE VIEW**

observer in the control van, along with four subsequent videotape viewers, independently identified the taxi as an HOV lane violator. However, the motor officer observing traffic in the lane downstream from the taping point reported that there was a small child in the cab's back seat. Yet four different observers failed to identify the child in repeated viewings and reviewings of the videotape.

**Accuracy and Ambiguity: Tinted WIndows.** Exhibit 3.13 shows three views from the eye level camera. In the first view, the rear seat contains a passenger, the second vehicle is a violator (verified by the roadside observer), and the third vehicle has tinted windows, making a judgment on the occupancy of the rear seat impossible. Such problems as tinted windows, sight-obscuring headrests, windshield posts, and ill-positioned vehicles generally caused the videotape viewers to list the occupancy as unknown or guess at the occupancy from a single front view. Most test viewers were reluctant to identify vehicles as potential violators when one or more of the supporting views was obviously obscured. While tinted windows can produce indeterminant or biased occupancy counts, therefore, they are not likely to trigger false violation alarms, so long as the videotape viewers are well trained.

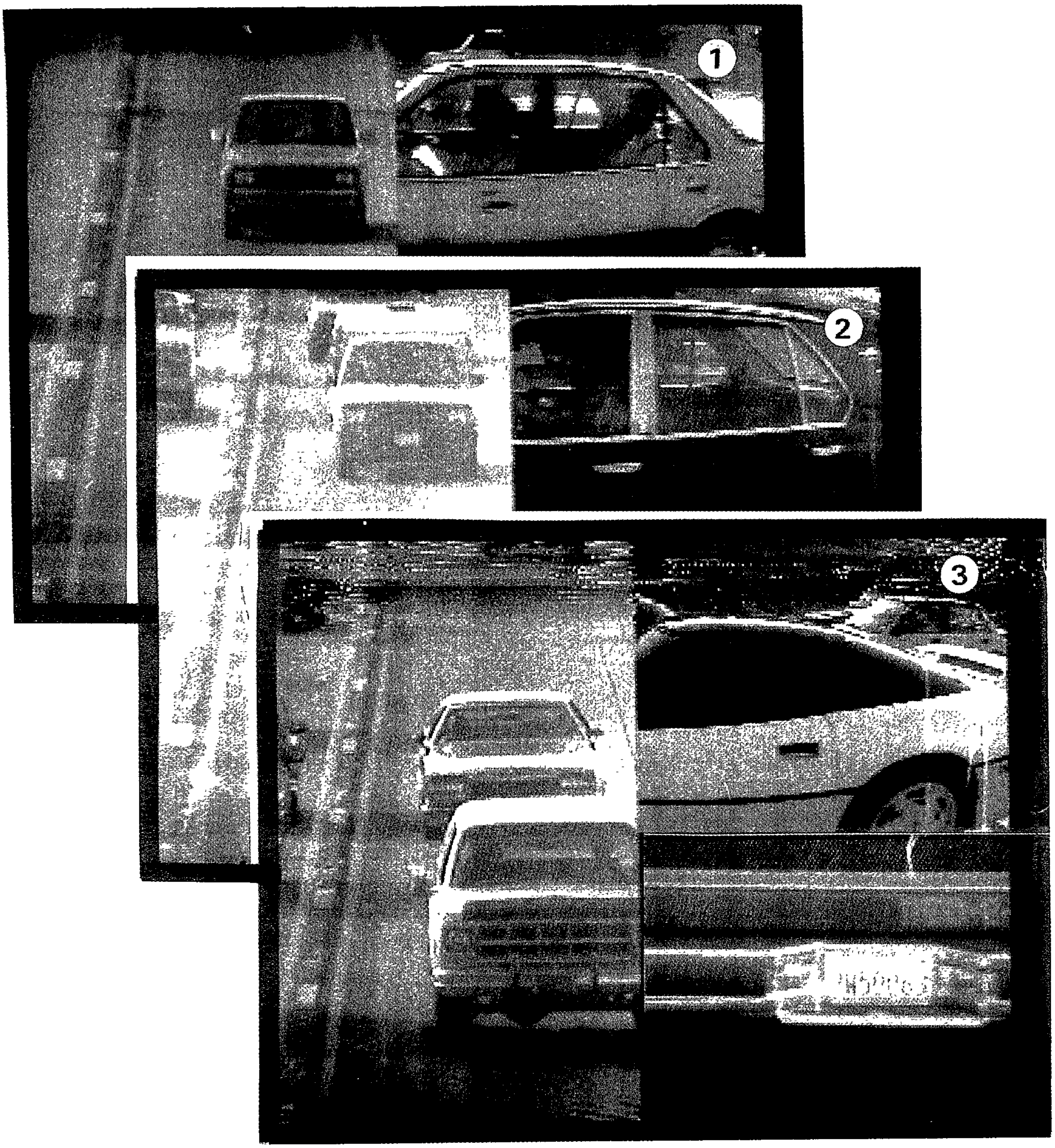
Certain vision-obscuring problems could potentially bias occupancy counts. The vehicles most likely to have windows out of range of the eye-level camera were buses and vans, precisely those vehicles which are likely to carry a high number of occupants. If videotape viewers ignore these vehicles because they can't see into the rear windows, occupancy rates will be artificially low. As noted, moreover, ambiguous views can cause different viewers to react in different ways. Faced with a large number of obscure views from the eye-level camera, one viewer understated violation rates because she shouldn't be sure there wasn't a second occupant somewhere in the car. Another viewer understated the number of vehicles with three or more occupants because he couldn't be sure the back seat was occupied.

## EXHIBIT 3.13
## VIEWS FROM EYE-LEVEL CAMERA SHOWING

1 – Rear Seat Occupant

2 – Empty Rear Seat

3 – Tlnted Windows



# 4.0 TEST FINDINGS

This chapter summarizes the findings of the various field tests. Technical considerations related to camera selection and positioning are discussed, display preferences are outlined, and issues of accuracy are addressed.

## 4.1 EQUIPMENT CONSIDERATIONS

### 4.1.1 Illumination

**Ambient Sunlight.** The only lighting used during the enforcement tests was the ambient light from the sun. Thus every recording session presented a challenge, because the light intensity and angle of incidence was changing throughout the daytime hours. For instance, if the early-morning sun is directly behind the camera and the sunlight is directed downward into the front passenger compartment, then the passengers in the front seat will be well-illuminated and considerable detail can be recorded. However, late in the afternoon, the opposite condition will exist and the passengers will be seen in silhouette.

Clean, well-polished vehicles can also present a problem for the camera. As these vehicles move down the highway under the sun's rays, bright reflections can bounce off of the bumpers and chrome trim. On occasion, these reflections have been severe enough to mask the occupants of the vehicle.

Filters. Problems with glare were partially solved by using polarizing filters. The effect of these filters varied considerably, depending upon the angle of the sun in relationship to the passing cars. The polarizing filters had the undesirable effect of reducing the light-gathering capability of the cameras by one complete "f" stop.

The most undesirable filters encountered were the privacy screens, or tinted windows, installed in many new vehicles. These tinted screens keep both cameras and roadside observers from viewing the interior of vehicles.

**Infrared Possibilities.** HOV lane surveillance must take place when the majority of HOV lane users are in transit. This usually means the early morning and late evening hours. Since peak traffic periods can start before dawn and extend after dusk, ATD tested the use of infrared lamps to augment ambient light from bridge-top camera positions. The infrared lamps made it possible to record license plates after dark. No attempts were made to illuminate oncoming traffic using infrared lamps, however, since it was feared that the lamps might prove to be a distraction for drivers.

It also appears feasible to use infrared lighting in conjunction with a low-level camera to extend the hours of operation of the surveillance system after dark. This approach would focus infrared lamps and a near-infrared sensitive camera on the windows of the car after it had passed, so that the light source could be shielded from the view of the driver. These lamps will illuminate the interior of the car from the low-elevation camera positions. This should make high-speed recording possible under night-time conditions, although ATD did not undertake a low elevation test employing infrared lamps.

### 4.1.2 Camera Specifications

**Contrast Ratio.** The NTSC television signal is limited to a contrast ratio of approximately 10:1 That means that ten shades of gray can be resolved when looking at the TV screen. Unfortunately, the ratio between the bright unfiltered sunlight and the light in the interior of a moving vehicle may exceed 100:1. Very careful adjustment of the camera system must be made to compensate for these wide ranging light levels. For instance, it may be necessary to let the sky "wash-out" in order to pick up the interior of the vehicle. As previously mentioned, highlights from windows or bright work will further complicate the recording of high-contrast images.

**Motion Blur.** HOV lane traffic typically moves at speeds from 50 to 65 mph. When using close-up images, the "blur" at a standard 1/60th of a second exposure rate will be unacceptable. At these speeds, tests were made at 1/100th, 1/500th, 1/1000th and 1/2000th of a second. These tests showed that an exposure time of 1/1000th of a second are required. This exposure rate reduces the light availability by four "f" stops. In order to compensate for the light loss, a modified color NTSC camera should be used that has at least 24db of gain boost. It is preferable to have an automatic gain circuit as well as a manually selected gain capability.

**Lens Selection.** Since high speed exposures are required, very low-light-level cameras must be used. Field tests showed that it was desirable for the observer to have five-to-ten seconds to determine the number of occupants in the front seat of an oncoming vehicle. To accomplish this, a lens with a long focal length must be focused on oncoming vehicles that are approximately 1/4 mile away. Experimentation led to the selection of a 14:l zoom lens having a focal length from 20 mm to 280 mm.

**Monochrome or Color Capability.** Tests were run with both monochrome (black and white) and color cameras. Although the monochrome system seems to have slightly better contrast and resolution capability, the advantages of using color in identifying vehicles far outweigh the slight loss in resolution when a color system is used. However, careful technical alignment of the cameras is required to satisfy the stringent timing requirements needed to synchronize color cameras. Slight timing imperfections can cause significant changes in the perceived color of the same vehicle displayed in different quadrants of the same picture.

