In any high volume corridor there are always going to be construction projects, which is both an opportunity and a threat. I think the people that run our system have been able to use those projects as opportunities to upgrade and improve the system, adding closed-circuit TVs and other elements.

Our department elected to hire a design consultant that helps integrate other corridor construction projects with INFORM. For example, if we have someone designing an interchange, we do not have that particular consultant design the INFORM features. Rather, we use one that works directly for our traffic people. They learn how to do it and they are very skillful at it. I think this has been a very positive element.

One of the problems that I think is a criticism of the consultant, and probably us for not catching it, has to do with replacement parts. The problem is when you design a project and there is no supplier 3 years down the road when you run out of parts. This is something that needs to be addressed.

The location of the control center probably, we now think, should not be at the east end of the job but towards the middle. I think we are going to be looking at the issue of moving the control center in the not too distant future. This might come out of some IVHS funding we are looking at in the Long Island area.

One of the big things that we did had to do with the communications cable. We had to cut costs when we let the job originally and could not afford to put conduits in, so direct burial was used. The first year of operation there were 200 cuts by our own contractors and maintenance people. We should have put it in conduit, I think that is a must.

In conclusion, I think that the bottom line is to look at the benefit and costs of the system. The benefit/cost for the March 1990 comparison was 1.82. When comparing 1990 to 1987 the benefit/cost was 8.27. Those estimates were made using $8 an hour delay time. The regional planning people in the Long Island area thought that the value should have been about $14 an hour, so I think the benefit/costs are even higher. Regardless, it is pretty obvious that the project is a success.

Gardiner-Lake Shore Corridor Traffic Management System

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The Gardiner-Lake Shore Corridor consists of an urban freeway (the F.G. Gardiner Expressway) and a parallel signalized arterial (Lake Shore Boulevard), which together form a major access route into downtown Toronto. Corridor traffic management systems have traditionally focused on freeway and arterial traffic operations, employing subsystems such as loop detectors, closed-circuit television cameras, changeable message signs, low power highway advisory radio, and ramp metering. However, the Municipality of Metropolitan Toronto Transportation Department recognizes that it is important to integrate other concurrently operating traffic management systems which are related functionally and geographically.

There are many good reasons for integrating traffic management systems. Foremost, integration serves to consolidate systems which would otherwise be isolated. Integration thereby allows for the coordination of activities and enables each system to take into account the operations, strategies, and capabilities of the other systems. Motorists, perceiving the road network as a seamless continuum, benefit from an integrated system which presents a unified package of information to assist them in making decisions such as route choice and departure time. Integrating several systems with similar functions enables operational efficiencies within the overall system. Interactions with external agencies are simplified and improved by providing a single point of contact with each source/user agency. Finally, by facilitating intensive cross-communication and cross-support among the linked traffic management systems, integration promotes synergy.

The Metro Toronto Transportation Department is currently in the process of implementing several projects to improve traffic flow within the municipality. I will be discussing four of these traffic management projects today. Not only will the projects be integrated operationally, but they will be controlled from one central location—the Integrated Traffic Control Centre (ITCC).

The first project is a freeway and arterial traffic operations system. As a major commuter route into downtown Toronto, the Gardiner-Lake Shore corridor accommodates directional peak volumes of 8,800 vehicles per hour, with an average daily two-way traffic volume in excess of 200,000 vehicles. Over 200 major special events take place annually at sites adjacent to the corridor, including the Canadian National Exhibition, Toronto Blue Jays baseball games and an Indy car race. The corridor currently experiences about 7 hours of congestion each weekday, divided about equally between morning and evening peak periods. High volume weaving sections, short merges, poor vertical alignment, and extensive rehabilitation and maintenance activities on the elevated portion of the Gardiner Expressway add to the congestion problems and are contributing factors to an accident rate of 6.6 accidents per million vehicle miles, almost five times the provincial freeway average.

Since capacity expansion is expensive and subject to major physical constraints, corridor traffic management through freeway and arterial traffic operations offers an opportunity to make more efficient use of available roadway capacity now and in the future. Freeway and arterial traffic operations are being implemented in three phases.

The first implementation phase, which will be completed in mid-1993, is the detection system. Loop detectors are being installed on both the Gardiner Expressway and Lake Shore Boulevard for the purposes of incident detection and congestion monitoring. Closed-circuit television cameras, offering virtually 100 percent coverage of both roadways, will also be in place. Detection and surveillance subsystems will be linked via a fiber optic trunk to the ITCC. Real-time detection will enable prompt emergency response through external interfaces.

The next implementation phase will be an advisory system in mid-1994. Changeable message signs, located upstream of key decision points on both the freeway and the arterial, will advise motorists of lane blockages, construction activities, and congested conditions ahead. Queue monitoring and automatic queue length estimation will be important features of the advisory system. More detail on events and traffic status will be provided by highway advisory radio and enhanced external interfaces with the media.

The final implementation phase, planned for late 1994, will be diversion strategies. Arterial advisory signs, changeable message signs, highway advisory radio, and external agency communications will provide diversion messages to motorists. Diversion will be based on travel time differences between the freeway and the arterial. Queue length data will be incorporated in travel time calculations for more precise estimates. Automatic traffic signal timing/phasing changes and ramp metering will support diversion strategies.

