Evaluation of INFORM: Lessons Learned and Application to Other Systems

STEVEN A. SMITH AND CESAR PEREZ

INFORM (Information for Motorists, formerly known as the Integrated Motorist Information System, or IMIS) is a corridor traffic management system designed to obtain better utilization of existing highway facilities in a 40-mi highway corridor on Long Island, New York. The system includes integrated electronic traffic monitoring, variable message signing, ramp metering, and related strategies to optimize traffic flow through a heavily congested corridor. The evaluation of INFORM was conducted using extensive field data, perception surveys, and data collected through the system. The overall results of the evaluation are presented, including comparisons of vehicle miles of travel, average speeds, ramp delays, motorist perceptions, and other congestion-related measures for the a.m. and p.m. peak periods. Incident case studies were used to evaluate motorist response to and effectiveness of variable message signing strategies. In addition to a summary of the quantitative results, an overview of the many lessons learned in the design, implementation, operation, and evaluation of INFORM is provided.

INFORM (Information for Motorists, formerly known as the Integrated Motorist Information System, or IMIS) is a corridor traffic management system designed to obtain better utilization of existing highway facilities. INFORM has been implemented in a 40-mi (64-km) highway corridor on Long Island, New York, as an operational demonstration. This demonstration was developed in accordance with a cooperative agreement between FHWA, the New York State Department of Transportation (NYSDOT), and the transportation agencies of local governments on Long Island.

The INFORM corridor contains two major freeway facilities, the Long Island Expressway (LIE, which is Interstate 495) and the Northern State Parkway/Grand Central Parkway (NSP/GCP), as well as a number of parallel and crossing arterial streets and freeways, for a total of 128 mi (206 km) of controlled roadways. The corridor extends east from the Queens borough of New York City through Nassau County and into Suffolk County. The system consists of electronic surveillance, communications, signing, and control components, all providing motorist information for warning and route diversion, ramp control, and signal control.

The various INFORM control elements and their functions include

- Overall supervision, provided by operators in a control facility at the State Office Building in Hauppauge, New York. Three minicomputers assist with traffic flow monitoring, traffic control, and response to traffic incidents.
- Traffic monitoring, consisting of 2,400 in-roadway vehicle presence detectors and 20 roadside citizens band radio monitor units. A limited number of closed-circuit TV cameras have been installed since late 1989 to monitor traffic in construction areas. A 160-mi (258-km) coaxial cable communications network connects equipment at more than 400 roadside locations with the control facility.
- Ramp metering, provided by traffic signals at 50 freeway ramps. Roadside hardwired digital controllers operate these ramp traffic signals, which are under the supervision of one of the control center computers (or independently, in case of communications failure).
- Variable message signs (VMSs) at 74 locations to provide information to motorists about congestion and delays. The controllers for these signs are roadside microcomputers, operating under the supervision of a control center minicomputer.
- Traffic signals at 110 arterial street intersections under INFORM control. New York's Model 170 signal controllers are used at these intersections, with supervision of coordinated signal indications by one of the INFORM control center computers.

This paper presents summary information on the results of various aspects of the INFORM evaluation. The emphasis is on the overall evaluation of INFORM, lessons learned, and guidance that can be provided in the design, operation, and evaluation of traffic surveillance and control systems such as INFORM. It also presents specific information on the evaluation of the variable message signs and the ramp metering subsystem. In addition, it documents perceptions of INFORM by the public and by those responsible for its planning and implementation.

One of the difficulties in conducting a time-series type evaluation is determining which time segments to compare. In the evaluation of time periods for INFORM, it was determined that two comparisons would be of most value: March 1990 metering versus March 1990 nonmetering, and March 1990 metering versus spring 1987 metering. The comparison of the two March 1990 data sets best reflects the traffic restraint impacts of metering. The comparison of March 1990 metering with spring 1987 reflects more of the long-term change. The long-term changes could have been brought about by several factors, including change and redistribution of volume, change in commuting patterns due to metering, and motorist response to variable message sign information.

As indicated earlier, INFORM was designed as an operational demonstration of corridor traffic control technology. INFORM has broken ground, but not without difficult encounters with the reality of building a system of this scale.

S. A. Smith, JHK & Associates, 1650 Iowa Avenue, Riverside, Calif. 92507. C. Perez, Federal Highway Administration, IVHS Research Division, 6300 Georgetown Pike, McLean, Va. 22101.