**Resolution.** In order to see sufficient detail in the interior of a moving vehicle, adequate resolution must be achieved by the camera, the recording medium, and the viewing monitors. A color system having the resolving capability of 300 tv lines is desirable. It is necessary to record multiple images within one frame of view. The recorded resolution is reduced by about 25% in each quarter/frame image. In order to resolve the license plate numbers, the field-of-view must be limited to no more than an eight foot segment of the traffic lane. This makes it possible to resolve five horizontal dots across each letter or number on the license plate.

### 4.1.3 Camera Positions

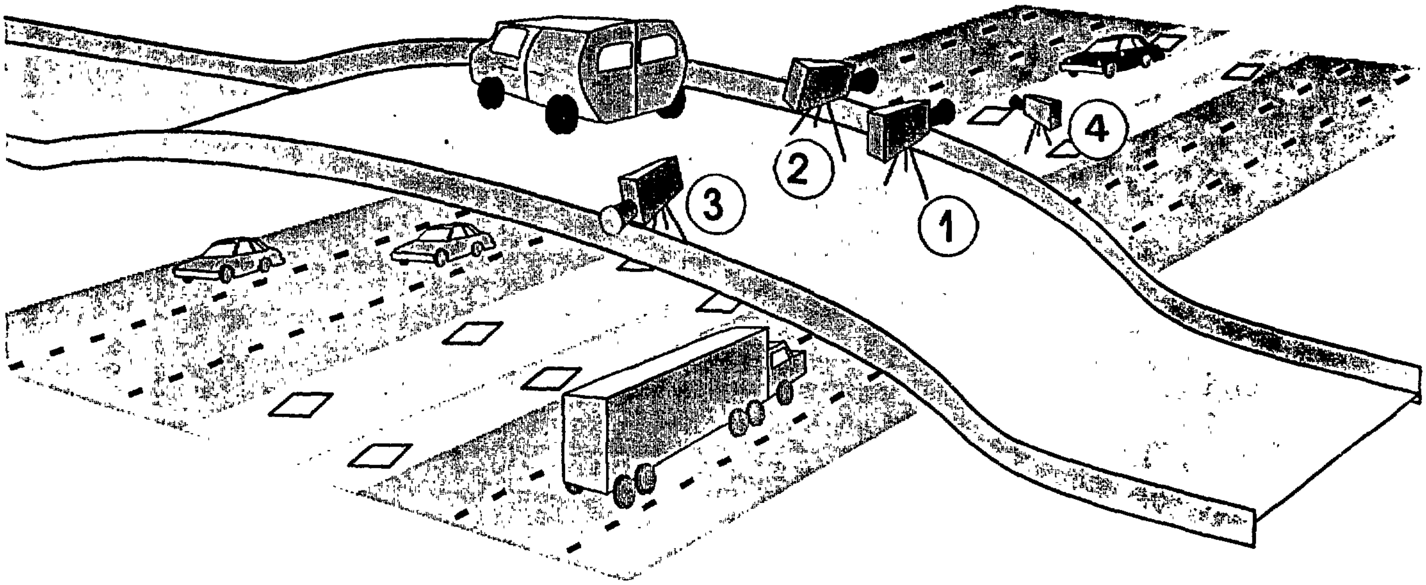
Many tests were conducted with cameras situated in different locations on top of overcrossings and at various locations in the median shoulder alongside HOV lanes. Four camera views appeared to provide the maximum amount of information about vehicle occupancy. These views are diagrammed in Exhibit 14.1.

**Bridge Cameras.** As shown in this exhibit, one camera is set up to observe oncoming traffic at approximately 1/4 mile from the overcrossing. The long range view provided by Camera #1 does not allow the observer to look down into the front seat to see a rider who is resting in a reclining seat, or a child who is below the level of the dashboard. To overcome this defect, a second camera is positioned to look down into the vehicle at a much steeper angle. This camera should be aimed so that the vehicle is picked up shortly after it disappears from the view of the first camera. If the views of cameras 1 and 2 are tightly synchronized, monitor observers have an easier time picking up the second image, and are more likely to rely on it in making on-line decisions.

EXHIBIT 4.1

# SAMPLE CAMERA POSITIONS

1. Oncoming View
2. Oblique Oncoming View
3. License View
4. Eye-Level View



**Eye-Level Camera.** A third camera is set up in the median barrier approximately 100 feet from the overcrossing. It is located approximately five feet above the level of the road and is pointed at an angle approximately 30° from the perpendicular to the traffic. This camera provides a view of the rear seat occupants and a second check on the occupants of the seat next to the driver. Best results were obtained from the eye-level camera when it was positioned under the overpass itself. The shadow of the overpass minimized ambient light changes and maximized the contrast available in shots inside the vehicle.

**License Camera.** The fourth camera is set up to document license plate numbers. If the plates are being recorded primarily for subsequent off-line reviews, the license plate camera should be located on the overcrossing and aimed downward at a steep angle. This downward angle often provides additional information on the occupants of the rear seat.

If license plates are being recorded primarily as an aid for on-line enforcement, the license plate camera should be located approximately five feet above the roadway about 125 feet from the overcrossing. This license plate camera should be aimed to record the vehicle at the same time that the eye-level camera is documenting occupancies. In this way, both images will be on the screen at the same time, and the task of identifying the particular vehicle is simplified.

### 4.1.4 Cable Requirements

Recent introduction of some color high-speed video cameras that allow power to be transmitted down the video cable have simplified the set-up of HOV cameras. These units can be used up to 500 feet from the control van without the use of additional power cables. This allows the use of only one small (1/4" diameter) cable for each camera. In addition, cameras that are powered from one simple control are relatively easy to time correctly from the van location.

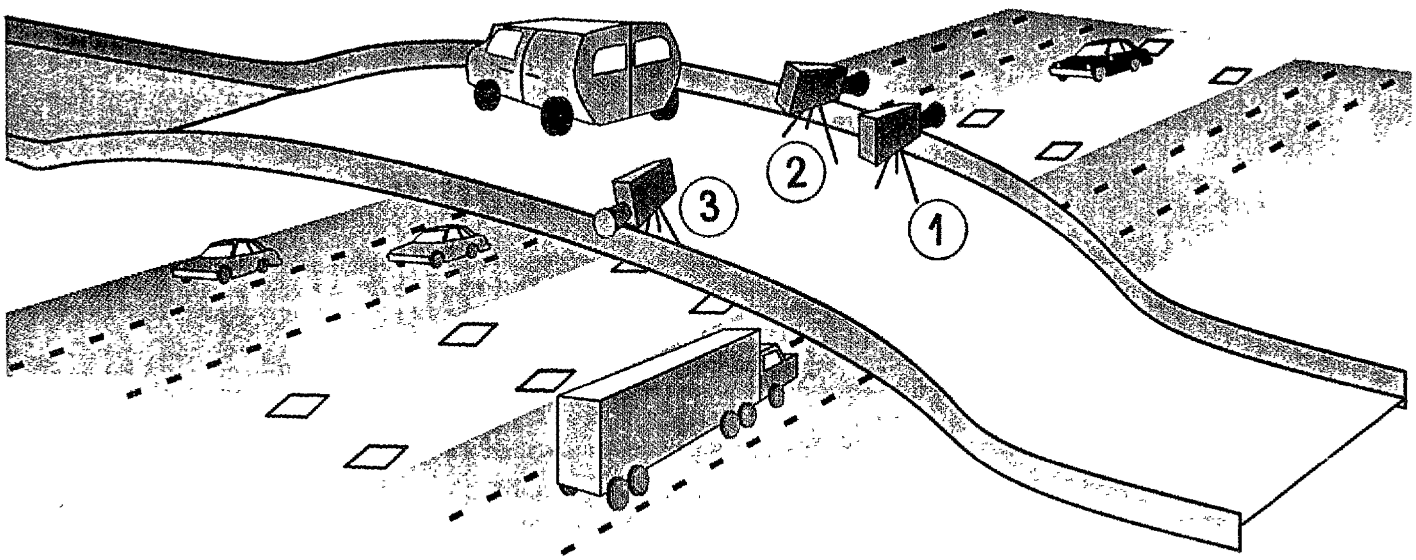
## 4.2 DISPLAY PREFERENCES

### 4.2.1 Real Time Decisions

For real-time decision-making, viewers seemed to prefer a monitor display showing three views of the suspect vehicles: (1) An oncoming view; (2) An oblique view downward into the passenger seat; and (3) A view of the license plate. Exhibit 4.2 shows a sample of these three

EXHIBIT 4.2

SAMPLE VIEWS FROM BRIDGE CAMERAS




views. The view from the oncoming camera is displayed vertically on a full half screen in order to provide as much time as possible for an initial judgment regarding the number of occupants in a particular vehicle. The remaining views are each displayed on a quarter of the monitor screen.

When making real-time decisions, viewers tended to pay more attention to the oblique view of the passenger seat, because it followed closely after the oncoming view and was somewhat easier to locate in a review mode. If the first two views showed a potential violator, the monitor viewer would ultimately stop the tape to document the license number of the vehicle.

When the eye-level camera was used, the view from that camera tended to be delayed until about seven seconds after the image of the vehicle had left the screen, so that the viewers were forced to wait and stop the tape to obtain a second view of suspect vehicles, then search for the license number. The need to search for the second view proved so bothersome in an on-line environment that some viewers ignored the second view and made decisions solely on the basis of the view from the initial camera.

