Chapter 22
A Driver's Mind:
Psychology Runs Simulation

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ABSTRACT

Over the last decade, traffic simulation frameworks have advanced into an indispensible tool for traffic planning and infrastructure management. For these simulations, sophisticated models are used to "mimic" traffic systems in a lifelike fashion. In most cases, these models focus on a rather technical scope. Human factors, such as drivers' behaviours are either neglected or "estimated" without any proven connection to reality. This chapter presents an analysis of psychological driver models in order to establish such a connection. In order to do so, human driver behaviour is introduced from a psychological point of view, and state-of-the-art conceptualisations are analysed to identify factors that determine human traffic behaviour. These factors are explained in more detail, and their appliances in human behaviour models for traffic simulations are discussed. This chapter does not provide a comprehensive mapping from simulation requirements to particular characteristics of human driver behaviour but clarifies the assembly of human traffic behaviour, identifies relevant factors of influence, and thus, serves as a guideline for the development of human behaviour models for traffic simulations.

INTRODUCTION

Computer aided traffic simulation is a mighty tool. Currently, there are many professional simulation frameworks available that are able to simulate traffic in a life-like fashion. These frameworks predict road traffic in many ways. As an example, traffic simulations are frequently used to predict the effects of infrastructure changes, such as additional traffic lanes or entirely new roads on the overall traffic situation. Furthermore, traffic simulations are frequently used to predict the effects of 'logical' changes, such as adapted traffic light circuits or altered right of ways.

As opposed to practical approaches–where ideas are directly implemented in the real traffic system–traffic simulations allow to predict effects without really affecting the traffic system per se. Changes to the traffic system frequently entail additional stress-factors for traffic participants and also increase the

DOI: 10.4018/978-1-5225-8356-1.ch022

accident probability since traffic participants are confronted with a new situation. Mistakes in planning may also result in heavy congestion, and–last but not least–practical experiments usually involve major costs–a factor that is significantly reduced by computer-aided predictions.

The potential to decrease investments has significantly fostered the development of sophisticated and highly realistic simulation frameworks. The operation principle of these frameworks varies from implementation to implementation and highly depends on the application's scope.

As an example, there are so called *macroscopic* simulation frameworks that focus on the traffic flow 'as a whole' and neglect individuals. These simulation frameworks frequently apply fluid dynamics in order to predict traffic movements. As opposed to that, *microscopic* traffic simulation frameworks simulate the movements of each single vehicle. For this purpose, efficient and quick longitudinal- and lateral models are used.[1]

Nevertheless, when it comes to road traffic, there seems to be no parameter more essential than the driver itself. The question what actually happens on the road is not only determined by physics of motion, but also by the perception and attitudes of the drivers and external conditions (Lützenberger et al., 2011; Lützenberger et al., 2012).

There are some approaches that use conceptualisations of driver behaviour for traffic simulations (e.g., Ehlert et al., 2001; Krajzewicz, 2010; Fellendorf & Vortisch, 2010; Sykes, 2010; Beuck et al., 2008, to name but a few). In most cases, an agent-based model is used as a foundation. The reason for the appliance of agent-based technics is the nature of the multi-agent system paradigm, which considers autonomous, reactive, proactive, and socially competent entities as intelligent agents (Wooldridge & Jennings, 1995)–this system description, almost naturally fits for simulated traffic participants.

Considering traffic participants as intelligent agents simplifies the entire development of traffic participant models as the agent community provides many tools, concepts and methodologies for the conceptualisation and implementation of agent-based software. The problem, however, is that it is inherently difficult to find a formal model for the behaviour of human beings. Most approaches make assumptions about such behaviour, nevertheless, a calibration that validates hypothesised behaviour structures against empirical data, is generally lacking. The reason for this is simple–it is difficult to perform such evaluation. Human behaviour is highly individual and where a model fits for some behaviour characteristics, the same model may totally fail for others.

But how can one learn about the requirements for a valid conceptualisation of human driver behaviour? This question is easily answered: If one wants to learn about a particular domain, it is always a good idea to refer to where there is a lot of experience. Whenever it comes to human behaviour, there are practically no other research domains with more experience than human factor psychology. In fact, the history of traffic-related psychology even outnumbers the history of computer-aided traffic simulations. The first serious work dates back as far as 1938 (Vaa, 2001; Carsten, 2007), when Gibson and Crooks (1938) presented their formal description of safe driving behaviour.

Currently, there are many psychological driver conceptualisations available, each one trying to capture and to explain the traffic behaviour of human beings, and each one with a particular focus on particular aspects of the driving task.