# THE LOS ANGELES 42-MILE SURVEILLANCE AND CONTROL PROJECT

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For many years, the need for better communication between users of the California highway system and the system itself has been recognized. The 5-phased surveillance and control project in the Los Angeles area is considered to be a major step toward meeting that need.

The project is an experimental effort to test and evaluate a freeway surveillance and control system that could eventually become a standard installation on most of the urban freeways. The project will include four basic phases: (a) an electronic surveillance system with traffic-responsive ramp control, (b) early detection and rapid removal of unusual incidents, (c) real-time warning and information, and (d) service for stranded motorists. In addition, a major air monitoring experiment is being coordinated with the project. This experiment will determine the amount and distribution of exhaust emissions on and adjacent to the freeway. It will then attempt to relate the level of emissions to freeway geometrics and operating conditions.

The Federal Highway Administration (FHWA) is participating in the cost of the electronic surveillance system and may participate in the construction of changeable-message signs in relation to the real-time warning and information system. In addition, the FHWA is participating in the evaluation of most phases of the project. The second phase of the project (early detection and rapid removal of unusual incidents) has received a $2 million grant from the National Highway Traffic Safety Administration.

The project is located in the center of the Los Angeles urban area on three of the most heavily traveled freeways in the world: the Santa Monica, San Diego, and Harbor Freeways. The project is 42 miles in length and has within its boundaries 56 freeway interchanges. This 42-mile loop of freeways serves downtown Los Angeles, the University of Southern California, the Los Angeles campus of the University of California, and the Los Angeles International Airport.

The primary purpose of this project is to see whether we can reduce delay, accidents, and aggravation caused by nonrecurrent (incident-caused) congestion. The first objective is to test and evaluate various techniques that (a) detect incidents and remove the cause and (b) communicate information to drivers. The second objective is to integrate those techniques showing greatest promise into an effective operating system.

Surveillance systems are often erroneously thought of as exotic ramp controllers. Although ramp control and freeway surveillance are complementary, they are actually two separate concepts. Surveillance and control attempt to reduce nonrecurrent congestion, whereas ramp control is a technique used to reduce or eliminate recurrent (geometric bottleneck) congestion. The surveillance computer is used to drive the ramp control simply because of its availability.

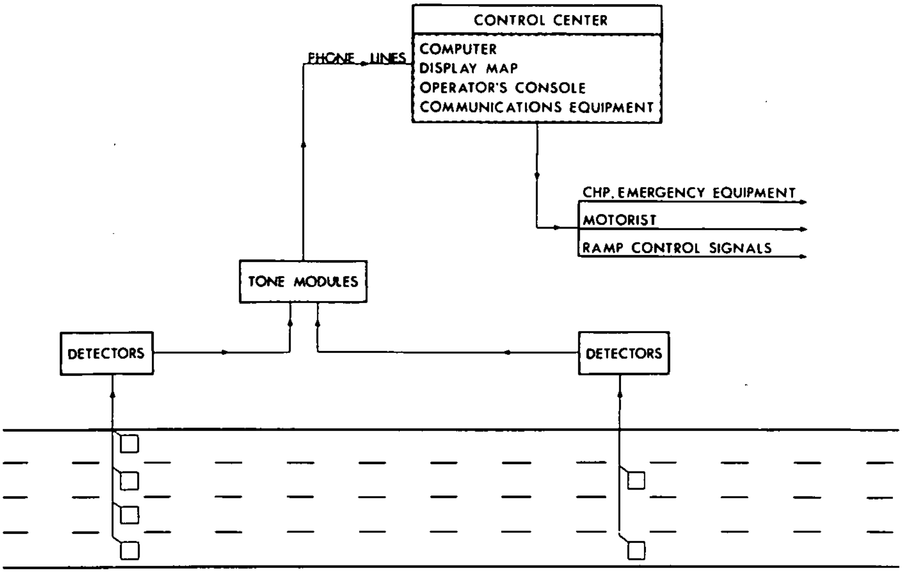
I consider ramp control to be beyond the experimental stage. Many ramp-control projects are being planned and installed in California without elaborate surveillance. We are, however, beginning to realize that some surveillance is necessary to keep operating personnel informed of ramp-control efficiency. This same philosophy also applies to traffic signals on conventional arterial highways.