### 4.2.2 Delaved Decisions

When decisions regarding vehicle occupancy could be delayed for more leisurely review away from the freeway, the most useful monitor display appeared to be one which provided the most information – that is, four views of the suspect vehicle. The four recommended views are the four views produced by the camera positions sketched in Exhibit 4.1: (1) An oncoming view of the vehicles; (2) A view of the license plate; (3) An oblique view downward into the passenger seat; and (4) An eye-level view through the side windows.

These four views were not tested simultaneously in an enforcement setting in the current study. However, such a test should be part of any future research program.

## 4.3 ACCURACY

### 4.3.1 Buffer Violations

Buffer violators, those drivers who enter or leave the HOV lane illegally by crossing the double yellow line where lane changing is not allowed, were easily identified by the camera recording oncoming traffic. Violator sightings were unambiguous, and the license plates of those drivers entering the lane are recorded by the video surveillance system.

### 4.3.2 Occupancy Violations

Videotape reviewers cannot currently identify the number of vehicle occupants with enough certainty to support citations for HOV lane occupancy violations. In early tests with three cameras located on an overpass, subsequent videotape review produced a false alarm rate of 21%. In later tests with one of the three cameras moved to the freeway itself, the false alarm rate rose to 51%. The chief cause of false alarms appeared to be small children and sleeping adults located out of the view of all three cameras.

Ambient lighting conditions, glare, and such vehicle design features as tinted windows, headrests, windshield posts, and high windows also made it difficult to interpret the number of videotaped vehicle occupants consistently. Videotape reviewers differed widely in their attempts to document vehicle occupancy levels. These differences suggest that tape reviewers must be well-trained to ensure that certain conditions (i.e., glare) do not trigger false alarms and that ambiguous views are treated consistently by all reviewers.

### 4.3.3 Roadside Occupancy Counts

It is difficult to draw general conclusions regarding the accuracy of roadside counters from the observations of two crews, since it is possible that the observations of different roadside observers will vary as greatly as those of different videotape reviewers. It appears, however, that roadside counters may overstate the number of HOV lane violators. One set of counters clearly understated the number of 3+ vehicles passing the observation point (this was the highest number of occupants required by their count sheets). Another set of counters apparently overstated the number of 6+ vehicles using count sheets with a heading for 6+ vans passing their observation point by assuming that most vans had six or more occupants.

## 5.0 POTENTIAL APPLICATIONS

This chapter discusses potential applications of videotape technology in HOV lane surveillance and enforcement in the light of the field test findings. Issues of cost-effectiveness and public attitudes are addressed, and future research directions are identified.

### 5.1 ENFORCEMENT APPLICATIONS

Videotape can be used to support HOV lane enforcement in at least two ways:

1. **On-Line Assistance.** Video cameras can serve as enforcement eyes, identifying and recording the identity of potential violators who are then pursued and cited by officers located downstream from the control monitor.

2. **Remote Ticketing.** Videotape records might potentially be used to trigger a system of mailed warnings or citations, reducing the need for on-line enforcement.

#### 5.1.1 On-Line Assistance

The use of videotape as an on-line enforcement aid appears to be somewhat limited. An officer stationed beside an HOV lane in an enforcement area is in a better position to observe violators than an officer stationed in the control van watching a video monitor. Furthermore, the roadside presence of an officer in an enforcement area can have a cautionary effect on drivers. Both officers can radio ahead to pursuit units and are likely to see far more violators than a team of two pursuit units can handle (larger enforcement teams are likely to cause rubbernecking and traffic breakdowns).

The only locations where an officer in the videotape van might be better able to assist on-line enforcement than an officer on the freeway would be those locations where there is no refuge area adjacent to the HOV lane. If there is no median shoulder or enforcement area where an officer can be situated for enforcement purposes, video-assisted enforcement stops might make more sense. The Marin 101 HOV lane is a good example of such a location. In the previous test of enforcement tactics on Marin 101, it was virtually impossible to find an adjacent location where a motor officer could safely observe traffic (Billheimer, 1990).

### 5.1.2 Remote Ticketing.

From an enforcement standpoint, the real promise of videotape is its potential use as a triggering mechanism for a system of mailed warnings or citations. The successful implementation of such a system could save officer time, reduce the number of hazardous pursuits needed to apprehend HOV lane violators, and improve traffic flow by eliminating much of the rubbernecking which follows ticketing activities during peak commute hours.

**How It Might Work.** If such a system were implemented, a four-camera set-up could be used to document HOV lane use. Videotapes of peak commute hours would be screened by trained observers, the license plates of violators would be noted, hard photographic copies documenting the violation would be produced, and warning letters or citations would be mailed to the registered owner of the violating vehicle. Photographic evidence of the violation would not be forwarded to the vehicle owner. However, this evidence would be available in the event that the citation is appealed in court.

Although California cannot currently issue warnings or tickets by mail to registered owners, a few states have instituted such procedures.* Exhibit 5.1 contains a copy of the letter sent to Seattle drivers as part of that city's HERO program to discourage the illegal use of HOV lanes.

**Implementation Problems.** A number of hurdles need to be cleared before HOV tickets by mail could become a reality in California. These include:

1. Demonstration of the technical feasibility and accuracy of videotape as an enforcement tool;
2. Clearing of the legal impediments to citing the registered owner of a vehicle by mail;
3. Consideration of the public information issues associated with a ticket-by-mail campaign and the campaign's impact on the public acceptance of HOV lanes.

* Two such states are Washington and Virginia. Seattle has relied on other drivers for descriptions of violating vehicles as part of their HERO program (Reference, 1). Virginia relies primarily on the observations of police officers in identifying violators who are sent citations through the mail (Tollett, 1990).

## EXHIBIT 5.1

## WARNING LETTER TO SEATTLE DRIVERS

JOHN SPELLMAN
Governor

DUANE BERENTSON
Secretary

STATE OF WASHINGTON

DEPARTMENT OF TRANSPORTATION

**Office of District Administrator D-1, 6-131 Corson Ave. So., C-81-110 . Seattle, Washington 98 108**

**Date**

Name
Address
City, State, Zip

Dear:

At approximately time on date your vehicle, license number ORH606 was observed in violation of-the bus/Carpool lane restrictions on Location.

State law restricts usage of these lanes to buses, motorcycles or vehicles carrying three or more persons. This restriction is in effect 24 hours a day. If your vehicle la observed again in violation of the bus/Carpool lane restrictions, the State Patrol will be notified.

We are concerned with the unauthorized use of the bus/carpool lanes.

More new freeways cannot be built because of high cost. environmental factors, and land consumption. Therefore, alternative means of travel must be found to relieve present congestion and to accommodate future growth in the Seattle area.

The bus/carpool lanes increase the people-moving capacity of Interstate 5. Running at only a quarter of their capacity. the bus/carpool lanes carry 2700 people in the peak hour. The other lanes each carry 2200 people in four times as many vehicles and run virtually at capacity.

Because there are fewer vehicles in the bus/Carpool lanes, speeds are higher than in the ocher lanes. Higher speeds provide the commuter with a shorter travel time -- an incentive to Carpool or take a bus. Each time someone shares a-ride. everyone benefits since fewer vehicles are competing for space in the other freeway lanes.

If you did not violate the bus/carpool lane restrictions or would like to discuss the bus/carpool lanes or our actions, please call me at (206) 764-4376.

Sincerely,

Traffic Systems Management
Washingeon State Department
of Transportation

This study has focused on the first aspect, the technical feasibility and accuracy of videotape as an enforcement tool. Legal issues are beyond the study scope, as are public information concerns, which are addressed briefly in a later section.

Based on field test findings to date, videotape technology by itself does not appear to be sufficiently accurate for use in a system of mail-out warnings and citations. Although the technology is capable of providing accurate views of vehicle windows and license plates when traffic is moving at top speed, and certain offenses (i.e. illegal buffer crossings) can be unambiguously recorded on tape, the false-alarm rate caused by children and adults out of camera range is too great to support citations for occupancy violations.

The problem of accuracy is further exacerbated by the need to deal with ambient lighting. As a day's shooting progresses, the movement of the sun can cause the view provided by a particular camera to be obscured by glare or to lose definition. Filters and aperture adjustments can sometimes overcome these problems, but camera crews need to remain alert to make such adjustments.

**Promising Configurations.** Although videotape by itself does not appear to be accurate enough to provide a basis for citations, the combination of videotape and an observing officer could conceivably provide the accuracy needed for a system of mailed warnings and citations. Such a system could work in much the same way as the recent field tests. That is, an officer would be posted far enough downstream from the video cameras to verify the occupancy of suspect vehicles and identify violators who escaped the notice of observers in the control van. Warnings or citations would be mailed only to vehicles which were identified as violators by the observing officer and by a review of the videotape.

This process is not foolproof, since it is possible that the observing officer could fail to see a child or sleeping adult who also escaped the notice of the camera's eyes. However, such mistakes should be relatively rare, and the officer would have the videotape record to back up any required court testimony. The proposed procedure also fails to free officers entirely from special overtime assignments to HOV lane enforcement. However, a single officer used in conjunction with a videotape set-up should be able to identify nearly all of the violators passing both the video camera and the officer's observation post. This would result in the issuance of far more citations than the officer could possibly write on his own. Furthermore, a mail system would eliminate the need to pursue and cite violators during rush hour, thereby improving officer safety and reducing congestion caused by rubbernecking.

**Future Research Needs.** Future videotape research should explore the use of four camera views in an enforcement setting. Although the current research experimented with four views, the most promising combination of views (long shot of oncoming vehicles, oblique view of passenger seat, eye-level view of rear seat, and downward shot of license plate) was never tested.

Future research should also test the concept of mailed warnings by using the combination videotape and observing officer to identify violators. Lane activity should be monitored on several successive days, warnings should be mailed to suspected violators (i.e., violators identified by both the officer and videotape reviewers), and the impact on freeway violations and public response should be monitored. By using videotape to monitor HOV lane operations in this fashion, it should also be possible to develop a better understanding of the incidence of repeat violators on violation totals.

