SENKA PAŠAGIĆ, D.Sc.
Fakultet prometnih znanosti
Vukelićeva 4, Zagreb
ANĐELKO ŠČUKANAC, B.Eng.
Zagrebačke ceste, Zagreb

Traffic Engineering
Review
U.D.C. 656.054/.057 "18" (091)
Accepted: Oct. 5, 1998
Approved: Dec. 23, 1998

HISTORICAL DEVELOPMENT OF TRAFFIC SIGNS

SUMMARY

The road regulations and traffic signs, as we know them today, are not older than a hundred years. When the first motor vehicles appeared on the roads, passing the state borders ever more frequently and easily, and that was at the beginning of the 20th century, the need arouse to determine international regulations that would harmonise the information on all the roads.

This paper presents the historical development of the traffic signs.

1. INTRODUCTION

Road regulations and traffic signs as we know them today are not older than a hundred years. The international conventions dealing with these issues had been preceded by an era of steam omnibuses at the beginning of the 19th century. That was the time when railway transport proved to be the cheapest, faster and more comfortable than the horse carts. At the same time the railway traffic signals developed which are therefore older than the signals and signs used in road transport.

At that time, in the most developed industrial country in the world, in England, the number of steam propelled vehicles travelling the roads, the so-called steam omnibuses, transporting even up to 20 passengers, was increasing. Their advantage compared to horse carts was the comfort and regularity of transport. However, the proprietors of horse cart transportation societies did not give up fighting to bring their passengers back. They could hardly wait for the traffic accidents of steam omnibuses. The first one, in 1931 in London, was not really a severe one, but people did get frightened. Soon, there was another accident in Glasgow in which a steam omnibus with 18 passengers hit a wagon and ran over a farmer. The issue of steam omnibuses was also raised in Parliament. After a lot of discussion the "Locomotive Acts" was passed in 1836, and supplemented in 1865. This Act can be considered as the first traffic regulation on road speed limitation. It limited the speed of every steam vehicle (it did not refer to the harnessed vehicles) to 3.2 km/h within residential areas and to 6.5 km/h on open roads. It also obliged every driver to have a rider 100 meters in front of the vehicle to wave a red flag and warn the passers-by of the approaching danger. The coachman only needed to raise his hand and the vehicle had to stop. The Act assumed that in case of any accident the responsibility was only on the driver of the steam vehicle.

This Act, known also as "Red Flag Act", was revoked as late as 1896, and caused England to lag behind other developed industrial countries in designing all kinds of power-driven vehicles.

The rule of left driving was founded on the old customs inherited from the coachmen. They drove, namely, their wagons along the left side of the road, and the first regulations only enacted this custom, spread throughout the English colonies. All the other peoples followed the French customs and regulations, and abided by the rule of driving along the right side of the road.

2. INTERNATIONAL REGULATIONS ON TRAFFIC SIGNS

When the first motor vehicles appeared on the roads, and started to cross the state borders with more ease and more frequency, and that was at the beginning of the 20th century, there arose a need to define international regulations in order to co-ordinate the conditions on all the roads.

The first international Convention on Road and Automobile Traffic was agreed upon in 1909 in Paris. Later, conventions in other cities followed, and the most important one was in Geneva in 1949, when the Protocol on Road Signalling was accepted, followed by its amendments in 1968 brought by the International Conference of the United Nations Organisation on Road Traffic.

These conventions recommended that all states should stipulate equal traffic signs, that these traffic

signs should not contain written instructions or information, since these could not be understood by the foreigners and the illiterate. At time when these regulations were made, there were quite many good but illiterate drivers, and symbolic signs were preferred. That was the reason why traffic signs and other notes, such as e.g. "Landslide", "Watch out - wild animals on the road", "Drinking water", "Fire risk" were abandoned and replaced by images. So e.g. the Motor Sport magazine, which was the official newsletter of the Automobile Club of the Kingdom of Yugoslavia, Zagreb Section, in the February issue of 1937, stated that *"although it is difficult to drive on our roads, still, not only foreigners but also our motorists have even more trouble to manage their way among our orientation boards and signposts. The signposts that can be found now, show the direction only from village to village, that are mostly even not marked on the road-maps. Southwards from Karlovac, the signposts are usually written only in Cyrillic. All the signposts are of very primitive design, so that very soon they become impossible to read. In short - the great majority of these signposts has no value whatsoever for the motor traffic and tourism".* [1]

3. FIRST PARIS CONVENTION

The traffic sign shapes were determined already at the First Paris Convention. The warning signs are in the shape of equilateral triangle with the peak upwards, Figure 1, the regulatory signs are round, Figure 2, and guide signs are rectangular, Figure 3. Their number has been changing over the time - from the initial dozen to the present some two hundred signs (not including additional notes and other symbols and markings).

