11. Results of VRU-TOO

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11.1. OBJECTIVES

The work in DRIVE II Project VRU-TOO was targeted specifically at the reduction of risk and minimization of delay to vulnerable road users, namely pedestrians with as little inconvenience to motorized traffic as possible. To achieve this, the project linked practical implementations in three countries with behavioural studies of the micro-level interaction of pedestrians and vehicles and the development of computer simulation models. This paper concentrates on the implementations. These took the form of pilot projects to test the impact of applying advanced detector systems to improve conditions for pedestrians at signalized junctions and crossings on main roads. The overall objectives of the implementations conducted by VRU-TOO were to reduce waiting time for pedestrians, to obtain increased safety and comfort for pedestrians, and to do so without a negative effect on the efficiency of vehicle traffic in terms of queues, delays and capacity.

11.2 SYSTEM AND LOCATIONS

The generic VRU-TOO system is extremely simple in concept. It is illustrated in Figure 1.

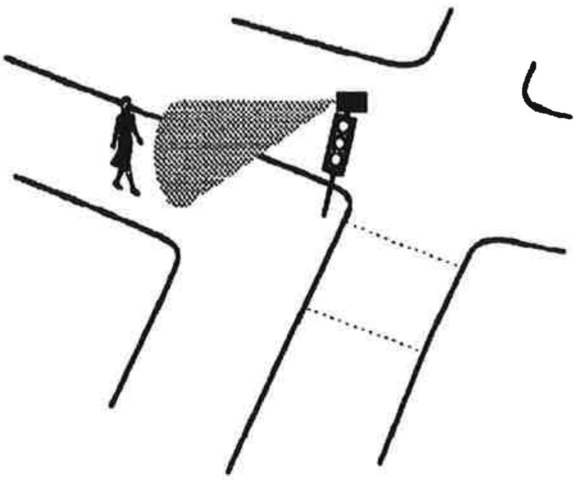

Figure 5:
The VRU-TOO "system"

Microwave detectors are mounted on traffic signals to register the approach of pedestrians. This detection can be applied to:

a) Replace the normal push-button on signalized pedestrian crossings;

b) Provide earlier activation of the pedestrian stage;

c) Provide an extension of the pedestrian stage for late arrivals;

d) Provide longer pedestrian stages when there are large numbers of detections.

The three locations for the trials were very different. The first set of crossings was in Leeds, England. Three crossings along one quadrant of the new one-way loop road that encircles the city centre were fitted with the VRU-TOO system. The second of these crossings links two large indoor shopping precincts as well as being on a major pedestrian radial route to and from the city centre. As a consequence flows of up to 6,000 pedestrians an hour can be observed. The other two carry lower flows of pedestrians.

In Porto, Portugal, the location was on a major east-west arterial, linking the city centre with the coastal industrial zone. The road is a dual carriageway, with a tram line running down the central reservation. The site was at a crossroads with a school on the north-west corner. As a consequence of the presence of the school, very large flows of children could be observed using the two pedestrian facilities across the carriageways of the arterial on the western arm of the junction.

The site in Greece was in the centre of Elefsina, an industrial suburb of Athens located along the coast to the west of Athens. The location was a crossroads in the town centre on what, prior to the building of a bypass, had been the main Athens to Corinth highway. This road runs east-west through Elefsina. The junction was not signalized at the start of the project.

Although there was a large common element in the manipulations at each of the sites, in particular the use of pre-arrival detection, there were also substantial differences. In Leeds, the signals were operated by an urban traffic control system (UTC), which used a set of fixed time plans for coordinating the signals. At Site 1 and 3, the push button was supplemented with automatic detection, and the normal pedestrian green man stage was extended by up to four seconds if pedestrians were detected approaching during the stage. Finally, pedestrians, whose approach was detected during the four seconds before the controller registered whether or not there was a pedestrian demand, now triggered the pedestrian stage. At site 2 in the after situation, the peak-hour situation was changed from a fixed pedestrian stage to a demand-based one. Demand could be registered either by the detectors or by the push-buttons. In the off-peak times, the pedestrian stage continued to be demand-based, but with demand now being registered either by the detectors or by the push-buttons. In addition, both for peak and off-peak times, the pedestrian green man was extended by four seconds if pedestrians were detected approaching the crossing in the last 10 seconds of the standard green man period.