Other uses of videotape technology should also be explored. For example, a micro-camera installed in the helmet of a motorcycle officer could document vehicle occupancy at the same time that the officer does. The camera would provide a record of both vehicle occupancy and driver identity, and could even document the license plate as well. If the legal obstacles to mail-out tickets could be overcome, the micro-camera could provide a videotape record in support of a mailed citation. This would make it unnecessary for officers to pull vehicles over during commute-hour traffic, thereby improving their efficiency and avoiding the congestion resulting from rubbernecking.

Virginia has established a system of mail-out warnings based on the visual observation of officers (Tollett, 1990). However, registered owners are currently able to escape prosecution by claiming they weren’t driving their vehicle or asserting that a small child was aboard at the time. A videotape record provided by a micro-camera could counter this line of defense.

## 5.2 PERFORMANCE MONITORING

Although videotape systems do not currently appear to provide enough accuracy to support occupancy citations, there are several applications for which such systems are ideally suited and provide a marked improvement over current practice. These include:

1. **Freeway Monitoring** to document vehicle type and occupancy over time.
2. **HOV Lane Monitoring** to document occupancy rates as an aid for enforcement planning; and
3. **Project Evaluation** to document the impact of HOV lanes and other carpool incentives on occupancy rates.

### 5.2.1 Freeway Monitoring

The task of documenting vehicle occupancy and vehicle type in monitoring freeway performance over time is new to most operating agencies. In many areas of California, there are no historical records of vehicle occupancy rates which can provide a basis for tracking carpool trends or assessing the likely impact of proposed carpool incentives. With the increased emphasis on air quality control and ridesharing, it is important that freeway operations personnel begin to document not only the number of vehicles using freeway segments, but also vehicle mix and occupancy levels. Current tests suggest that video cameras can provide a more consistent and accurate record of vehicle occupancy rates than roadside counters. Moreover, the tape supplies a permanent record of freeway activity which can be consulted long after the initial counts were made.

### 5.2.2 HOV Lane Monitoring

Intelligent planning of HOV lane enforcement requires, at a minimum, annual monitoring of violation rates so that appropriate levels of overtime enforcement can be allocated. This is especially important in the case of ramp meter bypass lanes, which rely almost exclusively on special overtime enforcement. Recent experience in California suggests that monitoring activities have fallen behind or been set aside as bypass lanes have proliferated. Video surveillance provides a technique for obtaining and maintaining consistent and accurate records of the use of ramp bypass lanes and other HOV facilities for planning purposes. Furthermore, this availability of license plate data can identify the incidence of repeat violators. The permanent record provided by the videotape can also help to silence skeptics who challenge figures cited in support of HOV lane operations.

### 5.2.3 Project Evaluation

Objective evaluation of HOV projects requires careful measurement of vehicle occupancies before and after the installation of a new HOV lane. If proper occupancy measurements are not made (or are made inconsistently) before a lane is installed, the lane's impact can never be documented adequately.

Even if many manual counts are made, the inconsistencies of individual counters can color results. On the Santa Monica Diamond Lanes, for example, one observer responsible for counting vehicle occupancies before the lanes were installed consistently understated the number of vehicle occupants. When this observer was replaced following the lane installation, subsequent counts showed steep (but overstated) carpooling increases (Billheimer, 1978). Similarly, early occupancy counts on the separate HOV lane on San Diego I-15 proved to be inaccurate because one particular observer consistently understated violation rates. The use of videotape records provides a consistent and verifiable approach to documenting occupancy rates before and after the installation of an HOV project.

## 5.3 UNIT COSTS

### 5.3.1 Equipment

**Purchase Cost.** The cost of outfitting a van with four color cameras capable of recording HOV lane activity at the same level of detail as the field tests documented in this study is estimated to be $108,000. Exhibit 5.2 itemizes the individual components of this cost. The largest components are the van itself ($36,000), three U-Matic three-quarter-inch video recorders ($14,500), four high-speed color cameras with telephoto lenses ($10,800), a special effects generator ($1 O,OOO), and California sales tax ($6,828).

**Contracting/Licensing Costs.** For jurisdictions which do not have sufficient surveillance needs to invest in a fully equipped van and train personnel to record and reduce data, ATD Incorporated has set the cost of videotaping a peak period of HOV lane activity at $5,000. This price includes the use of the equipment listed in Exhibit 5.2, along with the services of trained operators. It does not, however, include the costs of reducing the videotaped data.

EXHIBIT 5.2

HOV VIDEO VAN COST ESTIMATE

| Item | Description | Qty | Cost | Extended |
|---|---|---|---|---|
| 01 | Motor Van with Toilet and Cab-bed | 1 | $36,000.00 | $36,000.00 |
| 02 | Air Conditioner | 1 | 1,500.00 | 1,500.00 |
| 03 | Motor Generator (4Kw) | 1 | 2,500.OO | 2,500.OO |
| 04 | Awning | 1 | 2,000.00 | 2,000.00 |
| 05 | Trailer Hitch | 1 | 350.00 | 350.00 |
| 06 | Custom Equipment Racks | 1 | 2,000.00 | 2000.00 |
| 07 | Mobile Phone | 1 | 1,500.00 | 1,500.00 |
| 08 | Emergency Light/Generator | 1 | 800.00 | 800.00 |
| 09 | Fire Extinguishers (2) | 2 | 100.00 | 200.00 |
| 10 | Battery Powered Work Lights | 3 | 50.00 | 150.00 |
| 11 | Portable Lantern | 1 | 25.00 | 25.00 |
| 12 | Safety Cones | 24 | 25.00 | 600.00 |
| 13 | Safety Signs, Stands and Flags | 2 | 100.00 | 200.00 |
| 14 | Walkiefialkie Radio | 2 | 300.00 | 600.00 |
| 15 | Sand Bags | 12 | 25.00 | 300.00 |
| 16 | Tool Kit | 1 | 300.00 | 300.00 |
| 17 | Hard Hats | 4 | 50.00 | 200.00 |
| 18 | Safety Vests | 4 | 25.00 | 100.00 |
| 19 | Equipment Storage Case | 4 | 200.00 | 800.00 |
| 20 | Hi Speed Color Camera | 4 | 1,500.00 | 6,000.00 |
| 21 | Telephoto Zoom Lens | 4 | 1,200.00 | 4,800.OO |
| 22 | CCU with Genlock | 1 | 600.00 | 600.00 |
| 23 | Heavy Duty Tripod with Arm | 4 | 450.00 | 1,800.00 |
| 24 | Fluid Pan/Tilt Head | 4 | 300.00 | 1,200.00 |
| 25 | Quick Release Plates | 4 | 25.00 | 100.00 |
| 26 | Portable Viewfinder (4”) | 2 | 300.00 | 600.00 |
| 27 | U-Matic “B” VCR | 2 | 4,000.00 | 8,000.00 |
| 28 | U-Matic “B” Edit VCR | 1 | 6,500.00 | 6,500.00 |
| 29 | Edit Controller | 1 | 1,900.00 | 1,900.00 |
| 30 | 13” Hi Res monitor, Color | 3 | 500.00 | 1,500.00 |
| 31 | Quad B/W Monitor | 1 | 950.00 | 950.00 |
| 32 | Quad Split Device, Color | 1 | 2,900.00 | 2,900.00 |
| 33 | Special Effects with Dual TBC | 1 | 1 0,000.00 | 1 0,000.00 |
| 34 | Video Cable Reels (150’) | 5 | 150.00 | 750.00 |
| 35 | Video Cable Reels (300’) | 5 | 300.00 | 1,500.00 |
| 36 | Power Cable Reels (50’) | 3 | 25.00 | 75.00 |
| 37 | Power Cable Reels (150’) | 3 | 50.00 | 150.00 |
| 38 | Video Cam-Corder with Case | 1 | 1,500.00 | 1,500.00 |
| 39 | Mounting Clamp Set | 1 | 100.00 | 100.00 |
| 40 | Wheel Chocks and Ramps | 2 | 50.00 | 1 00.00 |
| | Total Mobile Vehicle Price | | | $101 ,1 50.00 |
| | California State Sales Tax | | | 6,827.63 |
| | TOTAL COST OF VAN AND EQUIPMENT | | | $107,977.62 |

### 5.3.2 Personnel

**Recording.** Two experienced operators are required to set-up and operate the video equipment. The amount of personnel time required to cover one four-hour peak period is roughly sixteen hours, or eight hours for each operator. This includes set-up and tear-down time, as well as the time consumed in traveling to and from the site.

**Data Reduction.** Data reduction time can vary widely from individual to individual. Current experience in reducing test data suggests that the following ranges apply:

- Personnel time required to identify violators: 2 to 4 hours per hour of videotape
- Personnel time required to identify violators and document vehicle occupancy: 4 to 8 hours per hour of videotape

**Personnel Costs.** Assuming personnel costs of $30.00 per hour,* the following costs would be incurred in recording and reducing.

| | PERSONNEL COST OF RECORDING AND REDUCING FOUR PEAK HOURS OF HOV LANE DATA | |
|---|---|---|
| | VIOLATIONS ONLY | VIOLATIONS AND OCCUPANCY |
| Recording | 2 people, 8 hours = 16 hrs @ $30 = $480.00 | 2 people, 8 hrs = 16 hrs @ $30 = $480.00 |
| Reducing | 1 person, 12 hours = 12 hrs @ $30 = $360.00 | 1 person, 24 hrs = 24 hrs @ $30 = $720.00 |
| Total | 28 hrs @ $30 = $840.00 | 40 hrs @ $30 = $1,200.00 |

Data reduction costs will drop as trained personnel learn to perform the tasks and become more efficient. Data reduction costs could also be lowered by sampling occupancy rates rather than recording precise occupancy counts for each vehicle during the four hour period.

