What Causes Traffic Jams?

Ever since the invention of the automobile there have been traffic jams. Some traffic jams seem easy to explain: an accident or roadwork causes cars to slow down; or, rush-hour commuters take to the streets on their way to or from work.

Sometimes, though, there seems to be no obvious reason for a traffic jam: vehicles on the highway simply slow down. Indeed, many traffic jams were a mystery until a team of mathematicians from the University of Exeter in England solved the puzzle with a computer program that demonstrates how major delays on roads can occur with no apparent cause.

The mathematicians developed a mathematical model to show the impact of unexpected events such as a truck changing out of its lane on a two-lane highway. Their model revealed that a car slowing down in reaction to the truck forces the car behind to slow down even more, and the next car back to reduce speed further still, and so on.

The result is that cars several kilometres back are obliged to come to a stop, with drivers oblivious to the reason for their delay. The computer program predicts this as a very typical scenario on a busy highway of more than fifteen vehicles per kilometre. The jam moves backward through the traffic in a kind of wave so that even several minutes after the truck has changed lanes, drivers several kilometres behind have to slow down.

The mathematical model shows it is not the volume of traffic but the reactions of drivers that create traffic jams. In theory, even with many vehicles on the roads during rush hour, there would be no traffic jams if everyone kept at a safe distance and travelled at the same speed. In reality, however, this doesn't happen: most drivers follow too closely and don't give themselves enough time to avoid overreacting.

Dr. Gábor Orosz of the University of Exeter said, "Our program shows that overreaction of a single driver can have an enormous impact on the rest of the traffic, leading to massive delays. When you don't pay attention, you use your brakes more often. When you put on your brakes, the traffic may come to a full stop several kilometres behind you. It really matters how hard you brake, and how alert you are to problems on the road. A driver who identifies a problem early and breaks gently will allow the traffic flow to remain smooth. A driver reacting late to a problem can affect the traffic flow for many kilometres."

The answer to the mystery of traffic jams, it seems, is not how many cars are on the road, but how alert the drivers are.