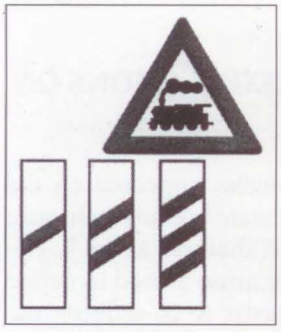

Figure 1

Figure 2

Figure 3

There are signs that had once been standard, and are not used any more today, such as e.g. guide sign - white triangle within a blue rectangle, which called for cautious driving; regulatory sign - round red and white sign with two crossed opposing arrows, meaning that overtaking at intersections was not allowed.

The latest amendments of the Protocol on Traffic Signalling from 1968 introduced the stop sign octagonal in shape instead of the previous round sign with a triangle drawn in it. This is the only sign of such shape, thus emphasising its special significance in relation to other signs.

The issue of the colour of traffic signalling is an interesting one. It is obvious that the red colour is prevailing, which is the colour of danger. No wonder then, that the stop sign and the traffic light for stopping are red.

At times when no light indications were obligatory on cars, which is used today to indicate change of direction, sound signals had been usually applied. Approaching the intersection one blow on the horn meant the continuation of straight driving, two were for turning right and three for turning left. By the increase in the number of cars in the cities and towns, this rule had to be abandoned as unsuitable. Today you can even get fined for unnecessary usage of sound signals within residential areas.

4. LIGHT SIGNALS

The origins of light signals can be found in transport branches that are older than the road traffic, i.e. in maritime and railway traffic, Figure 4.

Around the middle of last century the construction of railways was at its peak, whereas the road power-propelled vehicles were just starting to appear. Therefore, it is no wonder that the road traffic light was invented by an engineer for railway signals, J.P. Knight. The device looked like a railway traffic light of that time with a handle and a red and green light for night signalling. The traffic light was positioned in London, in 1868, at the intersection of the Bridge St. and New Palace Yard, near the Houses of Parliament. It had movable arms which gave free passage when set high, and warned of necessary caution when lowered. At night, the necessary information were given by means of a lamp with red and green light. The light was supplied by gas, which probably caused the explosion of the device and the end of its usage. The lamp, namely, exploded after several days of usage.

The American, William Phelps Fnou is claimed to be the first to have used a scientific approach to controlling the traffic using signals. Already in 1885, he started studying the issue and in 1889 he wrote the first

Figure 4

newspaper article about "Urgent needs of reforming our traffic" (Fnou, W.P.; 1889). In 1890 he published the first book on traffic problems "Road Traffic Control" (Fnou, W.P.; 1890). He received public affirmation in 1920 for his book "Science of Traffic Control on Highways 1899 - 1920" (Fnou, W.P.; 1920). It was supposed then, that by abiding by his instructions, many lives could be saved as well as a lot of time and money. The works of authors scientists mainly referred to the regulations of purposeful control of traffic, and less to technical devices. However, technical devices applied in accordance with his theory soon proved to be imperative.

Modern electrical signalling is an American invention. The first green and red lamps were set in 1914 in Cleveland. The third, yellow light was set for the first time in 1918 in a traffic light device in New York. This New Yorker traffic light was hanging at an intersection and indicated free and closed directions for all the four approaches simultaneously. The today used traffic light signal was put for the first time in operation on 9 October, 1917 in Detroit, USA. The device was designed according to the recommendations by W.P. Fnou.

A three-colour signal was set for the first time in Europe in 1926, in England, at an intersection in Wolverhampton.

5. DEVELOPMENT OF TRAFFIC SIGNS AND TRAFFIC SIGNALLING

As long as the man did not become dependent on cars as means of transportation, there was no need to study traffic signs. Previous journeys were often determined by topographic occurrences and very few decisions had to be made during travelling. Directions, distances, and safety on the roads were marked by traffic signs of various shapes, sizes, colours and design.

Drivers travelling abroad were coming upon signs that they had never seen before. In the USA this problem occurred even between various states. In studying and looking for solutions for such dilemmas, big states throughout the world started joint research in order to solve the problem.

