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Aspects Regarding Road Traffic Simulation

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Mihai Iliescu
Professor, The Technical University of Cluj-Napoca, Faculty of Civil Engineering, Str. Constantin Daicoviciu, Nr. 15, 400020, Cluj-Napoca, Romania

Dorin Barbinta
Lecturer, The Technical University of Cluj-Napoca, Faculty of Civil Engineering, Str. Constantin Daicoviciu, Nr. 15, 400020, Cluj-Napoca, Romania

ABSTRACT *The issue of overcharging the road network to be faced by road operators becomes more and more stringent, and the building of a new infrastructure has become more and more difficult to be fulfilled today. The main impediment is related to the lack of space though high cost of building and maintaining roads as well as environmental protection constraints or other road building influential factors are not to be neglected either. At present, the road network is used at its maximum potential.*

The present paper makes an attempt to draw in to evidence the need of using simulation methods for the road traffic in great urban agglomerations, to select and model an optimal road traffic management system. The simulation of the traffic, can respond, to a certain extent, to these drawbacks regarding road traffic mobility and safety duet o the methods used and to the high level of technology respectively.

1. INTRODUCTION

In today's conditions of increased traffic, the displacement of vehicles and pedestrians, in large urban congestions, is difficult, if not impossible, to fulfil. Thus, where necessary, urgent measures to solve such drawbacks for the road traffic need to be implemented.

The occurrence of such drawbacks and the impossibility to build new roads in certain areas has led to the rapid and continuous development of the technologies to be used in this field and, implicitly, to the so called ITS (Intelligent Transport Systems). These systems are based on a relatively simple principle: they consist in adapting traffic, in real time, to the existing conditions. The principle requires the satisfaction of some conditions which are not easy at all: having exact information on road networks and the capacity of the driver to take a rapid and optimal reaction [2]. Part of the research in this field shows that building new roads is not always a solution for the mobility issue of the road traffic, at least in some specific time interval. At the same time, the latest techniques to optimise traffic in real time are not always suitable to all locations and hence, they need adapting to a specific area situation.

In Romania, more attention has been paid lately to road transportation as it showed to have a significant advantage over the rest of transportation systems, namely that related to the ability to penetrate difficult to cross regions and the fact that it is ranked first in the modal distribution of goods and passenger transport, as shown in Table 1 below.

Table 1. Modal distribution of goods and passenger transportation

Transportation way	Goods transport (%)	Passenger transport (%)
Road transport	49,34	76,68
Railway transport	20,67	20,12
River transport	12,53	0,03
Maritime transport	14,89	0,01
Air transport	0,01	3,17
Pipeline transport	2,56	-

Source: Adapted from Romanian National Institute of Statistics

2. CHARACTERISTICS AND OBJECTIVES OF SIMULATION MODELS

In the Highway Capacity Manual 2000 (HCM 2000) [8] a simulation model is defined as a computer based software that makes use of mathematical models to make experiments with traffic related events, on a transportation system in a certain time interval.

The simulation of a complex system consists in decomposing the system in question in a large number of items and in describing every element and the interactions among these elements during the interval of investigation. These components and interactions are repeated very many times in order to determine the state of the system in a given time interval [3].

Romanian norms present calculation methods for the capacity of intersections when their capacity does not exceed more than 50%. If intersections are congested, the results of the calculations do not reflect the actual state in the field and consequently, alternative calculation methods need to be used, such as traffic microsimulation methods.

The selection of road traffic simulation technique has two reasons at its basis:

- technical reasons – performing tests in real conditions in the infrastructure would require high costs and a high level of difficulty;
- the complexity of traffic phenomena – simulation lies in choosing start variables and testing performed, further evaluations and comparison more variants while looking for the optimal solution for practice.

In general, simulation models describe dynamic systems where time is dependent as a variable independent from the basis [4]. Simulation can be called microscopic, macroscopic or mesoscopic dependent upon the fineness degree of some of the elements in the simulation system.

Microscopic models are models with a high degree of detailing of system entities and interactions [4], representing the dynamic and stochastic modelling for the displacements of individual vehicles. They are oriented to a wider category of drivers and vehicles or to the interactions between vehicles and entities, as, for example, traffic signals and traffic signs.

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Macroscopic models have a low level of detailing, describe the movements of the vehicle flow without considering the reciprocal interactions among vehicles. They are widely used in the management of traffic systems for major urban roads and highways.

Mesoscopic models describe entities with very many details, while the activities among them are poorly presented. For instance, vehicles are modelled as physical flows with no interactions taken into account. The mesoscopic simulation models [6] combine the approach at aggregate level of macroscopic models with the individual interactions of the microscopic ones.

The laws describing the function of every constitutive element and the laws describing the interactions among the elements can be deterministically reproduced [3], with exact mathematical relationships, or stochastically and randomly, with probability functions.