* This represents the high range of fully loaded costs for ordinary time, and the low range of overtime costs for CALTRANS personnel at the level needed for field observations.

### 5.3.3 Relative Cost Effectiveness

**Enforcement Costs.** Although video technology has not yet proven itself capable of supporting a system of mail-out citations, it is instructive to consider the potential cost-effectiveness of such a system. The most promising system identified in the current research would use a video van in combination with a roadside officer to provide the license plate information needed for mailing out citations. Such a system would not replace the routine enforcement activity currently in place on California's mainline lanes, but it might reasonably be expected to replace the overtime assignments needed to augment this routine enforcement.

Concurrent research suggests that a program aimed at ticketing 2.5% of HOV lane violators can be expected to keep overall violation rates within an acceptable 10% level (Billheimer, 1990). There are currently roughly 500 peak commute periods in California each year (two periods during each of 250 weekdays). Covering 2.5% of these periods would require enough personnel to ticket every violator during 12.5 peak periods. However, experience has shown that routine enforcement is responsible for well over half of the citations issued for mainline HOV lane violations in California. Thus special overtime enforcement needs to pick up less than half of the total citations needed, say enough citations for all violators encountered during six peak periods on each project,

The personnel cost of covering a single peak period on one of California's mainline HOV lanes with a combination of video recording and officer observation can be approximated as follows:

| | | |
|---|---|---|
| One motor officer on overtime | 6 hours @ $50/hour = | $300 |
| Van personnel - 2 people | 8 hours @l $30/hour = | 480 |
| Data reduction - 1 person | 12 hours @ $30/hour = | 360 |
| Total Personnel Costs | | $1,140 |

Allocating these personnel costs to each of California's ten mainline HOV lanes and allowing for equipment depreciation produces the following annual cost:

| | |
|---|---|
| Personnel Costs - $1140 x (54 peak periods*) = | $61,560 |
| Equipment Depreciation ($107,977.62 - 4**) = | 26,994 |
| | $88,554 |

* Eight of California's ten mainline lanes operate during both am and pm peaks. Two (SF 280 and LA 91) effectively operate only during one peak, producing a total of 54 peak periods of special enforcement (six for all lanes operating during both peaks, and three each for LA 91 and SF 280.)
Assumes that the equipment is fully depreciated over four years.

Thus the annual costs of supplementing routine enforcement with a system of mail-out citations supported by a combination of video documentation and officer observation would be $88,554. Since the CHP currently allocates at least $334,000 to the special overtime enforcement of HOV lanes, this represents a considerable savings. In addition, a video-based surveillance system would obviate the need for pursuit and citation by special enforcement units during peak commute periods and therefore would be both safer for CHP officers and motorists and less likely to cause congestion than the current approach.

Accordingly it appears that the prospect of video-based enforcement is sufficiently attractive so that the CHP should continue to attempt to develop a system capable of supporting mail-out citations.

**Monitoring Costs.** The personnel costs of recording and reducing four peak hours of HOV lane data using a three-camera video display have been estimated at $840 if the data reduction activity focuses only on violations, and $1200 if both violations and occupancy are recorded for every car. (See Section 5.3.2.) To these personnel costs must be added an allowance for equipment depreciation. If every mainline HOV lane in California were monitored twice yearly during each peak period, the cost of video monitoring could be computed as follows.

Annual cost of monitoring violations only:

| | | |
|---|---|---|
| Personnel Costs: $840 x (36 peak periods) = | $30,240 | |
| Equipment Depreciation ($107,977.62 ÷ 4) = | 26.994 | |
| | | $57,234 |

Annual cost of monitoring violations and occupancy:

| | | |
|---|---|---|
| Personnel Costs: $1200 x (36 peak periods) = | $43,200 | |
| Equipment Depreciation | 26.994 | |
| | | $70,194 |

On the other hand, the cost of obtaining the same data through manual observation, as it has historically been obtained, is considerably cheaper:

Personnel Time:

| | |
|---|---|
| On-Site Recording: 2 people x 6 hours = | 12 hours |
| Data Reduction: 1 person x 2 hours = | 2 hours |
| Total | 14 hours |

Annual Cost of Manual Observation

| | |
|---|---|
| Personnel Costs: 14 hours x $30/hour x 36 peak periods | $15,120 |

Thus manual monitoring of HOV lanes is considerably less expensive than videotape monitoring. While these figures are rough estimates, and the annual depreciation charged to mainline HOV lane monitoring could be much less (if, for example the video equipment were applied to other uses such as the surveillance of ramp meter bypass lanes or freeway monitoring in support of air resource board calculations), the personnel costs involved in videotaping lane activity and reducing the taped data will always be at least double the cost of manual observation.

The videotape observations, to be sure, provide far more information than the manual records provided by roadside counters. Videotape provides more accurate records, a consistent data base, and a permanent, verifiable record of traffic activity. It also provides information on the vehicle mix, traffic speeds, and the license plates of violators and carpoolers.

Officials contemplating the use of videotape in monitoring HOV lane performance must ask themselves whether the added benefits provided by the videotaped data are worth the added cost. If the data can be used as a basis for enforcement, of course, the question is moot. As noted earlier, the cost of videotaping and reducing mainline HOV lane data appears to be more than justified if that data can be used as a basis for citing violators and offsetting the need for overtime enforcement activity.

## 5.4 PUBLIC RELATIONS

In a state in which radar cannot legally be used to enforce speed laws on state freeways, videotape surveillance of HOV lanes has significant legislative and public relations implications. These implications are beyond the scope of the current study. However, two activities occurring during the study may shed some light on the possible reactions of the public and the media to the possibility of videotape surveillance.

(1) In a previous segment of the study (Billheimer, 1990), focus group participants were asked their opinion of a ticket-by-mail system supported by video surveillance.

(2) The field tests undertaken during the current segment of the study attracted the attention of the Los Angeles media and resulted in a limited amount of press coverage.

### 5.4.1 Focus Group Reactions

During an investigation of HOV lane violations (Billheimer, 1990), six focus group discussions were conducted with drivers on four freeways having HOV lanes: Orange County Route 55 (two groups), Los Angeles Route 91 (two groups); Santa Clara Route 101; and Marin Route 101. These focus groups probed drivers' perceptions of and attitudes toward HOV lanes, violations, and enforcement activities. In five of the six focus groups, the possibility of video surveillance and tickets-by-mail was suggested by members of the group. At the close of all six group discussions, this possibility was outlined and participants were asked their opinion of the concept. Discussions were invariably heated, with strong feelings on either side of the issue. In the end, participants in three focus groups favored using mail-out citations, while participants in the three remaining groups were opposed. A summary of the arguments for and against the concept appears below:

(1) **Arguments For.** One OR 55 driver noted that "Mail-out tickets is the best way (to enforce HOV lanes). Pulling violators over is almost out of the question...It really messes up the traffic pattern." Another OR 55 driver felt that mail-out tickets would "...free police for more important duties. But that doesn't mean the CHP should disappear. That visibility is important." Several drivers made the point that before mailing out tickets, the state "...needs to educate the public first." The public needs to understand both the need for compliance with HOV regulations and, in particular, the need for video surveillance.

(2) **Arguments Against.** "Shades of Big Brother" was the most frequently cited argument against mail-out citations. Many drivers expressed concern over the technological problems involved in making sure that the camera hadn't missed a baby or a sleeping adult. Even when the majority of the group favored mail-out tickets, there was generally a vocal minority which felt strongly that they were an invasion of privacy.

In short, driver opinion split dramatically on the desirability of videotape surveillance and tickets-by-mail. Opponents cited "big-brotherism" while proponents argued that freeway ticketing caused significant traffic slowdowns. Most drivers agreed that the public would have to be educated regarding the need both for HOV lanes and mail-out citations if such a procedure were to succeed.

### 5.4.2 Press Coverage

The Los Angeles Times took an interest in the videotape tests and sent a reporter and cameraman to the Warner Avenue overcrossing on the day of the final field test. The reporter, Eric Bailey, interviewed most of the participants in the test, as well as representatives from the Orange County based Drivers for Highway Safety. The text of Bailey's story, which ran in the Although the story predictably raised the specter of Times on January 9, appears In Appendix B. Big Brother, it was balanced and informative, and has evidently generated remarkably little negative reaction. A follow-up piece by John Rezendes-Herrick of the Daily Report/Progress Bulletin in Ontario, California was similarly balanced (see Appendix B). To the extent that these stories can be viewed as an indication of press and public reaction to the use of videotape in HOV lane enforcement, there was no suggestion that CALTRANS and the CHP would be exposed to a massive public outcry if videotape proves to be technologically and legally feasible as an enforcement tool. Furthermore, it can be assumed that the articles themselves made potential HOV lane violators in the Los Angeles area more cautious.

# 6.0 CONCLUSIONS AND RECOMMENDATIONS

## 6.1 CONCLUSIONS

### 6.1.1 Enforcement

- Videocameras operating alone cannot currently identify the number of vehicle Occupants with enough certainty to support citations for HOV lane occupancy violations. While certain HOV lane infractions, such as illegal buffer crossings, can be identified unambiguously and the license plates of violators can be recorded accurately, the rate of false alarms encountered in using videotape records to document occupancy violations is much too high to support enforcement actions. The chief problem encountered involves the size and positioning of vehicle occupants. Small children and sleeping adults can regularly escape the camera's eye.