Already in 1909, the delegates at the International Convention in Europe signed a union which should help in marking the highways. In 1931, a Convention on Unification of Road Traffic Signs and Signals was signed in Paris. Towards the end of World War II, these agreements became more or less obsolete.

A signalling device which could be controlled by the traffic participant was installed in 1929 in New Haven and in Baltimore, USA. Controlling was done by means of a microphone, and the drivers' requirements were announced using the horns.

Around the 30s, during the big economic crisis, the development of signalling devices was poor. In Germany, the Ministry of the Interior issued in 1934 a circular letter and criticised the excessive investments in studying the traffic signals. Traffic control should be left to traffic wardens.

After World War II, a comprehensive modernisation of signalling devices started, due to the sudden increase in the number of vehicles. Modern, traffic controlled, signalling devices with control depending on the volume, density and speed of traffic spread widely. Computers started to be applied in 1959 in Toronto. The processing of a great number of traffic parameters, optimisation tactics of control instructions, high speeds of processing, etc. established the today's application of processing computers in all signalling systems.

Zagreb got its first traffic light in the early 60s, at the intersection of Vodnikova Street and Savska Road. The device was located in the traffic warden's

little cabin, visible enough so that the traffic warden could efficiently control the traffic.

The company "Nikola Tesla" installed their first "domestic" signalling device on 9 September 1963. The device was produces in Sweden based on the business co-operation LM Ericsson - "Nikola Tesla". Designing, installing, programming and testing of the device were carried out by the "Nikola Tesla" experts. The intersection of Šubićeva and Zvonimirova Streets was thus for the first time equipped by the signalling system, which automatically changed the signalling concepts according to a signalling plan.

In April 1964, a device was installed at the Kvaternik square. The signalling device had already then the possibility of detection. Detectors were specially embedded and the vehicles could require their own green light. When there were no vehicles, the traffic phase was not switched on.

During 1965, there was a substantial increase in the application of signalling systems in Croatia, since the company "Nikola Tesla" started to use their own capacities to develop and produce the devices for independent, detecting and co-ordinated control.

In 1965, the first "green wave" (phased traffic lights) was installed along the Braće Kavurića Street, controlling traffic by the devices produced in the above mentioned company. The exchange which co-ordinated the operation of devices was installed in the police building in Đorđićeva street. By extending the zone to the two neighbouring directions, two "green waves" (phased traffic lights) were formed in the opposite direction. The main exchange was moved to Martićeva Street. Today, there is a new microprocessing zone exchange which controls all the local signalling devices in the city centre.

The first and most important agreement on traffic signs which forms the basis of the European system on traffic signs, was published under the auspices of the United Nations in Geneva in 1949. This protocol is based on symbols, not using words. As supplement to this protocol, a Convention Draft was made in 1953, with the attempt of using the existing system with the amendment originating from the US system. In the meanwhile, several more agreements were made, so that there were several systems until the end of the 70s. There are several systems of signs used in the world:

1. In USA, Australia and New Zealand a system is used mostly based on written words, Figure 5.
2. The system in Europe, defined by the Protocol, is mainly based on the symbols not using words, Figure 6.
3. Latin America, the states of Central America and some countries in Asia abide by the Convention Draft from 1953. Symbols are also used, but in various ways. Warning signs are in the shape of rhombus instead of triangle, the red diagonal line on signs is used only for prohibition. Signs of prohibition and permission cannot differ on the basis of colour.
4. Canadian system uses mostly symbols, and it is based on the Protocol and Convention Draft of 1953, and the American system with some new signs.
5. In some parts of east and south Africa some kind of an old British system is used, which is a combination of symbols from the Protocol and written texts. British signs are to a great extent a combination of words and symbols.

Figure 5

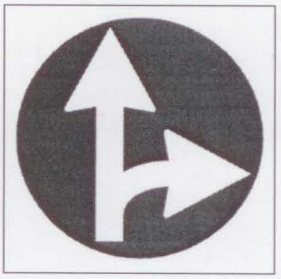

Figure 6

In order to unify and standardise the traffic signs at the international level, a new Agreement has been reached at the Conference on Road Traffic in Vienna in 1968, also under the auspices of the United Nations. In this Vienna Convention of 1968, the attempt was made to include as much as possible the most widespread system from the Convention Draft of 1953, and the Protocol implemented by Europe. This Convention is the basis for our traffic signs as well. More agreements followed later, aimed at easier communication among peoples and states.

