ADAPTIVE TRAFFIC CONTROL AS FUNCTION OF SAFETY

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ABSTRACT

The new telematic-based road traffic control technologies enable the application of a large number of various control strategies. Ranging from the fix-time control to adaptive control there is a whole series of combined strategies that eventually depend only on the skills of the traffic expert who by choosing traffic parameters realizes for a certain traffic demand in the given physical conditions, the optimum of throughput capacity and safety.
Sometimes this is a difficult task and does not always lead to the desired results.
The fact is that experience and practice with the implementation of advanced technologies have the best chance of achieving the best possible results.
The work shows an example of adaptive control and the safety results "before" and "after" at an intersection in the City of Zagreb.

INTRODUCTION

The intersection of the Slavonska avenija and Heinzelova ulica and Radnička cesta is located in the south-eastern part of the Zagreb road network and it is one of the most significant intersections in the urban network. The traffic at this intersection has been controlled for many years now by light signalization (signaling system) which was replaced several times in accordance with the reconstruction on the main direction.

Before the latest reconstruction of the existing signaling system, traffic congestions had been occurring during most part of the day, partly due to the poor-quality signaling plan and partly due to the insufficient intersection capacity.

The safety condition was more than worrying, which imposed additional requirements on the measures of urgent reconstruction.

That was also the reason to undertake reconstruction and modernization of the respective intersection by installing a new signaling device that would enable the traffic participants

entering the intersection to achieve within the available space a "fair" distribution of available time. The control method established on the basis of such requirements was adaptive, i.e. the duration of the signaling aspects (green – red) and the signal group sequence were adapted to the real-time traffic demand.

TECHNICAL SOLUTION

In order to realize the adaptive control, 26 vehicle detectors and 18 pedestrian buttons had to be installed. In order to recognize the real entities – groups of participants with equal requirements regarding traffic demand, the sequence of traffic phases depended on the independent signaling groups, so that the signaling device had a capacity of 8 driver's and 18 pedestrian signaling groups (*see Figure 1).*

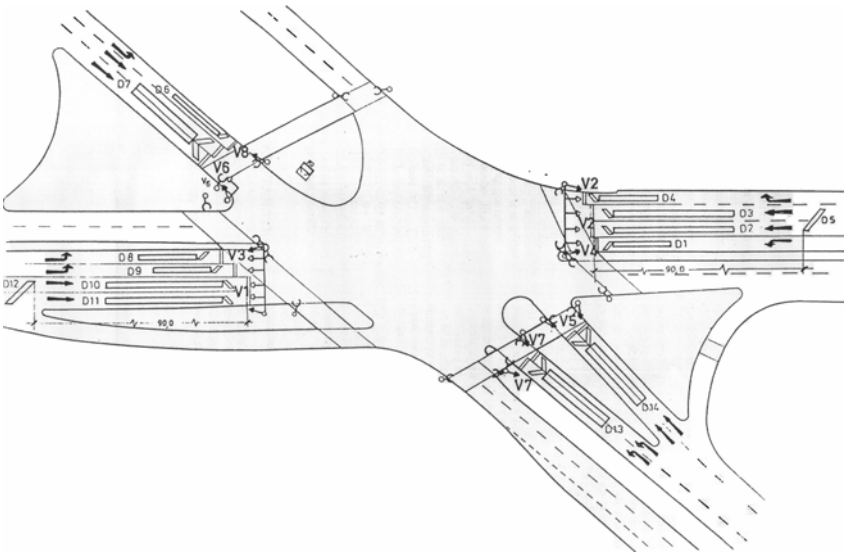


Figure 1 - Design of external units

The control method was defined by assigning each signaling group the duration of the green aspect depending on the demands for the respective group (number of vehicles in green aspect) depending on the number of vehicles queuing and the queuing time (vehicles in red aspect). In order to realize this type of control, the mentioned parameters were adjusted every second by the adaptive control process *(see Figure 2)*.