INFORM continues to change and improve, but experience with the system has taught many lessons that are important in designing, constructing, and operating corridor traffic control systems. Some of the lessons have been learned the hard way—by trial and error. INFORM can also lay claim to some legitimate successes. This summary draws from both sides: it highlights the major findings, and it presents a variety of lessons learned in several areas of design, construction, and operation of INFORM.

MOTORIST INFORMATION

INFORM is one of the most advanced VMS-based motorist information systems in the United States. In addition to the benefits it has given the motoring public, it has been and will continue to be a testing ground for further improvement of motorist information strategies. Some of the specific findings and lessons learned are discussed in the following.

Impact on Delay

Variable message signs are an effective part of INFORM. The incident case studies have indicated that drivers, in fact, do modify their routes if they are consistently given accurate information. Estimated delay savings for the peak period incidents analyzed ranged up to 1,900 vehicle-hr. The estimated annual delay savings for the incident-related effects of the variable message signs is 300,000 vehicle-hr. Delay savings are also attributable to INFORM involvement in recurring traffic congestion, construction activity, and special events, but they are difficult to quantify. The availability of the signs for certain functions also eliminates the need to perform that same service in another more expensive way (e.g., nighttime closure of the LIE or NSP/GCP for construction and maintenance).

Automated Sign Message Selection

Automated sign message selection is an important part of INFORM. It is accurate within the limitations of the detector data provided by the surveillance system and is essential in allowing the operators to keep up with the information demands in a corridor the size of INFORM, particularly in the peak periods.

Commitment to VMS Operation and Information Quality

Significant operational staff time is invested in maintaining the timeliness and accuracy of the INFORM sign information. A commitment to the installation of variable message signs must be backed by a commitment to their operation. Monitoring and controlling the INFORM VMS information takes an estimated 80 percent of the operator's time (based on operator interviews), even with an automated message-selection algorithm. Advances have been made in sign control algorithms, but one cannot expect the system to run itself and maintain the quality of information that the motoring public expects. INFORM produces more than 14,000 sign messages a month in an attempt to maintain the quality of information.

Level of Diversion

Clearly, diversion is taking place in response to the sign messages. For typical incident conditions using passive messages (i.e., no recommended alternative route), 5 to 10 percent of mainline traffic in the INFORM corridor could be diverted over several upstream off-ramps (typically 3 to 4 percent at an individual ramp). Data from incident reconstructions indicated that, for a typical incident using passive messages, volume at upstream off-ramps (up to three ramps) increased by 40 to 70 percent. However, this can vary widely on the basis of location and severity of the incident, availability of alternative routes, and other factors. This suggests that motorists have some degree of faith that the INFORM information is accurate and that motorists believe faster travel can take place on an alternative route.

Diversion and Alternative Route Traffic Control Schemes

The development of effective corridor diversion schemes is heavily dependent on the ability of alternative routes to absorb traffic from the mainline. Parallel freeways such as the LIE and NSP/GCP offer an ideal opportunity for such diversion to take place, and such diversion has been identified from INFORM. The lack of traffic-responsive capabilities on parallel arterials is the greatest detriment to the potential overall effectiveness of diversion strategies. Several incident reconstructions indicated a high initial diversion to arterials, followed by arterial breakdown when capacity was exceeded.

Importance of Information Quality

Maintaining the quality of the information displayed by the signing system must be a top priority of system operation. Signing is a passive method of control that relies on an informed, voluntary decision by drivers. Motorist confidence in the system is difficult to earn and easy to lose.

Ramp Detectorization Strategies

Detectorization of all on-ramps and off-ramps, as was done on INFORM, is an important part of the signing and diversion strategy. On-ramp and off-ramp volumes are often referred to by operators to determine whether the signing messages are having an effect (or too much of an effect). Even if on-ramps are not metered, they should still be detectorized. Under budgetary constraints, this could be done selectively, with emphasis on important diversion-related ramps.

RAMP METERING

Overview of Ramp Metering Results

A.m. peak period freeway speeds for the March 1990 metering increased 3 to 8 percent over speeds for March 1990 nonmetering and 13 percent over speeds for spring 1987. Certain subsections showed higher increases, and others showed lower increases or no change. Vehicle miles of travel (VMT) were either higher or remained stable for the metering case. Changes were statistically significant at the 95 percent confidence level.

P.m. peak period freeway speeds for March 1990 metering were unchanged from those for March 1990 nonmetering; they increased 13 percent over speeds for spring 1987. VMT increased approximately 1 percent over the March nonmetering case and approximately 5 percent over the spring 1987 case.