  Other problems encountered in attempting to document vehicle occupancy through video surveillance included glare, ambient lighting conditions, vehicle size and position, tinted windows, and sight-obscuring headrests and windshield posts. These other problems, however, do not appear to be insurmountable. Some (i.e. glare and ambient lighting) can be solved technologically through the use of filters and continuous camera adjustments. Others simply lead to indeterminate occupant counts which would not trigger a citation. In any case, these problems are not the kind which lead to the mis-identification of violators. They may cause some violators to escape detection, but they should not produce false alarms so long as the videotape is carefully interpreted.

- Video cameras operating in conjunction with officer observation may provide sufficient accuracy to support mail-out citations for HOV lane occupancy violations. An officer stationed downstream from the video cameras is in a position to verify the occupancy of vehicles which appear suspect to observers monitoring camera output. If a system of mail-out warnings or citations can be installed, this officer would not have to pursue violators, and a videotape record of driver, occupancy, and license plate will be available for court hearings. This system is not foolproof, since the roadside officer may fail to see a small child missed by the video monitor, but it appears to have considerable promise. Moreover, the presence of an observing officer may remove some of the "Big Brother is watching" stigma from the use of videotape.

Analysis suggests that a combined system of video recording, officer observation, and citations-by-mail is far more cost-effective than the current system of freeway pursuit and roadside citing. The combined video/observation system should be able to produce the same number of tickets for less than one-third the cost of special overtime assignments to roadside enforcement. Furthermore, by eliminating the need to pursue and cite violators during rush hour, the combined system improves the safety of both officers and drivers and reduces the congestion caused by rubbernecking.

- The use of videotape as a real-time on-line enforcement aid appears to be limited to those locations lacking a median shoulder or enforcement area where an officer can be posted for observation purposes.

  The use of videotape as an aid in enforcement activities requiring officer pursuit and on-line citations appears to be somewhat limited. An officer stationed beside an HOV lane in an enforcement area is in a better position to observe violators than an officer stationed in the control van watching a video monitor. Furthermore, the roadside presence of an officer in an enforcement area can have a cautionary effect on drivers. Either officer can radio ahead to pursuit units.

  The only locations where an officer in the videotape van might be better able to assist on-line enforcement than an officer on the freeway would be those locations where there is no refuge area adjacent to the HOV lane. If there is no median shoulder or enforcement area where an officer can be situated for enforcement purposes (as in the case, for example, on Marin 101), video-assisted enforcement stops might be considered as an option.

### 6.1.2 Surveillance

- Individual interpretation of occupancy levels by both roadside observers and videotape reviewers varies widely with the individual and the instrument used. Evidence suggests that roadside obsevers overstate occupancy violations. While some observers understated the number of vehicles with three or more occupants, others using different count sheets overstated the number of high occupancy vans carrying six or more people.

- Videotape provides a freeway monitoring tool which is potentially more consistent and accurate than existing techniques for documenting vehicle occupancy. In addition, videotape provides a permanent, verifiable record of the vehicle mix, traffic speeds, and the license plates of violators and carpoolers.

## 6.2 RECOMMENDATIONS

In view of the improved accuracy of videotape surveillance and the potential promise of videotape as an enforcement tool if used in conjunction with officer observation, it is recommended that CALTRANS and the CHP take the following steps to explore further the potential uses of videotape in HOV lane surveillance and enforcement.

- Test the relative accuracy of a four-camera set-up in conjunction with an observing Officer. Further field tests should be undertaken to explore the relative accuracy of a four camera set-up in a freeway setting. As in past field tests, a downstream officer should verify the occupancy of suspect vehicles. However, as an additional check on the accuracy of the officer/videotape combination, motor officers should be available to pursue and cite vehicles identified as violators by both the videotape observers and the verifying officer.

- Test the impact of mailed warnings on violation rates. Video surveillance should be used in conjunction with a roadside officer to monitor several days of HOV lane operations. Written warnings should be mailed to the registered owners of vehicles identified as violators by both the videotape monitors and roadside officers. The impact of this activity on HOV lane violations should be documented through subsequent videotape surveillance and follow-up surveys. Media support for the demonstration should be enlisted through a carefully designed program of public information.

- Explore the use of videotape on ramp meter bypass lanes. The current study has tested and demonstrated the use of videotape in documenting violation activity on mainline HOV lanes. Similar tests should be undertaken on ramp meter bypass lanes.

- Continue to explore the legislative/legal ramifications of mail-out citations. The CHP should continue to explore the necessary legislative and legal steps necessary to support the use of tickets-by-mail for HOV lane infractions.

- Continue to explore the uses of advanced videotape technology in HOV lane surveillance and enforcement. Two promising avenues of investigation identified through the current research include:

  1. The use of micro-cameras installed in the helmets of motorcycle officers; and

  2. The use of low level infrared lighting installed at freeway level to document vehicle occupancy under conditions of darkness or low visibility.

# APPENDIX A

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## BIBLIOGRAPHICAL REFERENCES


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# APPENDIX B

## SAMPLE PRESS COVERAGE

Staff Photo by Tom Zasadzinski

Montclair police Officer Dennis Conlin looks for speeders with a radar detector

# Technology hits the streets

## Electronics aid traffic enforcement

By J Rezendes-Herrick
Staff Writer

No high-tech tools for former police officer Roger Remlinger

"It kind of takes the thrill out of the hunt," said Remlinger, an attorney in Rancho Cucamonga. "We did it the old-fashioned way — pace 'em, pull them over and give them a ticket "

But increasingly, police departments from New York to California are using sophisticated electronic devices to nab speeders and other errant drivers Budget constraints on departments' traffic control operations — coupled with explosive growth in the numbers of drivers — have led officers to seek new ways to improve safety and obedience on roadways

The latest wrinkle has surfaced in Southern California, where computer controlled video cameras are aimed at car-pool lane scofflaws in Orange and Los Angeles counties

"We've gotten to the point that we can't build our way out of this freeway mess,"said Phil Jang, chief of Caltrans' high occupancy vehicle operations "So we're indicating people can use car pool lanes as one way to lessen congestion."

A $250,000, 18-month study may rectify the problem Caltrans and the California Highway Patrol have retained Systan Inc to examine all phases of car pool lane operations design and construction standards, optimal operating plans and catching violators driving with fewer than the required number of occupants

Burning up patrol officers to enforce car pool regulations is impractical during rush hour commutes And the process of zipping in and out of stalled traffic to stop violators borders on being reckless, some experts say

The officer is driving along and watching in the rear view mirror,' said John Billheimer, Systan vice president "They're going from a standing start to a lane where the traffic is going 50, 60 mph "

"We want to lessen the manpower it requires to enforce these lane violations," Jang added "Right now, we don't have the enforcement for all the HOV lanes and it's quite unsafe "

That could change once the study is completed Beyond the design and construction innovations, the $100,000 system could give law enforcement a leg up on the commute madness Violators could be tracked until an officer could pull them safely into enforcement areas

"There have been quite a few error rates and we really haven't adopted a stance yet," said Lt Shawn Watts with the CHP's planning office in Sacramento "If it does work, we're looking to help the officers out by interfacing with the cars "

Photo traffic enforcement got its start in Europe Speeders are routinely nailed by still cameras and receive citations days or weeks after the violations In California, the Pasadena Police Department pioneered the use of photo radar in June 1988

"We were experiencing a high incidence of speed-related accidents," said Lt Bob Huff with the department's photo radar unit "And the number one complaint we were receiving was speeding in residential neighborhoods We talked about speed bumps, stop signs — our eyes were open to things like this."

A city traffic engineer found a flier on photo radar from Traffic Monitoring Technologies in Houston The company was contacted and representatives offered to demonstrate the device The city Board of Directors commissioned a 45 day, $27,000 study and the police department began photographing speeders and mailing warnings to violators

The apparatus uses radar hooked to a computer that activates a camera Drivers moving faster than the speed pre-set for the radar trigger the computer, which then tells the camera to photograph the driver and license plate About 1,400 warnings were issued during the testing period, accompanied by surveys to gauge residents' reactions to the program

"I was kind of surprised the people accepted it," Huff said "There were some letters to the editor but not that many "

The systems cost about $65,000 each But Pasadena leases the equipment from the Texas firm in return for a $20 payment for every ticket assessed With most fines netting the city less than $20, the company has agreed to take no more than the city's share and the program is essentially a break-even proposition.

The radar unit is mounted in the rear of a white Chevy Blazer with Police Department markings A single officer works the radar unit for between 70 hours and 150 hours a month That frees the city's remaining 15 traffic officers to concentrate on other vehicle hazards and violations

The department mailed 16,599 tickets during the program's first 18 months While the number of acci-

See TECHNOLOGY/B4

# Cameras, computers as traffic police raise new legal issues

By J Rezendes-Herrick
Staff Writer

The debate over police spy eyes for traffic enforcement runs the gamut.

"In our community, people have been 100 percent behind it," said Sgt. Ron Warner with the Paradise Valley, Ariz., police, who have used photo radar since 1987

"I have enormous concerns about privacy rights under the Constitution," said Erwin Chemerinsky, USC law professor and Southern California American Civil Liberties Union board member

From minor legal glitches to major concerns over individual rights, officials are coming to grips with laws that govern the use of high technology photo-traffic devices

"When Paradise Valley first started using (photo radar), there was a lot in the media about Big Brother," said Jim Redpath, chief transportation division counsel with the Arizona Attorney General's Office "There were a lot of letters that said this was just one more example of the government invading and taking over "

But courts in Arizona have largely upheld the enforcement tool And municipal courts in Los Angeles County have sustained photo radar use by the Pasadena Police Department.