## ELECTRONIC SURVEILLANCE AND RAMP CONTROL

### Surveillance and Incident Detection

The electronic surveillance system (Fig. 1) will be composed of (a) about 700 loop

Figure 1. Basic surveillance process.




detectors, (b) telemetering equipment to transmit traffic data over telephone lines, and (c) a control center. The control center will have (a) a digital computer to log incoming data and to help make decisions, (b) a display or status map of the surveillance project showing the status of traffic on the freeway at all times, (c) other display equipment including status lights for all metered ramps, computer output devices, a television screen, and (d) communication equipment. The control center will be operated by an interdisciplinary team composed of traffic engineers, maintenance personnel, and highway patrol officers.

The freeway traffic detectors will provide traffic data in the form of volume and occupancy. Occupancy is a measure of "how occupied" the freeway is and can be compared to density. These data will be processed by the computer into useful information for decision-making.

The traffic sensors will be placed in each of the freeway lanes at approximately ½-mile intervals. At some of these locations, traffic sensors in all lanes will be active; these locations are called full count detector stations and will be located at approximately 3-mile intervals. At other locations, only two traffic sensors will be active; these locations are called sample detector stations and will be located between the full count detector stations.

A vehicle on the freeway is detected by the traffic sensor, and a signal is transmitted to the digital computer in the control center via voice-grade telephone lines. The computer then converts this information into volume (vehicle counts) and percentage of occupancy data for each active traffic sensor in the freeway pavement. Using these parameters and programmed logic, the computer performs several functions, including the following real-time functions:

1. Update display map;
2. Detect incidents affecting traffic flow on freeway;
3. Drive ramp-control signals at some ramps; and
4. Calculate delay on the system in vehicle-minutes.

Volume and occupancy are the basic data for this system. The sample time can be 20 or 30 sec (as determined by the operator). Both flow rate and occupancy are smoothed by averaging the most current three samples; i.e., they are 1-min averages updated every 20 sec.

Volume is the total number of vehicles passing the detector station for a specific time period. For a full count detector station, where traffic sensors in every lane are active, the volume is the actual number of vehicles counted. Occupancy is calculated every 20 or 30 sec (depending on the chosen sample time) for each individual active sensor and then averaged over the number of active sensors at that detector station. A running average of the detector station occupancy is calculated and updated at every sample time.

The 42-mile freeway system is schematically displayed on a map display panel. Status lights on the map indicate the quality of traffic on the system. The status light indications are controlled by the computer according to the occupancy level at each detector station. One of four colored light indications can be displayed at any one time. The colors displayed are green, yellow, and red. The red is also capable of being flashed. A green light indicates free flow conditions with no congestion; a yellow light indicates traffic is moving with some congestion; and a red light indicates stop-and-go conditions. A flashing red light indicates an incident at that detector station. The display map is updated by the computer at the end of every sample time.

The detection of incidents is handled by the computer utilizing the computed occupancy data at each detector station. The incident detection logic is based on a comparison of occupancy values at each adjacent detector station. When part of the freeway is blocked (such as in the case of an accident), the occupancy upstream of the incident increases and the occupancy downstream of the incident decreases.

If the difference in occupancy produces a value greater than some constant, $K_1$, a bottleneck condition exists; however, it has not necessarily been caused by an incident. The occupancy of the downstream detector station is then compared with the previous sampling (20 or 30 sec prior). If that difference produces a value greater than some constant, $K_2$, then an incident has occurred somewhere between the two detector stations.