The maximum increase in throughput in a bottleneck section for the metering scenario was 7 percent. Other bottleneck sections increased by 2 to 3 percent, and still others were unchanged. Thus, ramp metering may produce marginal increases in throughput through bottleneck sections but not likely more than 2 to 3 percent, on average.

Average queues at metered ramps throughout the metering periods are relatively short, ranging from 1.2 to 3.4 vehicles over the typical 2-hr period. This represents only about 0.1 percent of the total VHT on the LIE and NSP/GCP. Contributing factors to this low number are several low-volume ramps as well as the propensity for metering to be shut off on the higher-volume ramps to avoid surface street impacts. Later versions of the ramp metering algorithm have enabled the metering operation to be preserved more frequently.

Limitations in Ramp Metering Effectiveness

Ramp metering resulted in a slight increase in average speed, but the potential effectiveness of ramp metering on INFORM is constrained by the limitations in the number of ramps metered, in the storage areas to manage queues, and in the maximum metering rates for single-lane metering. Ramp metering proved to be not as effective as was anticipated in the feasibility study. INFORM does not have sufficient ramp metering control over enough traffic to produce a noticeable, sustained change in freeway speeds. Some of the potential ramp meters were eliminated from the design, and others were eliminated by construction projects. Significant use of two-lane metering is needed to exercise greater control over high-volume on-ramps. More ramps also need to be metered, including selected freeway-to-freeway ramps, before adequate control can be established.

PUBLIC PERCEPTION

As part of the evaluation, a survey of households in the INFORM corridor was performed to measure public perception of the system. A brief summary of the results follows.

Driver Awareness of VMSs

Ninety-six percent of the residents surveyed in the INFORM area stated that they had seen the variable message signs.

Usefulness of Information

Overall, 29 percent of the respondents rated the sign information very useful; an additional 46 percent rated it moderately useful.

Accuracy of Information

Seven percent of the respondents indicated that the information was always accurate; an additional 56 percent indicated that it was usually accurate.

Changes in Route

Approximately 45 percent of the drivers stated that they sometimes change their route in response to the sign messages. Slightly more than 25 percent have never changed their route in response to a message.

Perceived Wait Time at Ramp Meters

Waiting time at the ramp meters is perceived to be 1 min or less by 80 percent of the drivers who have had to wait. This seems to correspond to the findings of the ramp delay studies.

Diversion to Avoid Ramp Meters

Some 15 percent of those encountering a red merge light indicated that they frequently use the service road or another roadway to avoid waiting. Another 27 percent indicate that they do this occasionally. Thus, ramp metering does produce some diversion effects.

Overall Perception of Ramp Metering

Approximately 40 percent of respondents viewed ramp metering to be a good idea, and another 40 percent viewed it to be a poor idea. The rest had no opinion.

Overall Perception of INFORM

Twenty-five percent of respondents viewed INFORM to be quite helpful. Forty percent indicated that the system helps once in a while. Overall, it can be concluded that drivers view the variable message signs positively, but their reaction to ramp metering is mixed.

OTHER OBSERVATIONS ON DESIGN, OPERATIONS, AND EVALUATION

Ongoing Traffic Engineering Involvement in All Phases of Operations

A corridor traffic control system cannot be expected to run itself. A commitment must be made to traffic engineering involvement in all phases, including ramp metering initiation, VMS operations, refinement and modification of metering operations, tuning of incident detection algorithms, traffic signal operations, communications with emergency services, and communications with the media.

Commitment from Top Management

Commitment from top management and constant provision of information to them is needed to sustain continuity over time. Several commissioners were involved over the course of INFORM implementation, and state personnel had to keep each one of them informed. Transition in leadership is inevitable; operators of traffic control systems should have the mechanisms in place to keep upper management and elected officials informed about the system: what it is, how it operates, and what benefits it provides.

Designing for System Evaluation Needs

There is a need for including plans for operation and maintenance in the system design phase. This should be expanded to include provisions for evaluation. In fact, a strong case can be made that surveillance needs for operation and evaluation are highly correlated, if not identical. What the system evaluator knows after the fact should also be known by the system operator as input into control decisions. For example, little information was available for the evaluation concerning arterial traffic performance. INFORM operators are also, in effect, blind to what is occurring on the arterial system. This knowledge is essential for obtaining the best use of VMSs for diversion, and the lack of detectorization undoubtedly results in the underutilization of INFORM's capabilities. Designing for evaluation needs should cost no more than designing for effective operation and, in the long run, will limit outlays for extensive field evaluation. Traffic simulation may also play a future role in bridging gaps in real-time data.

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