The model structure should allow considering potential evolutions, so that a system architecture enabling its update should be designed [3].

More models were developed in the course of the time, though many have remained as projects, in a drawer and are not known and used. On the other hand, the multitude of software existing already, made us select some of the best known. General information regarding the selected models is provided below.

Table 2. Simulation software found in literature

Name	Developer	Model type
CASIMIR	Institut National de Recherche sur lis Transports et la Securite, France	microscopic
CORSIM	Federal Highway Administration (FHWA), USA	microscopic
DYNASMART	University of Texas at Austin, USA	mesoscopic
NETFLO	Federal Highway Administration, USA	macroscopic
SIMTRAFFIC	Trafficware LLC, USA	microscopic
STEER	Network Control Group at University of York, UK	microscopic
VISSIM	University of Karlsruhe, Germany	microscopic

The CASIMIR model [1] serves at simulating operations for traffic lights in an isolated intersection in order to evaluate the efficiency of more algorithms. It has a simple interface enabling the user to select the intersection geometry and establish various operational parameters.

CORSIM is a microscopic stochastic simulation model used for highways, urban roads and corridors [6]. This simulation software is used for scenarios involving alternative geometrical configurations, such as changing lanes, entering or exiting the network, incidents etc.

DYNASMART is a mesoscopic simulation model for the ATMIS (Advanced Traffic Management and Information System) software. Its objective is to identify traffic characteristics and to assess the performance of the network in a system based on real-time indications and observations. With this program, vehicles can choose the route with respect of their features and the capacity of collecting information [5].

NETFLO is listed among the macroscopic models called CORFLO. NETFLO 1 and NETFLO 2 can simulate traffic at urban street level with various detailing capabilities. NETFLO 1 is a street simulation model based on event. NETFLO 2 is a determinist simulation model, modified as TRANSYT, with no optimising capacity. NETFLO 2 describes the traffic flow under the form of statistical histograms [9].

SIMTRAFFIC [7] is an easy to handle and efficient application for simulating the traffic. In Figure 1, one can see an image captured from the simulation of an intersection, from the 3D Viewer, application giving three-dimensionally the simulations made with SimTaffic.

SimTraffic can operate in intersections with or without traffic lights and on urban roads with mixed traffic of vehicles, trucks, buses and pedestrians. Different from other software, animation is displayed concomitantly with the simulation.

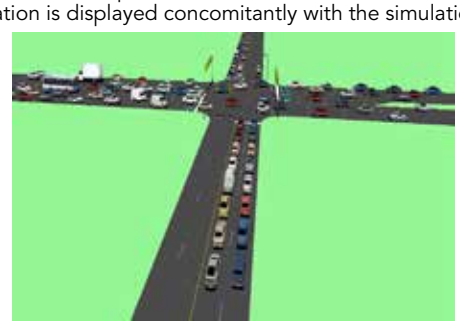

Figure 1. Traffic simulation with SimTraffic.

STEER [1] is a software created to simulate traffic in urban networks. It is thought to be a programme running on real data and able to operate with a large number of vehicles. Among its features, one can enumerate the following: dynamic microsimulation, multi-modal type travel, travel cost simulation, presentation of advantages in case of route changing to avoid crowded areas etc.

VISSIM is a microscopic and stochastic model for simulating road traffic. Figure 2 shows an image captured from simulating an intersection, made with VISSIM.

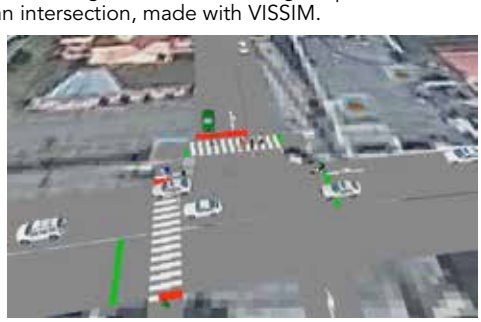

Figure 2. Traffic simulation with VISSIM.

This model was developed for the urban traffic. The software is extremely useful in the assessment of more variants, function of the traffic planning and engineering measures taken. Besides animation capability, the software generates customised user files containing: information on the travel time and statistics regarding delays, statistics on the length of the vehicle queues, details on traffic light timing (green light timing, cycle duration etc), time-space and speed diagrams, environment indicators [1].

3. CONCLUSIONS

The simulation models for the road traffic have their contribution to the efficiency of the road traffic management systems as they create virtual conditions for running the traffic at conditions near to the actual ones, met in the network.

All the research contribute to solving issues related to the traffic flow and its safety while reducing costs to minimum. The simulation models can help optimise traffic flows by modifying some of the system parameters until values reached come very near to the actual ones.

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At the same time, with the help of such simulation software, traffic forecasts can be made and the rapidity of performing the determinations, evaluations of the networks and comparisons of the results obtained make them indispensable for the further road traffic optimising policies.

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