

The fifth amendment

Implementing an intelligent hard shoulder: when congestion relief meets safety needs in the biggest bottleneck in Europe, by ERIC TOFFIN

It's no secret that the world's largest cities are experiencing ever-growing traffic and congestion problems as more and more vehicles appear on the road.

The Ile-de-France region around Paris is one such area that experiences recurrent and heavy traffic jams, particularly in the Eastern part of Paris. The A86 highway is the second Paris ring road. It goes around the French capital. The A4 is a major highway going from downtown Paris to Disneyland Paris. Both highways rank among the most congested sections of the Paris metro and have seen regular increases in traffic volume over the past years.

Near Nogent-Sur-Marne and Joinville-Le-Pont, the A4 and A86 highways merge on a single highway length of 2,200 meters (1.5 miles). There, 2 x 2 lanes on A86 and 2 x 3 lanes on A4 merge onto 2 x 4 lanes. With an average daily rate of 250,000 vehicles and average rush hour congestion spreading over 10 km, the A4/A86 junction was once named "the biggest bottleneck in Europe."

In 1995 heavy road construction was approved by the French public authorities to help remedy traffic problems. The project involved the construction of two tunnels of 1.5 km each under the Marne River. The project was estimated at €800m. Due to some difficulties the French authorities did commit to find alternative solu-

tions, even temporary, to enhance traffic conditions at a reasonable cost.

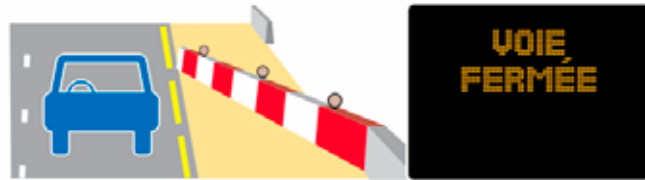
Studies from the region's highway authority, Direction régionale de l'équipement Ile-de-France (DREIF), led to a solution with five lanes per direction using the emergency lanes during rush hours

Intelligent shoulder

Given the complexity and urgency of the situation, and in order to keep the best level of safety on this high-risk infrastructure, they had to come up with innovative solutions.

The idea was to use the fifth lane as a traffic lane as

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long as no hard shoulder was required, or rather as long as no vehicle came to a stop because of an incident such as a breakdown or accident.

If a vehicle did stop the fifth lane would be closed to traffic, thus artificially recreating a hard shoulder and a protective environment for the stopped vehicle and its passenger. As you can imagine, remotely implementing this in real-time involves complex and quick coordination. Signage and related devices were vital to providing instant lane closure information to travelers. These systems had to be very efficient, simple and quick to implement in order to disseminate information rapidly.

Three key elements were necessary for the success of the operation:

- A reliable means to detect vehicles stopped on the junction
- A reliable means to prohibit vehicles entering the junction to use the fifth lane when closed to traffic
- A method to efficiently inform road users in real time of lane closures

Automatic Incident Detection System

CCTVs are in wide use today to aid traffic management operators in handling traffic and congestion. The images from these video-based solutions can greatly provide efficiency and safety in traffic when properly deployed and used. Because the image is a universal and consensual language, the CCTV is a key tool in Traffic Operation Centres to locate incidents, assess their severity

and respond adequately.

Images remove all doubt, allow for detailed analysis, and are easily transmitted. However, behaviour studies clearly show that the ability of a Traffic Operator to focus on his traffic monitoring task decreases with the time and with the number of screens to monitor. There can, of course, literally be dozens of screens to watch at the same time. This is the reason why the stakeholders for this project decided to put CCTV at the centre of Traffic Operations but at the same time to use a system able to assist operators in detecting incidents – a video-based Automatic Incident Detection System.

Video-based Automatic Incident Detection is a technology that delivers automatic real time detection of traffic incidents on roadways based on image processing techniques. It uses images from CCTV video cameras. Those images are processed by a Video Detection Unit by means of an algorithm that identifies and tracks moving objects (vehicles) and computes their trajectories, enabling the ability to spot stopped vehicles.