The Porto signal was not tied into a UTC. The after configuration in Porto was more sophisticated than that in Leeds. It was designed both to take into account the size of pedestrian demand, i.e. to give more immediate response (up to 9 seconds sooner) and extra time (up to 4 seconds) when there were large groups (defined as at least 30% occupancy of relevant detectors), and to provide prolongation of the green on the second crossing for pedestrians who were slow walkers or late arrivals. The prolongation of green was intended to prevent pedestrians from becoming stranded in the central reservation or alternatively violating the red light and perhaps having conflicts with vehicles. As a result, the maximum time available for a pedestrian to cross the full width of the main road on green was now 18 seconds, in contrast with the previous normal time of 14 seconds, which was now the minimum. Late arrivals could result in a further 4-second extension. In addition there was still 3 seconds of flashing green and 3 seconds of all red.

The Elefsina configuration was more straightforward. The junction was signalized in November 1993. The signal staging was a very simple two-stage setup, with the vehicles on the main road having priority until either a vehicle was detected on the northern arm or button was pushed for one of the two pedestrian crossings. The pedestrian green man only came up if a button had been pushed. Vehicle movements from the side road were permitted simultaneously with the pedestrian green. The pedestrian stage was 7 seconds. The red time for vehicles on the main road could be extended by up to 5 seconds if a vehicle were detected on the northern arm, but the pedestrian signal would be red. There was a four-second inter-green period. This is the "before" situation.

Subsequently detectors were installed at the junction and the new system became operational in March 1994. On the western crossing, two detectors were positioned to detect approaching pedestrians and provide pre-arrival detection, supplementing the push-buttons. This was the "VRU-TOO" crossing for which a detailed evaluation was carried out. With regard to the pre-arrival detection, no change was made in the signal staging but the green time for pedestrians to cross was reduced to 6 seconds. The facility to extend the green for the side road traffic was eliminated. On the eastern crossing, no automatic pre-arrival detection was provided. Instead, at the request of the Greek Ministry of Transport, the microwave detectors were positioned pointing towards the centre of the main road, so as to detect pedestrians in the crossing and provide an extension of the green man.

11.3 RESULTS

A comprehensive evaluation of the sites was carried out, covering vehicle to pedestrian conflicts, pedestrian behaviour and effects on vehicle traffic. At all the sites, except Site 2 in Leeds, the system worked in direct sense: the proportion of pedestrians arriving on green increased. In Leeds, there was an 18% ($p<.10$) reduction in serious conflicts if the figures for the three sites are combined. This was accompanied by a reduction in the number of pedestrians who crossed the road whilst the signals were green for vehicles. Expected pedestrian delay (the time from arrival to the next green man) was substantially reduced, but actual delay, perhaps because of the large number of red light violators was hardly affected. In terms of vehicle behaviour, there was no increase in the number of vehicle red light violations. There was also no increase in any of the queue lengths but the survey showed some increase in total journey times.

In Porto, there was no statistically significant reduction in the number of serious conflicts. There was no overall change in the number of pedestrian red light violations when vehicle traffic had green, although there were variations in the effects on different sides of the dual carriageway. Expected delay was reduced on one crossing. Actual delay was reduced on the crossing nearer the school, but increased on the other crossing in line with the reduction in red light violations. In terms of the effects on vehicle traffic, there was no increase in the observed traffic queue lengths and also no significant increase in journey times.

In Elefsina, there was a 51% overall reduction ($p<.01$) in the number of serious conflicts on the "VRU-TOO" side. There was no change in pedestrian red light violation. Expected delay decreased, but actual delay was virtually unchanged. The proportion of pedestrians who had to wait for more than 30 seconds decreased from 28 percent to 18 percent. In terms of vehicle behaviour, there was a slight reduction in the number of vehicles who violated the red light on the main road from 7 to 5 vehicles per hour. There was no increase in the length of the vehicle queues.

11.3. CONCLUSIONS

The conclusions of the evaluation were as follows:

Pedestrian Safety: In two of the three locations there was an overall reduction in the number of serious conflicts between pedestrians and other vehicles. There were however considerable variations between the sites and even between different carriageways on the same site. There were no increases in the number of vehicles going through red lights.

Pedestrian Mobility: There was a reduction in the average length of time pedestrians had to wait at the kerb edge. There was an overall increase in the number of pedestrians who arrived at their crossing point to a green signal; this increase was greater than would have been expected from the actual increase in pedestrian green time on the signals.

Vehicle Effects: There was no significant increase in vehicle queue length at the individual sites although there was a slight increase in overall journey time over the length in Leeds.

11.4. REFERENCES

HYDÉN, C. (1987) The development of a method for traffic safety evaluation: The Swedish traffic conflicts technique. Bulletin 70. Department of Traffic Planning and Engineering, Lund Institute of Technology.