

## Removing clots from the arteries of our cities

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As people around the world reflect on the initial success of London's congestion charge, Stephen Phillips meets the scientists trying to free our streets and get us moving

It may have shocked the newspaper pundits, but the initial success of London's congestion charge comes as no surprise to the world's leading traffic-flow analysts. Piecemeal measures would have been ineffectual. Hani Mahmassani, professor of civil engineering at the University of Maryland, insists that only drastic action could tame London's traffic quagmire. And he expects other major cities will follow suit.

As cars proliferate and the world's highways clog up with their number, the insights of experts are ever more of a premium. It is a burgeoning academic field. Spreadeagled across mathematics, physics and civil engineering faculties, these researchers often publish their findings in the journals of their home field. So the opportunity to compare notes at the interdisciplinary American Association for the Advancement of Science annual meeting in Denver last month was seized with excitement.

Of mayor Ken Livingstone's effort to tackle London's congestion, Mahmassani observes: "It required strategic thinking about the role of the car." This boiled down to a £5 daily toll in the centre of the city. The result so far has been an easing of congestion beyond Livingstone's 15 per cent goal. The dramatic effect on traffic flow, which previously crawled at the positively horse-drawn clip of less than 10 miles an hour, appears to reflect the workings of what Mahmassani dubs the "5 to 10 per cent effect".

This holds that minor changes across large systems can yield significant impacts - in this case much increased traffic flow. Mahmassani adds that London's "clearly defined central zone and good public transport" also suit the levying of charges on motorists. The latter point betrays a lack of acquaintance with the vagaries of London Underground's Central Line. But the list of cities lining up to emulate London - including Hong Kong, Tokyo and Edinburgh - testifies to the mileage in traffic scientists' anti-congestion

prescriptions.

Livingstone might have filched the road-charging idea from, of all people, University of Chicago free-market economist Milton Friedman, with perhaps a nod to smaller-scale initiatives in Singapore and Oslo. But traffic-flow tools such as charging systems are typically the outcome of carefully thought-through considerations, leaning on mathematical models and insights gleaned from painstaking empirical field studies of driver behaviour. There is more to road planning these days than makeshift cordons of bollards on the motorway.

But there is no generic formula for alleviating congestion, says Michael Cassidy, associate professor of civil and environmental engineering at the University of California, Berkeley. "One has to be intimately familiar with all the features of a (road) system to work out which measures need to be deployed - they're very site-specific."

Mahmassani has seen for himself the rich variety of driving habits to be found in cities around the world. He learnt to drive in the Lebanese capital Beirut, where the aggressive strategy of bargaining in is the norm.

This is also a standard rule of engagement on the roads of Tehran and Rome, he observes. "Driving in Cairo or Paris, your responsibility is not to hit someone else," he says. "If you drive defensively - to avoid getting hit - you'll get stuck." And although drivers in the UK, North America and Germany generally pay more heed to road signs, differences in the proportion of large automatic-transmission vehicles and the range of national speed limits still lend each nation its own driver stereotype.

Experts can learn the most about user-friendly road systems by observing the anarchic driving in Mediterranean metropolises, says Dirk Helbing, professor of traffic modelling and econometrics at Dresden University of Technology. In Cairo, motorists routinely carve up four-lane carriageways into six channels. But within this apparent mayhem, Helbing detects order at work. Driving in the Egyptian capital is a process of mutual negotiation among motorists to optimise flow, he says. "It is astonishing to see how these things work and how intelligent transport systems could learn from them."

The method in the madness even applies to the protocol for pedestrians crossing Cairo's hectic streets. "If you want to cross the road, just start - every driver will assume you will continue moving," Helbing says. "But don't step back or you're dead," he adds chillingly.

The experts have, however, been able to tease out driver behaviour that appears common to all cultures. One important area has been studying how drivers respond to traffic information alerting them to the driving conditions ahead and of alternative routes that bypass bottlenecks. In fact, there is an

optimum number of drivers you want to respond to such advice or the jams merely get redistributed. Then there is the hard core of drivers who always ignore such instructions. This must also be factored into considerations. Helbing has found fascinating parallels between the way groups of drivers respond to traffic information and stock market behaviour. Acting on a tip, a group of investors might snap up shares in a particular company. But this pushes up the share price, so it eventually ceases to be a bargain. Similar overreactions undercut the time-saving utility of alternative routes when they become too popular.

Despite individual eccentricities, Helbing adds that people tend to modify their driving behaviour in standardised ways, such as avoiding collisions, to cut their journey time. This, he notes, means that traffic phenomena are remarkably predictable. Helbing even extends this to pedestrians and the way they spontaneously organise into lanes to avoid colliding with one another and hence slowing themselves down. "It's like repulsive reactions among charged electrons - people behave consistently," he says.

Traffic scientists have formulated various elegant equations to represent the tendency of traffic to jam under certain conditions. But reducing traffic flow to a mathematical formula is tricky. The sheer size of road systems mean they quickly spiral into complex behavioural patterns, and models must take account of disparate variables.

With the roads in most developed countries pretty much built to capacity, experts are typically called on to retrospectively fit traffic-management features into existing systems, says Paul Nelson, a computer science professor at Texas A&M University and expert in traffic-flow mechanics. In cities, this means tweaking the number of vehicles entering and leaving an area by altering variables such as traffic lights to regulate traffic flow across the network, Mahmassani says.

At the AAAS summit, Mahmassani demonstrates the impact such measures can have. He runs a computer model that has been plotted using morning rush-hour traffic data from Knoxville, Tennessee - a city about the size of Dundee.

In his first simulation, the vehicles are represented by pulsing red dots coursing through the city's arteries like blood cells. They form clots at various bottlenecks during the speeded-up 7am to 9am time frame. These clots dissipate as traffic volume tails off at the end of rush hour.

Mahmassani then reruns the sequence. This time, roadblocks are thrown up to worsen blockages at various points.

He repeats the simulation once more. This time, however, signs are added to

divert drivers around the bottlenecks. The effect is dramatic. Traffic swarms virtually unimpeded through the city streets. Mahmassani beams at his audience. The challenge is now to translate that magic touch to the streets of a big city.

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