This information is then transmitted to Traffic Operators by means of audible and visual alarms. In short, an Automatic Incident Detection system becomes the eyes for the traffic management center so that operators do not have to be concerned with monitoring literally dozens of screens for an incident to possibly happen. The system catches incidents in real time for you and then intelligently alerts operators – both with alarms and with on-screen highlighting of the incident. In this way, not only are error rates dramatically reduced, time to reaction becomes almost instant.

Video detection technology was chosen versus other technologies because:

- It provides the operator with an alarm quickly after the event occurs: a stopped vehicle will be signaled after 15 seconds. Detection time is paramount to enable quick clearance of the site after occurrence of an incident.
- It is a modular and flexible system that gets rid of the constraints imposed by the use of roadway sensors: closing lanes for repairs, deterioration of the road surface.
- It provides wide-area-detection: it covers several lanes per camera over distances up to several hundred meters.
- It not only allows an operator to instantly verify and access the location where the incident occurred, but also to visualize digital video clips of the incident, thus enabling the operator to assess the severity of the incident and define appropriate actions.

Dynamic lane-closure barriers/driver alerts

Considering that the concept of a “dynamic hard shoulder” was new, there was a sufficiently high risk of vehicles at average or possibly high speed colliding into a vehicle stopped on the fifth lane. This is the reason why means were sought to physically keep vehicles away from using the fifth lane when closed.

Dynamic lane-closure barriers were deployed at 300- meter intervals along the junction. These barriers are remotely activated and slowly deploy to ensure a



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progressive closure of the lane. They are complemented by an information system to alert drivers of the sudden lane closure.

The Road user information system consists of:

- a series of information signs at the entrance of the A4/A86 junction explaining how the intelligent shoulder operates
- a series of Variable Message Signs on portals indicating lane closures
- a specific road paint to clearly identify the fifth lane/shoulder.

Operation of the intelligent shoulder

During low volume traffic, the shoulder is not open to traffic and is physically closed using the dynamic lane-closure barriers. During high volume traffic (rush hours), the shoulder is open to traffic. Incidents are detected in seconds by the video-based Automatic incident Detection system and signaled to traffic operators at the Traffic Management Center.

Traffic operators then check the incident in real time using the CCTV cameras and determine the severity of the incident and the adequate response which may include closing the shoulder with dynamic barriers and informing road users through Variable Message Signs.

Once the incident is cleared, the shoulder is re-opened to traffic. All incidents are video-recorded for real-time and post analysis and performance audits.

Results and benefits

An effective increase in road capacity was achieved without new construction. The “intelligent shoulder” solution had a positive impact on traffic backup duration and severity: travel time gain was measured at a range from 20 per cent to 50 per cent, traffic flow increase, and a 10 per cent speed increase to an average of 30 km/h during rush hours. Overall, the additional lane created

enough capacity to absorb the traffic congestion of the A4 and A86 during rush hours.

The “intelligent shoulder” also allowed a mitigation of the impact of incidents on mobility: faster detection resulted in faster incident clearance thus minimizing the consequences of incidents on congestion.

The Video-based Automatic Incident Detection system enabled an effective management of road hazard events, or incidents. The quick detection and the reduction of time-to-response allowed operators to minimize the impact of incidents on overall traffic.

A faster reaction also minimizes the likelihood of secondary crashes and other incidents that can affect traffic congestion and safety. Video clips of incidents and accidents allow for a more efficient and appropriate response. As mentioned, traffic operators can assess the severity of an incident and determine the response required. In so doing, only appropriate units are sent, thus costs are reduced and other units are free to respond to other incidents.

Return on investment

The total cost of the Intelligent Shoulder project was €19m. The total estimated benefits were of €15m per year, including reduction in CO₂ emissions (greenhouse effect reduction), significant reduction in local pollutants emission (CO/HC), reduction in fuel consumption. Hence the return on investment was less than two years.

The Intelligent Shoulder project was 40 times less expensive than the alternative project involving actual road construction. In addition, because of the on-going use of an automatic incident detection system, the return on investment will continue to blossom as future incidents and congestion are more efficiently monitored and managed now. **TH**

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