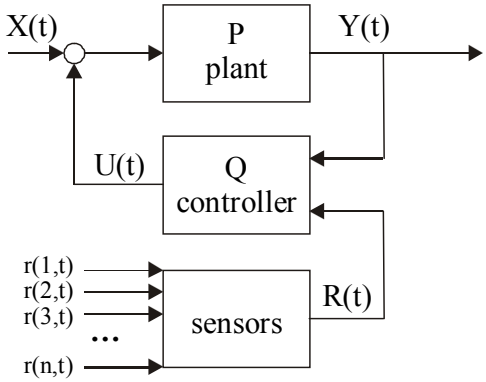


Figure 2 – Adaptive control process

THE PARTICIPANTS' SAFETY

"BEFORE"

During the one-year period "before", there were 57 traffic accidents at the intersection in which a total of 27 persons were injured.

The most critical days were Wednesday with 10 and Thursday with 16 traffic accidents allowing for more than 45% of the total number. The greatest number of injured persons (11) was between 8 a.m. and 10 a.m. – about 40%. The most frequent types of traffic accidents were bumper-to-bumper driving (vehicle-to-vehicle collisions) – 24 accidents and parallel driving (changing the traffic lane) – 18 accidents, as well as side collisions – 9 accidents, which allows for about 90% of all the accidents. Due to these three (3) types of collisions, 23 persons were injured or more than 80%.

Improper and excessive speeding not adjusted to the traffic and road conditions (27 accidents), insufficient distance headway (9 accidents) and entry into a closed intersection – red light (9 accidents) were the most frequent failures committed by the drivers, which caused the traffic accidents. The mistake of entering a closed intersection (9 accidents) only was the causes for 19 persons being injured, out of a total of 27 which is more than 70%.

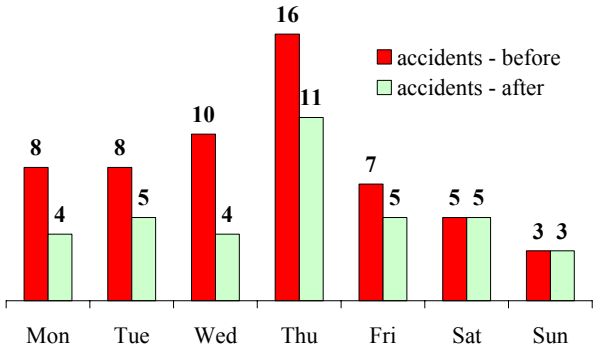
"AFTER"

During the one-year period "after", there were 37 traffic accidents, which is 20 accidents fewer or by about 35% less.

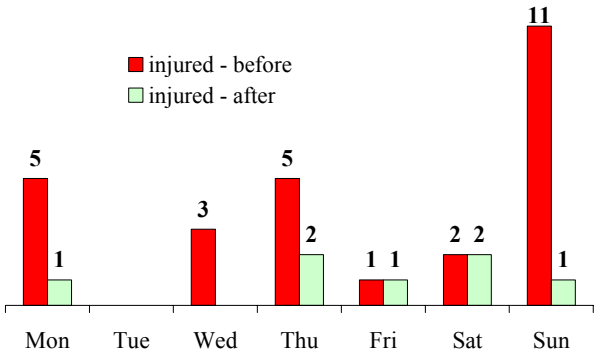
In these accidents only 7 persons were injured, which is 20 persons fewer or by about 80% less. The most critical day remained Thursday with 11 traffic accidents, and the time in which most accidents occurred was between 10 a.m. and 2 p.m., 17 accidents, which is more than 45%.

The most frequent type of accidents in the period "after" remained the bumper-to-bumper driving (vehicle-to-vehicle collision), in 19 accidents, which is more than 50% of all accidents. In these accidents 3 persons were injured out of a total of 7 injured. Improper and excessive speeding (20 accidents), insufficient headway (10 accidents) remained the main failures that resulted in traffic accidents. There was an obvious reduction in the number of accidents caused by vehicles entering a closed intersection (red light) – only 1 accident.