Computer-controlled cameras photograph motorists who run stoplights under a pilot program in New York City But cameras cannot testify in

See LAWS/B4

# Need outweighed by cost for local police agencies

By J Rezendes-Herrick
Staff Writer

Pomona motorists won't run afoul of photo radar and Ontario drivers can feel secure from video camera surveillance

Few of the technological innovations being pioneered on Los Angeles County's highly congested roadways are being used in the Inland Valley's less-dense traffic corridors

'It's been looked at," said Sgt Bob Racine with the Ontario Police Department "It's a good idea However, in terms of the effort and the cost involved, that's more than the benefits derived from it "

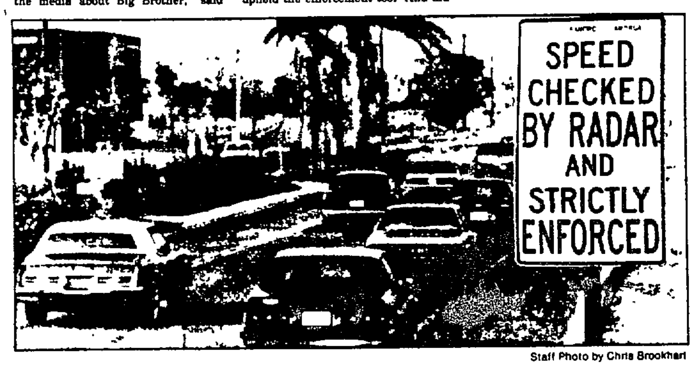
'We've got brochures from companies building these kinds of things," added Lt Mike Ingram with the San Bernardino County Sheriff's Department Rancho Cucamonga Station. "I've talked to some people but we feel our traffic program is effective and they cost so much it's kind of prohibitive "

The high cost is the biggest barrier to using photo radar and other enforcement systems, local officers say Photo radar units cost upwards of $65,000 Sensor activated cameras that police intersections run about $45,000 each Covering an entire intersection with units would cost $180,000 — as much as or more than the traffic lights themselves

The region lacks carpool lanes — the first is slated for the Riverside (91) Freeway and is still in the design stages And while several thorough fares are recording crisis traffic counts, the region's overall car and truck flows are not sounding alarms

About the only remote-control traff-

See LOCAL/B5




Staff Photo by Chris Brookhart

Late afternoon traffic streams past one of Rancho Cucamonga's radar warning signs.

# 'Hot Spots' results in drugs arrests

By Sharon Greengold
Staff Writer

Pomona police assigned since Jan 19 to an aggressive month-long patrol through high-crime neighborhoods have arrested 60 people suspected of selling drugs

A group of 20 police officers have been taken off their regular patrols and paired up to crack down on neighborhoods notorious for sales of illicit drugs

Dubbed "Operation Hot Spots," police cars are driven around in pairs through neighborhoods in an effort to root out drug profiteers and haul them off to jail

Police have made 35 felony arrests for sales of narcotics and 25 misdemeanor arrests for possession of dangerous drugs and drunken driving through Friday Police also handed out 49 citations for vehicle code violations said Pomona police Capt Rick Shaurette

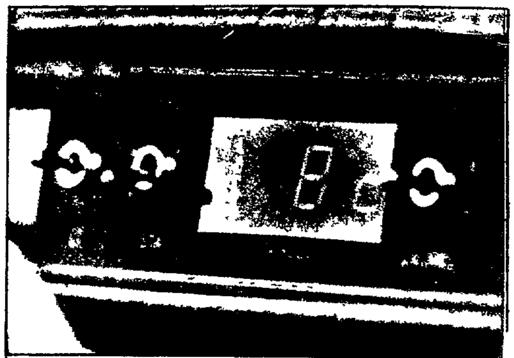
We did this in the 'Islands' a year ago, Shaurette said referring to a neighborhood north of La Verne Avenue, east of San Antonio Avenue and south of Arrow Highway

To protect strategy, neither the patrol schedule nor specific areas targeted by the team are divulged, Shaurette said

Basically we saturate the areas with reports of problems

See ARRESTS/B2

## Sunday Focus



Staff Photo by Tom Zasadzinski

California Highway Patrol Officer Ellen Conley's radar shows a speeders' rate of travel.

# Traffic control devices improving

## Advances making them more accurate

By J Rezendes-Herrick
Staff Writer

> *"It's doing very well. It's helped reduce accidents; that's the main reason for continuing it."*
>
> —Sgt. Ron Warner

Sophisticated traffic control devices rely on the latest tech nology to nab reckless drivers all over the world

But sometimes catching viola tors comes down to little more than the ancient shell game

"They have a system in Is rael, in Tel Aviv," said Victor Ross, assistant commissioner with the New York City Trans portation Department

"There are 40 intersections with black boxes But all they have is four cameras Those clever guys keep moving the cameras around It's certainly a deterrent because you pull up and there s a big black box loom ing at you"

Radar and computers have been used in law enforcement [illegible] But using radar [illegible] activated cameras [illegible] errant drivers on film has opened the possibility of remote control traffic police

"Particularly in Northern California, there is just no place even for an officer to stand and observe traffic," said John Bil lheimer, vice president of Systan Inc that is testing video camera surveillance of car pool lanes in Los Angeles and Orange coun ties "In one case, they were just shoehorning an officer in a little niche created by a bridge sup port"

Policing traffic violations via camera computer hookups ac complishes two goals Violators can be corralled and ticketed later in areas that are safer for both officers and passing motor ists And police are freed up to cope with other traffic problems

The systems were invented in the United States but have found their biggest success in Europe Departments in Sweden and Germany have been photo graphing speeders for about 15 years

Photo radar to identify speed ers was first used in the United States in 1970 by the police department in Arlington, Texas

"It took good pictures," said Arlington Officer James Belz A man out in the car with a woman not his wife would have a serious problem if he was speeding because they'd be on the picture"

Olin Gary is now rangemaster at the Arlington Police Academy but was coordinator for the de partment's radar program The ORBIS 3 was designed and built by LTV Corp

"The biggest problem was lo cating the driver and writing the ticket," Gary said "About 70 percent of the photos were not usable at all Out of those left over, half you couldn't iden tify or locate the driver It wasn t cost effective to issue citations"

Originally designed to work automatically, court rulings and concerns over vandalism forced the department to hire an LTV technician to staff the device

The program was stopped in 1972 and resurrected briefly in 1976 before being permanently discontinued

By the mid-1980s, technologi cal advances in computers and photography dramatically im proved the devices Traffic Moni

See LATEST/B5

# Technology/from B1

dents has held steady, the num ber of speeders was nearly halved, Huff said.

When the system was first used, 9.5 percent of the cars passing it were traveling faster than the speed limit That dropped to 3.6 percent right af ter the radar started and has since stablized at 5 percent.

And what little public outcry surfaced has since disappeared

A survey earlier this month of 1,000 residents in and around Pasadena provided some inter esting results. A total of 61 percent of those contacted fa vored the device In addition, 64 percent said they would like the program expanded and 39 per cent said they now drive slower because of the photo radar

"The speeders have really subsided and it's based solely on the photo radar," Huff said "It really helped me — when I give talks I can pull out the statistics to show them"

Some criticism arose of the department's trademark "smile" signs that tell people photo radar is being used by the city But Huff has tried to de flect the comments

"A city traffic engineer de signed it and we got a few calls," he said "Some people took it as a slap in the face But he designed it to tell the people of Pasadena that we're strictly enforcing the speed limits on their streets (to help them)"

# Laws/from B1

court and the city got a change in state law to permit prosecu tion of the offenses in city courts.

"Under ordinary circum stances you see a cop writing a ticket out," said Victor Ross, assistant commissioner for the city's transporation department "In this case, we're saying some one was driving the car, and, yes, it went through a red light and the violation is going to the registered owner"

That approach runs into prob lems in California, said Rancho Cucamonga attorney Roger Remlinger

"My main concerns would be the accuracy and whether you can link the vehicle and the driver," he said. "What do you do about the rental car? What if somebody borrows your car?"

A provision in California law governing police vehicle mark ings nearly scuttled Pasadena's photo radar program.

"It was housed in a Blazer that had a wide colored stripe around it," said Courtlande Crabtree, Pasadena's assistant city prosecutor. "We had to get rid of the stripe and start over."

Some are concerned that a private firm has access to motor vehicle records that are normal ly reserved for law enforcement agencies

"These kinds of issues come up," Redpath said "The big is sue is you had companies with monopolies with access to records as opposed to the police doing it themselves."

But some of the minor issues disappear in discussions of the legal principles involved.

"There is the specter of Big Brother taking your picture but what bothers me is the due process," Chemerinsky said "If a police officer stops you there is an individual you can respond to. If a picture is taken weeks ago, do you really have a mean ingful and fair opportunity to respond?"

Crabtree discounted the objec tions

"A lot of people including my self think this stuff about Big Brother privacy just doesn't fly," he said. "There is all kinds of case law about vehicles on the street being in a public place The camera sees less than a pedestrian looking into the vehi cle."

