MATHEMATICS *and the future of transport*

Mathematical modelling is playing an important role in the development of Personal Rapid Transit, a new form of on-demand, driverless travel which promises to be a safe and efficient system that will solve the problem of public transportation once and for all. Véronique Pagé found out more about this futuristic concept when she met transport mathematician **John Hammersley**, *and was impressed by what she heard*

It's five thirty on a windy October afternoon, and I am on my way to meet a mathematician and old university friend, John Hammersley. Or rather, I'm meant to be on my way – in fact I am clicking away at my laptop, trying to decide how best to get to his house. The internet is telling me that the driving time is an hour if the traffic isn't bad, exactly as long as the direct train – but then I would also need to take a bus from the station to Hammersely's house. Should I put up with the inconvenience of the bus and train or go by car and risk getting stuck in a traffic jam? As I finally set off by car, to the dismay of my green conscience, I can't help think that there ought to be a way of making public transport more efficient, and traffic jams a thing of the past.

Hammersley, a mathematical physicist-turned-transport mathematician, certainly believes so, as I discover upon my arrival. For just over a year now, he has been working at the Bristol-based Advanced Transport Systems Ltd (ATS), a company specialising in Personal Rapid Transit, a new form of public transport. The concept of Personal Rapid Transit (or PRT), Hammersley tells me, is one of small vehicles that operate on demand. "Most forms of mass transit that exist at the minute are based on the 'stagecoach principle' – a big vehicle that trundles around, stops at all these stops, and allows you to get on and off where you want. PRT provides each individual party with their own vehicle so they can travel on their own and without stopping for anyone else."

As Hammersley shows me pictures of ULTra, ATS's own version of PRT, I get to understand the concept a bit better. The small vehicles, called podcars, can each take a handful of passengers, but, unlike normal cars, are not the property of any of them – it's very much a mode of public transport. Podcars do not travel on ▶

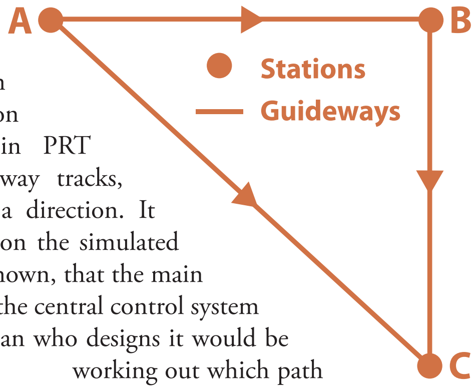
roads but on guideways that are specifically built for them. Those guideways form a network that connects a number of stations. Though in the future PRT could be built on city-wide scales, with a myriad of stations, a more immediate application is to solve what Hammersley calls the 'last mile problem' – the very problem I faced today. The train would have done a very good job at getting me very near Hammersley's house, but for the few miles I had left, the bus was my only option. A podcar would have been a more convenient alternative – it would have patiently waited for me and taken me very close to my destination. I think I'm hooked on the idea already!

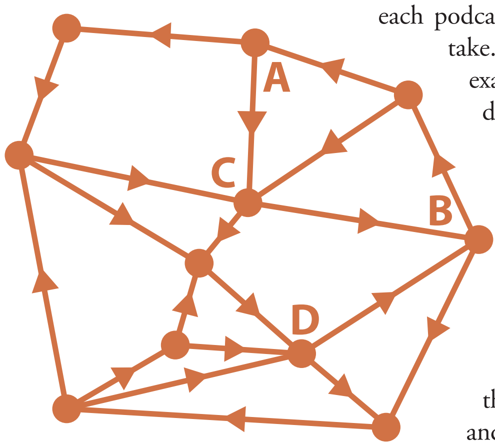
But wait a minute. This concept seems familiar from somewhere. Don't I know of another type of vehicle that hovers around train passengers who have just missed their connecting bus, like vultures around carrions? So, I ask: Aren't podcars just like taxis? "In a way they are essentially like automated, driverless taxis. The vehicles wait for you at the station; you get there, punch in your destination, pay, get in and go." Driverless? Automated? So this is all computer-controlled?

According to Hammersley, driverless vehicles would solve a number of issues that arise with cars, which, as we all know, aren't controlled by a central computer but by human beings with limited knowledge and computing power. This leads to accidents: a much larger proportion of car accidents are caused by human errors than by technical faults. Human drivers also cause congestion, since each individual driver has very little knowledge of where other cars are.

"PRT is different in that you do have a central control. When you select your destination, the computer works out what's the best route, where the other vehicles are and where they are going to be in the future; then makes sure you have a clear path to your destination before you set off." Hammersley reaches out for his laptop and opens a programme that simulates PRT networks. What resembles a super-intricate tube map appears on the screen, and, at a click of the mouse, little dots start going round the map, taking simulated passengers to their chosen destination. Seeing the mathematical side of the PRT concept in action awakens my curiosity. I'm keen to find out how the simulation works, and what mathematics lies behind it.

Hammersley takes me back to basics: the building blocks of a PRT network are the stations and guideways, which, following the conventions of network theory, are respectively identified as the nodes and edges of a graph (as shown in the diagram on the right). Since in PRT guideways are one-way tracks, each edge is given a direction. It seems to me, based on the simulated network that I was shown, that the main complexity faced by the central control system and the mathematician who designs it would be working out which path each podcar should take. Suppose for example that in the diagram shown on the left a podcar sets off from *A*, heading towards *B*. Once the podcar is on its way, the central control system might realise that the track between *C* and *B* is quite full, so it





HORIZONTAL ELEVATORS
An artist's impression of a podcar running inside a building

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