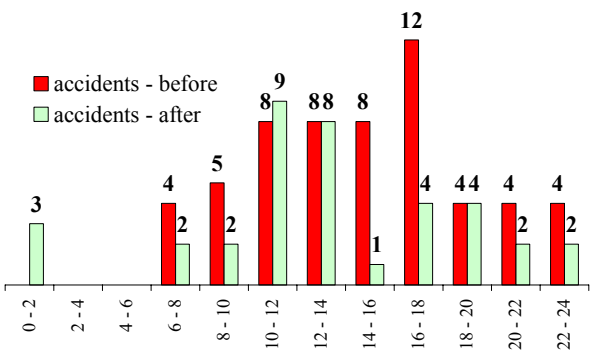
Thus, it may be concluded that the application of adaptive control has significantly increased the traffic safety at the intersection *(see Figure 3)*.



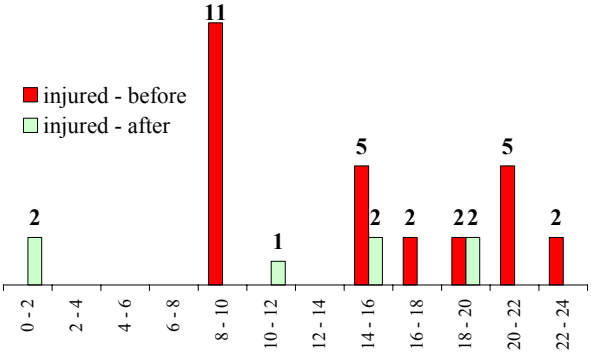
Number of accidents per day



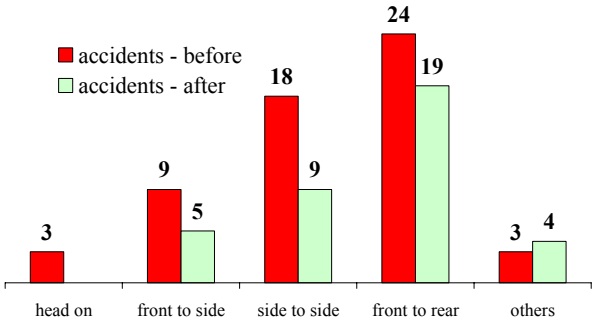
Number of injured per day



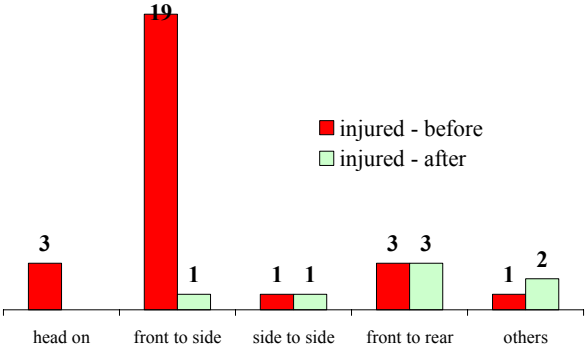
Number of accidents per hour



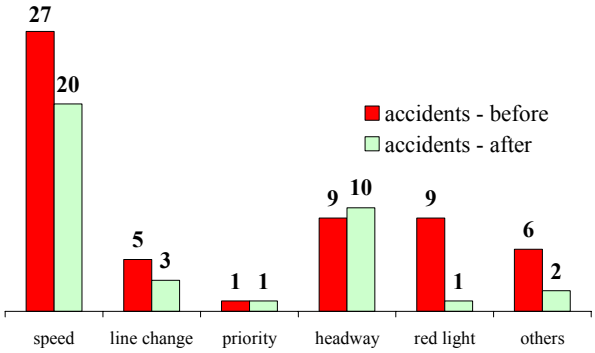
Number of injured per hour



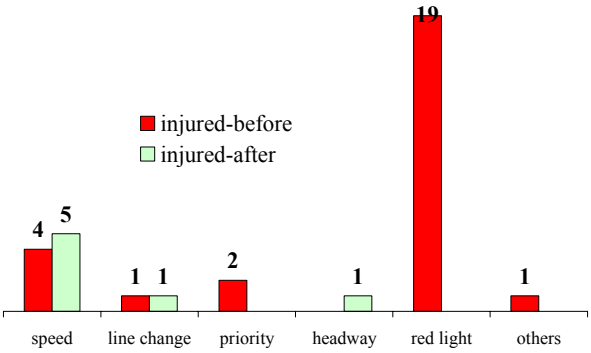
Number of accidents depend of types



Number of injured depend of types



Number of accidents depend of driver failures



Number of injured depend of driver failures

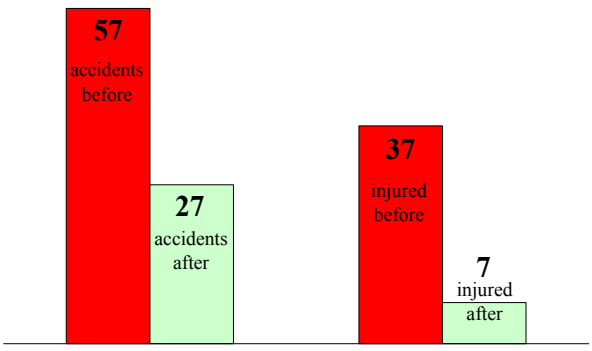


Figure 3 – Safety, a year before and a year after the introduction of adaptive control

CONCLUSION

The application of advanced telematic technologies represents a significant safety factor regarding traffic participants. In order to achieve maximum efficiency of the applied telematic technologies (devices) in adaptive traffic control, the following should be noted:

- the traffic participants (vehicles and pedestrians) who have the same characteristics and demand requirements, are assigned independent signaling groups in the system,
- the "adaptively" level of a signaling group (duration of the green aspect) should be simultaneously adjusted with the number and duration of the vehicle green queuing time,
- the distribution and location of the sensors depends on the traffic flows and is not condition less if it is known in advance that it is at the limit of the throughput capacity so that it may be combined with the fix-time control,