The second traffic management project will be a demonstration of SCOOT. SCOOT—which stands for Split, Cycle, and Offset Optimization Technique—is a computerized traffic signal control system that provides real-time traffic adaptive control on a signal cycle by signal cycle basis. The system incorporates a traffic model which predicts delays and stops caused by specific signal settings, based on actual traffic data detected and processed in the real-time model.

The Metro Toronto SCOOT demonstration project encompasses 75 intersections within three distinctly different operational control areas. One control area includes 42 intersections within a grid network of the central business district.

Another control area includes 13 intersections along a major suburban arterial. The third control area includes 20 intersections along Lake Shore Boulevard, within the Gardiner-Lake Shore Corridor. The control areas were chosen in order to evaluate the benefits of SCOOT under various types of operating and road environment conditions. The demonstration project is scheduled to be commissioned by September 1992, with subsequent before/after survey studies to be conducted and documented by the end of 1992.

In the future, SCOOT will function as the traffic signal interface to the Gardiner-Lake Shore Corridor Traffic Management System (CTMS). CTMS will provide input to SCOOT on suggested diversions from the freeway to the arterial, on-going freeway congestion, and the onset of freeway congestion. It is intended that a proactive response, through additional green time required to clear traffic diverted to the arterial, will be supplied by SCOOT, if the demonstration project is successful.

The third traffic management project will focus on the reconstruction of the Humber Bridges. The project involves rebuilding six bridges over a 6-year period, beginning in May 1993. The bridges span the Humber River, located at the west end of the Gardiner-Lake Shore Corridor. The rerouting of traffic and the unavailability of certain ramp movements throughout the reconstruction is expected to have a major impact on traffic along this heavily traveled portion of the corridor. Therefore, a local traffic management project in the Humber Bridges area is being initiated for the duration of the reconstruction.

Since the initialization of the first phase of the Gardiner-Lake Shore CTMS coincides with the start-up of Humber Bridges reconstruction, there is an opportunity to integrate the two projects. Humber Bridges traffic management will proceed on the basis that inputs from a number of sources—including overview cameras, Autoscope video incident detection, and on-site crews—will be sent to the ITCC for processing and response initiation. The responses will include emergency agency assistance at incidents, the use of accident investigation sites, and low-infrastructure advisory techniques, such as portable changeable message signs. External interface communications for the Humber Bridges reconstruction project will also serve as a pilot demonstration of the Traffic Situation Room, which I will be describing in a few minutes.

A number of components will continue to be used by the Gardiner-Lake Shore CTMS after the Humber Bridges relocation has been completed, including the overview cameras and accident investigation sites. The Humber Bridges project also provides an excellent test bed for new products, such as Autoscope. The results of Autoscope tests on traffic monitoring and video incident detection capabilities will be applied to other situations where imminent construction makes loop detectors impractical.

The final project is the Traffic Situation Room (TSR). The concept of the TSR is currently being planned and developed by the Metro Toronto Transportation Department. The purpose of the TSR is to act as a communications and coordination center among transportation, media, and other agencies to improve the overall efficiency and operation of the transportation system in the greater metropolitan Toronto area. Input from the Gardiner Lake-Shore CTMS and the urban Traffic Signal Control System (including SCOOT) will be combined with other traffic and road information to coordinate response to traffic events, and to provide user agencies with data on overall traffic status. An important role of the TSR will be as a central command site for major emergencies, drawing on the communications infrastructure that would already be in place.

Good interfaces with motorists, and with third party agencies that make it their mandate to redistribute traffic and road information to motorists, will ensure the areawide dissemination of travel information. Freeway and arterial traffic operations subsystems alone, such as changeable message signs and low power highway advisory radio, are not capable of reaching the wide audience accessible through external interfaces.

Given the number of potential external interfaces to the TSR, the potential diversity of two-way information flows, and the requirement for information that is timely, accurate and consistent, a central computer data base would be used for the entry, storage, processing, and retrieval of traffic and road information. A variety of dissemination technologies would accommodate the diverse requirements of different external agencies under different circumstances, and would maximize audience exposure to the information.

Linking all these projects together will be the Integrated Traffic Control Centre (ITCC), which currently is being developed by the Municipality of Metropolitan Toronto. A contract for major building renovations was awarded in December 1991, and occupancy is targeted for February 1993. It is expected that the consolidation of various traffic functions will improve the overall management and effectiveness of the transportation network throughout metropolitan Toronto. Among the shared-use areas in the building will be a control room, a computer/ communications room, and a room that combines the functions of a TSR command post, a visitors' viewing room, and an operator training facility.

The ITCC will enable new possibilities for information exchange, direct and immediate communications, efficiencies in computer and communications systems, and design flexibility, yielding benefits to all participating user groups. The major user groups in the ITCC include the Gardiner-Lake Shore Corridor Traffic Management System, the Traffic Signal Control System, the Traffic Situation Room, and other sections, such as the Traffic Data Centre. The building in which the ITCC is located is shared by the Communications Branch of the Metro Toronto Police Department, which includes the 911 emergency response center.

In conclusion, the benefits of disaggregate traffic management systems are typically too localized to be of great value to motorists. In addition, motorists typically do not recognize the boundaries of traffic management systems, but instead perceive the road network as being continuous. True areawide benefits of traffic management systems can be achieved only through integration. The Municipality of Metropolitan Toronto is applying this approach to several traffic management initiatives, to optimize the benefits of the combined system. Central control from the Integrated Traffic Control Centre further supports integration by facilitating interaction among the systems.