In spite of the tendencies towards maximum possible universality, it is not easy to achieve co-ordination in using traffic signs. There are numerous technical, economic, political reasons, and also different customs, making the co-ordination difficult. The need for unification and simplification of signs is most present in countries with high traffic density.

6. CONCLUSION

The study of history of traffic signs allows us to have a better understanding of further directions of research and efficient implementation of traffic signs. In studying the efficiency of traffic signs, and mainly of textual traffic signs, the ergonomic approach must be used. The studies should mainly continue in the following directions:

- identify the inadequacy of certain components of the traffic system towards psychic characteristics and abilities of humans
- analyse the effects of change in some traffic system components on the behaviour of drivers i.e. on the traffic safety.

More recently, especially the US schools claim that traffic safety can be substantially improved only by ergonomic changes in the traffic environment and the vehicle itself. Extensive ergonomic and technical and psycho-physiological research in the field of traffic "environment" is being carried out. Among these studies, the most important is the research in the field of traffic signs and ergonomic features of the vehicle itself, and the latter problems have been dealt with in many works recently, e.g. the number, colour and position of traffic signs is being studied.

In order to provide good traffic signs the following should be done:

- technical regulations should be supplemented by new regulations and standards that would define the need for new traffic signs, conditions of their production and positioning,
- abide by the already accepted rules, both in design and in production, maintenance and control
- provide a system for certification so as to assure the quality of traffic signs,
- establish a system of periodic control of the existing traffic signs, their supplementation, and replacement of inadequate traffic signs and notes,
- everyone responsible for traffic safety, should among other research, promote also the study of traffic signs from various aspects.

SAŽETAK

POVIJESNI RAZVOJ PROMETNIH ZNAKOVA

Cestovni propisi i prometni znakovi, kakve danas poznajemo, nisu stariji od stotinu godina. Kada su se na cestama pojavila prva motorna vozila koja su sve češće i lakše prelazila državne granice, a to je vrijeme početka 20. stoljeća, iskrsle je i potreba da se utvrde međunarodni propisi koji bi ujednačavali informacije na svim cestama.

U ovom radu daje se povijesni razvoj prometnih znakova.

REFERENCES

1. Source: Motor Sport, Zagreb, February, 1937.

LITERATURE

[1] **Abbott, F.**: *Modulation Transfer Function, The Optical Systems Directory*, Encyclopaedia Dictionary, E – 151, 1976.

[2] **Fisher, J.**: *Testing the Effect of Road Traffic Signs, Information Value on Driver Behaviour*. Human Factors, 1992, 34 (2), 231 – 237.

[3] **Forbes, T. W.**: *Visibility and Legibility of Highway Signs*, In T. W. Forbes (Ed.), Human Factors in Highway Traffic Safety Research, Wiley, New York, 1972, 95 – 109.

[4] **Forbes, T. W.**, *Factors in Highway Sign Visibility*, Traffic Engineering, 1969, 39 (12), 20 – 27.

[5] **Fried, D. L.**, *Optical Resolution Through a Randomly Inhomogeneous Medium for Very Long and Very Short Exposures*, 1966, J. Opt. Soc. Am., 56 (10), 1372 – 1379.

[6] **Gordon, D. A.**: *The Assessment of Guide Informational Load*, Human Factors, 1981, 23, 453 – 466.

[7] **Holmes, D. L.; Cohen, K. M.; Hait, M. M.; Morrison, F. J.**: *Peripheral Visual Processing*, Perception and Psychophysics, 1977, 22, 571 – 577.

[8] **Johansson, G.; Backlund, F.**: *Drivers and Roads Signs*, Ergonomics, 1970, 13, 749 – 759.

[9] **Loo, R.**: *Individual Differences and the Perception of Traffic Signs*, Human Factors, 1978, 20, 65 – 74.

[10] **Loo, R.**: *Role of Primary Personality Factors in the Perception of Traffic Signs and Driver Violations and Accidents*, Accident Analysis and Prevention, 1979, 11, 125–127.

[11] **Milošević, S.; Gajić, R.**: *Percepcija znakova na putu*, Project: *Utjecaj prometne signalizacije na opažanje i ponašanje vozača*, IV dio, Institut prometnog fakulteta, Beograd, 1983.

[12] **Pisano, P. A.**: *Developing a Standard Approach for Testing New Traffic Control Signs*, Public Roads, A Journal of Highway Research and Development, June 1992, Vol. 56, No 1, Washington, 1 - 8