- the drivers' "habits" to a fixed change of signaling aspects represent no condition that would disprove the application i.e. replacement by the adaptive control,
- after having applied the adaptive control process, the efficiency of the applied algorithms and traffic parameters should be checked periodically and adjusted as the need may arise.

REFERENCES

(1) Anžek M., Kavran Z., Blašković-Zavada J.: Traffic Flow Regulation at Intersection by Aplication of Fuzzy Logic, 5th International Conference, St Petersburg, 2000

(2) Anžek M., Lanović Z., Kaštela S.: Formalni prometni model, 9th INTERNATIONAL SYMPOSIUM ON ELECTRONICS IN TRAFFIC, Ljubljana, 2001

(3) Bombol K.M., Anžek M.: A Dynamic Model for Automatic Traffic Control System, Transportation and communications 2000, Ohrid, Macedonia, 2000

(4) Bužanić V., Anžek M.: Traffic Actuated Control on Signalized Intersection, 20th Conference on Transportation Systems, AUTOMATION IN TRANSPORTATION 2000, Zagreb, Amsterdam, Rotterdam, 2000

(5) Divić A., Pavlica Đ., Anžek M.: Sigurnost prometa na raskrižju Slavonska avenija – Radnička u uvjetima prometom optimizirane regulacije, Savjetovanje - Automatizacija u prometu, FER, Zagreb, 1995

(6) Kavran Z., Anžek M., Blašković-Zavada J.: Influence of Membership Function in Traffic Regulation at Intersection, 10th INTERNATIONAL SYMPOSIUM ON ELECTRONICS IN TRAFFIC, Ljubljana, 2002

(7) Rotim F., Mihoci F., Ajduk M., Anžek M.: Sigurnost cestovnog prometa i prevencija nezgoda (Road traffic safety and traffic accident prevention), Osmo međunarodno znanstvenostručno savjetovanje, “Promet i održivi razvitak”, Opatija, 2000