In a typical geometric bottleneck, occupancy upstream of the bottleneck is higher than occupancy downstream. The occupancy downstream of the bottleneck remains essentially constant. With the occurrence of an incident that reduces the capacity of the freeway, downstream occupancy not only is lower than upstream occupancy but also rapidly decreases from the occupancy value of the previous sampling time.

### Traffic-Responsive Ramp Control

Currently there are three successful ramp-control projects in operation in the Los Angeles area. All are simple fixed-time (i.e., preset rates) systems that meter traffic onto the freeway by using historical data. The preset rates are based on average conditions for various times of day. During the course of the project, several ramp-control projects (existing and proposed) within the limits of the surveillance project will be made traffic-responsive (metering rates and control decisions based on actual traffic) and will be controlled by the computer. A determination will be made of the marginal benefits of traffic-responsive centralized computer control.

Construction of the surveillance system is currently in progress at a cost of $1.3 million. Work is proceeding on both field and office installations, and completion is expected in the summer of 1971. This installation is the key element in the entire experimental project.

## EARLY DETECTION AND RAPID REMOVAL OF UNUSUAL INCIDENTS

The early location and rapid removal of freeway incidents remains one of the most promising areas for freeway operation improvement. Techniques to be evaluated in this are (a) a computer logic for rapidly detecting unusual incidents, (b) the use of aircraft surveillance and live closed-circuit television transmission from an aircraft, and (c) the use of specially equipped state-owned tow trucks to remove unusual incidents completely from the freeway.

The computer logic is a special computer program that provides an alarm for the control center team. The helicopter-television system is intended to provide additional information as required for control team decisions. This phase of our system is being funded under a $2 million grant from the National Highway Safety Bureau. The helicopter-television system (operated by the California Highway Patrol) and tow trucks (operated by the California Division of Highways) will begin testing and evaluation during the latter part of 1971.

## REAL-TIME WARNING AND INFORMATION

Most of the information that a motorist needs about the road ahead is provided by permanent freeway signing. There has been much discussion of providing motorists with current information on traffic conditions (i.e., real-time information); however, few field tests have been made. In this general area, the techniques to be tested and evaluated are (a) improvement of commercial radio traffic advisories, (b) roadside radio (i.e., limited-range broadcast through the normal AM radio), and (c) freeway-size changeable-message signs. Each of these communication modes offers unique opportunities, and the right combination of the three should provide a very effective system.

Contacts for the commercial radio traffic advisories have been made with the Southern California Broadcasters Association and major radio stations in the Los Angeles area. All have promised cooperation. An application for operation of a 16-mile roadside radio transmitting system has been filed with the Federal Communications Commission. A contract with the Institute of Traffic and Transportation Engineering of the University of California, Los Angeles, will determine the type of messages to be used with the changeable-message signs and roadside radio. A pilot project to test and evaluate these messages on a single-matrix sign is currently being planned for one ramp on the inbound Hollywood Freeway Ramp Control Project. Dates for the beginning of testing and evaluation are (a) commercial radio, January 1972; (b) roadside radio, January 1972; and (c) changeable-message signs, July 1972.

## SERVICE FOR STRANDED MOTORISTS

As part of the surveillance project, we are evaluating the existing urban freeway telephone system and other means of providing service for stranded motorists. One technique that we will be looking at is the service patrol. Testing and evaluation of the use of service patrol vehicles to assist stranded motorists will begin in July 1972.

## FREEWAY AIR MONITORING EXPERIMENT

The purpose of this phase will be to determine the amount and distribution of vehicle-generated air contaminants both on and adjacent to the freeway. The project will relate contaminant levels to freeway geometrics (e.g., grades and location) and to freeway operating conditions (e.g., free moving and stop-and-go). Both stationary and portable equipment (mobile labs) will be used to collect samples and other data. The design of mobile labs is under way, and sites for monitoring have been selected. It is hoped that testing and evaluation will begin during the fall of 1971.