

Something in the air

A number of developments in emissions modeling software from a notable player in the sector are helping transport planners to meet the ever more stringent legislation that affects traffic traveling through their cities and towns

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Traffic planners do not have an easy life these days. Reducing traffic emissions, in particular, is an especially complex field. The trend toward low emission zones in cities and the introduction of pollution-busting legislation means they're faced with all kinds of dilemmas, more so when up against the need to make journeys quicker while all the time trying to reduce congestion. But the quickest, most straightforward route through a town may not be the most efficient in terms of emissions. And as whole sections of networks become 'no go' areas for vehicles as a result of high pollution levels, the problems that traffic planners face rapidly multiply.

Historically, reducing emissions on the roads was targeted toward the vehicle OEMs. The introduction of catalytic converters for instance, has led to modern vehicles emitting very low levels of pollutants, such as carbon monoxide – so much so that in some areas, what comes out of your tailpipe may be cleaner than the outside air you breathe.

Without doubt, modern cars are far cleaner than they were even five years ago, but challenges nevertheless remain. Cold starts, for instance, are a huge conundrum: the first few miles before an engine and catalytic converter reach optimum operating temperature are of particular focus. Fifteen years ago, these first few miles were not as important as emissions were high overall – they were just part of the problem. Today, though, the relative importance of several



miles of higher emissions in what's normally a very low polluting vehicle should not be underestimated. And if you're only using the car for a three-mile journey, the issue is further exacerbated. A number of countries have launched campaigns to encourage motorists to leave their cars at home for short journeys – and if reducing CO₂ isn't enough of an incentive, they're being asked to focus on the cost of the fuel that they are consuming for those journeys that could be undertaken on foot or by bicycle.

So, with vehicle manufacturers and drivers themselves seemingly on the case,

traffic planners also have a vested interest in assessing fuel consumption and emissions in relation to their roles. As with transport planning/engineering and traffic simulation in general, there is always a need to consider issues either on an aggregated (macroscopic) level, or on an individual (microscopic) level, depending upon individual desires.

UNDER THE MICROSCOPE

A car that drives along a road, stops at a traffic signal and then continues will consume a certain amount of fuel, which is not used at a constant rate. Stopping at the signal results in more emissions as the car accelerates away from a standstill and all stops will increase overall emissions. The microscopic level involves looking at that individual vehicle. Planners are finding that emissions modeling tools are increasingly valuable to their day-to-day work. A signal control setting that is optimal for travel times may not be optimal for emissions levels, for example, so simulation will help find a balance between potential solutions.

Working at the microscopic level means more than just defining an individual car. The emissions generated differ hugely between a small VW and a large Mercedes, for instance. To simulate emissions on a second-by-second basis requires detailed



← With the new software, planners could see how changes to traffic signal timings or other measures could affect not only traffic flows but emissions at intersections or other critical points

information about different vehicles and how much fuel they consume in various driving situations. Very few organizations have such data (for instance, VW may have it, but only for its own vehicles). One institution that does have the data is the Dutch research organization TNO, which has partnered with PTV and another Dutch expert, Vialis, to develop a microscopic emissions package that can be integrated into PTV's VISSIM traffic modeling tool. TNO's existing emissions modeling tool was called VERSIT+ and was based on the emissions of around 2,800 cars measured in various conditions. By combining VISSIM and VERSIT+, a new product, EnViver, has been created.

Linking the emissions data of the TNO model with the simulated traffic behavior of individual vehicles in VISSIM has created a software add-on that can incorporate any kind of traffic situation – introducing a new roundabout or traffic signal, for instance – so the exact level of harmful emissions produced can be determined.

THE BIGGER PICTURE

When it comes to transport planning that regards things from a more aggregated level, this is where macroscopic modeling is useful. In layman's terms, macroscopic modeling allows planners to consider the effects of various strategies on whole chunks of the network. So, typical information available would consist of things such as how many vehicles per hour there are on a link. The main difference between this approach and the microscopic equivalent is that at the macroscopic level, there is no individual vehicle data – beyond classifying between cars and trucks. Strategic transport demand models such as PTV's VISUM calculate information on volumes per hour and how different traffic conditions impact emissions. These models yield traffic volumes either as totals or disaggregated by vehicle type (e.g. cars, light trucks, heavy trucks). The volumes are then multiplied by emissions factors, which represent combinations of several factors. Speed, link type (such as motorway versus city street), engine type, gradient, and even temperature all have a considerable impact.



PTV, TNO and Vialis have joined forces to combine VISSIM and VERSIT+ to create EnViver. This new emissions modeling tool combines TNO's emissions data with VISSIM's simulated traffic behavior of individual vehicles

The functional relationship is determined through a vast amount of empirical work, measuring actual emissions in the field and in the lab, taking a variety of driving patterns into consideration.

There is also a link between VISUM and the newly revised *Handbuch Emissionsfaktoren* (HBEFA) 3.1 – a comprehensive database of emissions factors that now encompasses data from a number of European countries. How does the VISUM-HBEFA 3.1 link simplify life for the transportation planner? The first step is mapping the vehicle types used in the demand model to those used in HBEFA. Demand models typically distinguish only a very small number of vehicle types, known as transportation systems (often only cars and trucks), which is much too aggregated for successful calculations. In fact, each transportation system represents a mix of many vehicle types that behave similarly in terms of demand modeling yet have very different emission factors. The providers of HBEFA offer ready-made mixed fleets for different countries and years as part of the



Governments can use hard environmental figures to tackle traffic flow, especially with an eye toward the environmental lobby

database. For a national model of a region in Austria, for instance, the planner might map the VISUM transportation system 'car' to the HBEFA standard fleet-mix 'car Austria 2015', composed of dozens of specific vehicle types. Different traffic situations (e.g. stop-and-go versus free-flow traffic) can also be defined. With these two mappings in place, emissions calculation becomes an easy post-processing of an assignment result from the demand model. For each network link, VISUM breaks down the volume to the HBEFA fleet mix, looks up the traffic situation and its emission factor, corrects for gradient, and multiplies the result.

Modern software packages such as VISUM store the full trajectory for each assigned trip, so by inverting this data it is possible to tell which fraction of the volume on a given network link corresponds to vehicles within the first few hundred meters of their trip, so accounting for cold starts. After adjusting for cordoning effects near the model boundary, this data can be used to make a calculation, derived from the model, rather than being a pure guesstimate of cold-start emissions. Such a capability may alter the total emissions distribution considerably.

With the new models on offer (the VISUM-HBEFA 3.1 link and the EnViver tool) PTV is in a position to exactly compute emissions. Whether a transport planner is tasked with assessing signal control with VISSIM or assessing the whole network with VISUM, they now have additional, accurate emissions data at their fingertips. ■

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