Some new legal problems are developing with photo identifica tion of traffic violators Private firms making the equipment also develop the film, locate the driver and mail the citat through information provided by the Department of Motor Vehi cles

But in July, television actress Rebecca Schaeffer was shot to death by an obsessed fan who apparently used DMV informa tion to get her home address Legislators in Arizona and Cali fornia subsequently wrote bills to restrict information that can be obtained from vehicle depart ments The new law's full effects won't be sorted out for some time

## Sunday Focus

# Latest/from B4

toring Technologies of Houston developed a compact system and a plan for servicing the device on a contract basis

Paradise Valley, Ariz, signed up for the program in late 1987, one of only two communities nationally now using the sys tem

"It's doing very well," said Sgt Ron Warner "It's helped reduce accidents; that's the main reason for continuing it"

The department has issued more than 20,000 tickets and about 70 percent of the offenders are either paying the fine or attending traffic school Acci dent rates have dropped 19 per cent overall since the program began

A different sort of technology is being tested by New York City Sensors implanted in the streets trigger cameras keyed to the traffic signals The program has spent two years looking at four different systems The de vices are currently policing in tersections in Manhattan, Queens and Brooklyn

"I would hazard a guess the companies think they're the greatest thing since Carter's Lit tle Liver Pills and that every body will fall in line," said the transportation department's Ross "But it costs money to implement it We have a unique situation where we have a fiscal crunch and we're not sure whether they'll be invited to implement it"

But running stop signs or red lights is virtually a pasttime in New York

"The idea is always in a mo torist's mind when he tries to creep into the street or rush through to beat the light," he said

Despite the dearth of current usage, traffic technology is gain ing popularity Dallas police are considering using photo radar systems, as are state police in Maryland and Virginia who pa trol the traffic-clogged Capitol Beltway around Washington DC

"We're doing a study to see if the device is practical for us," said Col Charles M Robinson with the Virginia State Police "That's in the infancy stages"

Yet police departments are confronted by the same choices as other governmental agencies

"We're just now looking into it," said Capt. Larry Sanbor ough with the Dallas Police De partment traffic division "The problem will be the budget Those suckers are expensive"

# Local /from B1

ic device in use locally are the speed boards Radar-activated display boards tell passing mo torists their speed, a gentle re minder short of a traffic ticket to slow down

The equipment is being used by the Los Angeles County Sher iff's Department in Walnut and the Ontario CHP office is debat ing whether to use the device

"Certain areas have them in Northern California," said CHP Officer Mike MacBean "It's been very productive as far as slowing people down"

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*Video Patrol of Car-Pool Lanes Gets Tryout in O.C.*

Los Angeles Times (LT) - MONDAY January 8, 1990
By: ERIC BAILEY; TIMES STAFF WRITER
Edition: Orange County Edition Page: 1 Pt. A Col. 5
Story Type: Full Run
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TEXT:

It could be the traffic cop of the future.

Across the country, from the Washington beltway to the streets of Pasadena, transportation officials are turning to the camera to crack down on motorists guilty of everything from speeding to running stop lights.

Now the concept could be coming to California in an even bigger way. Authorities at the California Department of Transportation and the California Highway Patrol are looking at using video cameras to nab motorists who violate car-pool-lane rules on freeways up and down the state.

The new video technology, which features cameras as tiny as a lipstick tube and super-slow-motion replay machines, has already had a dry run on the Artesia and Simi Valley freeways in Los Angeles County and was tested again last Thursday in Orange County along the Costa Mesa Freeway's car-pool lanes.

For the CHP, the idea has particular allure. If the video technique proves feasible, it could help shrink violation rates in car-pool lanes and relieve officers of the dangerous task of pulling scofflaws across three or four lanes of freeway traffic to issue a ticket.

"We're interested in testing any kind of technique that could help out," said Lt. Shawn Watts of the CHP's transportation planning unit in Sacramento. "This looks pretty good because it would possibly save a lot of officer time, reduce their exposure to traffic out there and hopefully catch more violators."

While transportation officials agree that the idea shows promise, obstacles remain. Technological hurdles must be overcome, and logistical changes might be necessary before tickets could be delivered to motorists via the mail.

But the biggest roadblock, experts say, may be legal. As they have in other parts of the country, some residents and civil liberty groups may conjure Orwellian images of "Big Brother," saying the cameras infringe on the privacy of motorists.

"Speaking for myself, the Big Brother aspect of it is a little disturbing," said Bill Ward, a leader of Drivers for Highway Safety, a small Orange County-based group opposed to car-pool lanes. "I think they'll have some problems getting it to stand up in court . . . I just don't see this going very far."

Transportation officials, however, insist that the benefits of such an approach would far outweigh the risks.

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"I think those kinds of arguments, the Big Brother thing, can be overcome and has to be overcome," said Steve Albert, a Texas-based expert on the use of video cameras for monitoring traffic. "It (currently) just takes too many man-hours to enforce these facilities. It's too costly. Like every other technological advancement, it will come in time."

Most authorities in California estimate it could be as long as five years before the video cameras could become a fixture along car-pool lanes in the state. A host of difficulties must first be addressed.

Initial tests, which are being conducted as part of a larger study of car-pool enforcement, have been hampered by the tedious task of positioning cameras just right so they can peer down into a car to spot the less-obvious passenger--a baby on board or someone lying down on the back seat. Tinted windows, sun glare, morning mist on the windshield and other environmental factors could also obscure the camera's view.

Assuming those sorts of troubles can be ironed out, state authorities would still have to deal with the problem of angry motorists, who might reject the idea of receiving a ticket through the mail. Laws would probably have to be adjusted so the burden of a ticket falls on the owner of a vehicle instead of the driver, a regulation that might irk any parent whose teen-ager got caught by the camera driving solo down the car-pool lane in the family car.

Even the issue of who monitors the cameras and videotape could prove vexing. Though some cities have hired outside firms to pluck violators from the pictures and search the records for vehicle owners, California authorities envision a system that would probably employ sworn peace officers to determine who has broken the law.

Whatever is decided, the concept promises to engender a fair amount of debate. Surveys conducted as part of the car-pool violation study found motorists "equally divided" over camera-patrolled car-pool lanes, according to John Billheimer, vice president of Systan Inc., a Los Altos-based transportation planning firm doing the study for Caltrans.

Despite that reaction, the concept has been in use for years in other parts of the world. West Germany has had an active "photo-radar" program for about two decades, and the technique is used to nab speeders elsewhere in Europe, Asia and South America.

Photo-radar, which combines still photographs with radar to determine a motorist's speed, has only recently made an appearance in the United States. Although some residents quickly dubbed it "robocop," the technique has been used successfully in Paradise Valley, Ariz., since 1987. Pasadena began issuing citations with the same Swiss-made device in June, 1988.

Since then, more than 14,000 speeding tickets have been issued in Pasadena for motorists caught by the photo-radar, according to Sgt. Gene Gray of the Pasadena police. Nearly 300 people fought their tickets, but the city prevailed in 90% of those cases, he said.

Still, there have been problems. Pasadena recently tried enlisting a similar

(cont. next page)

device that would photograph motorists who run red lights, but the machine proved largely ineffective. The same device was installed at several intersections in New York that have been plagued with accidents involving cars hitting pedestrians.

Then there are the troubles in Texas. A small suburban community outside Houston adopted photo-radar a few years ago, but discontinued use of the device after about six months. Though the official excuses were legal problems and public discontent, transportation planners say privately that it had more to do with sex, lies and photographs.

As the story goes, a prominent Texas politician was caught by the machine speeding along in his car with a woman who was not his wife. When the photograph was routinely mailed to his house along with a ticket, the politician's spouse caught a glimpse and hit the roof. The official then worked behind the scenes to get the plug pulled on the photo-radar.

Despite such potential pitfalls, the concept is being eyed for Washington, D.C. Officials with the Virginia State Police are investigating the use of photo-radar or video cameras to ticket speeders along the 60 miles of freeway circling the capital.

In California, authorities are focusing for now on using such high-tech ploys simply to uphold the law of the car-pool lane. While state officials are quick to emphasize that the concept is still in the raw testing stages, they have a hard time hiding their optimism.

"As far as the safety issues, I think it could be a great tool," said Scott McGowen, an assistant transportation engineer with Caltrans in Sacramento. "We'll have to look into the costs some more, and maintenance of such a system. But this could help with many problems we have now, like the way these traffic stops disrupt the flow in other lanes."

One day last week, McGowen and other state officials huddled with technological experts atop an overpass on the Costa Mesa Freeway to watch a demonstration of the videotape system at work.

Hunkered in a van crammed with TV screens, Ken Taylor of ADT Inc., a Woodland Hills firm that designs and builds video systems for everything from aircraft simulators to hospitals, squinted at the pictures being fed by three cameras. One screen showed cars roaring head-on down the freeway, another displayed license plates of passing vehicles in the car-pool lane and a third showed a side view of cars roaring by.

"We've tried all types of cameras, all sorts of angles," Taylor said.

The cameras in use on this day, he noted, were not the micro-sized models that may come in handy along tight stretches of highway. And these cameras and videotape machines were not even the best. Such super-sophisticated devices, which provide a more detailed picture, cost about $30,000 for just a videotape recorder alone, compared to $6,000 for the one in use Thursday, Taylor said.

When a visitor pointed to an approaching car that seemed to have just a single occupant, Taylor shifted in his seat, ready for action. His fingers danced across

(cont. next page)

the controls of the videotape machine after the car whizzed by, rewinding the film until a side view of the car stood frozen on the screen.

"Ah ha!" Taylor chirped, pointing to the screen. "You think that's a violator? Look at that baby in the back seat."

Those are just the sorts of results transportation officials like to see.

"I think we're in the new age," said McGowen of Caltrans. "Anything we can look at that's high tech, we have to. This may not be the way to go, but we have to explore everything."

CAPTION:
Photo: CHP officer Ed Exley checks out video system on Warner Avenue overpass as it monitors car-pool lane traffic on Costa Mesa Freeway.
Photo: Video Patrol
California highway authorities are looking at using video cameras to nab motorists who violate car-pool lane rules. The technology, including miniature cameras and slow-motion replay, was tested Thursday on the Costa Mesa Freeway. Advanced Technical Division President Ken Taylor watches from a van on the Warner Avenue overpass.
LEO JARZOMB / For The Times

DESCRIPTORS: FREEWAYS; VIDEO RECORDINGS; CARPOOLS; CALIFORNIA HIGHWAY PATROL; CALIFORNIA DEPARTMENT OF TRANSPORTATION; TRAFFIC MANAGEMENT; TRAFFIC VIOLATIONS; POLICE EQUIPMENT; DETECTION DEVICES; SURVEILLANCE; LAW ENFORCEMENT

## NOTICE



**DOT-T-91-02**

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# TECHNOLOGY SHARING

A Program of the U.S. Department of Transportation