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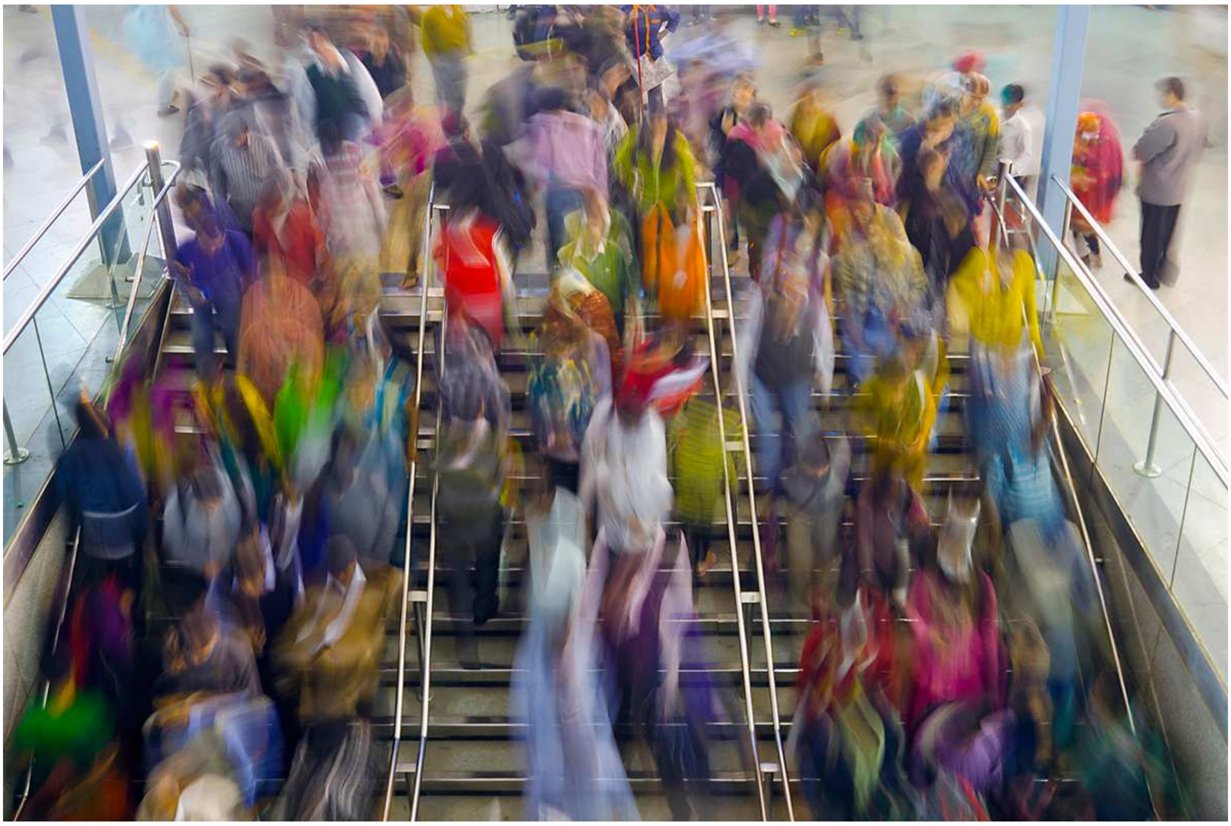
Maths explains how pedestrians avoid bumping into one another



Crowd behaviour is hard to model because individuals are unpredictable
Chinch Gryniewicz/Plainpicture

By **Jennifer Ouellette**

We may now have a universal law to describe how pedestrians behave in the wild.

Understanding crowd dynamics could help ease rush hour congestion and prevent tragedies like the stampede at a German music festival in 2010 that killed 21 people.

Individuals within large groups are difficult to track, so crowds are frequently modelled as collections of particles in a fluid, with each pedestrian representing a single particle. But people are more unpredictable than that.

Federico Toschi at Eindhoven University of Technology in the Netherlands and his colleagues wanted to build a model capable of taking into account the tiny random variations in how pedestrians move, such as suddenly perfoming a U-turn.

“Most models ignore the possibility of people going back, but in a train station it would happen every few minutes,” said Toschi.

Toschi's team set up cameras to record the movement of individuals along a single corridor at Eindhoven University connecting the cafeteria to the dining room. Foot traffic wasn't particularly dense, but it was consistent – allowing individuals to be tracked accurately.

The cameras used a Microsoft Kinect 3D motion sensor – designed for Xbox gaming – with a built-in infrared illuminator to correct for variable lighting conditions, and designed software to track the heads of the people as they walked.

The team then used footage of more than 72,000 pedestrian paths captured over the course of a year to model the average path people took – taking into account random fluctuations.

The model can, for instance, predict how often someone is likely to make a sudden U-turn, which could clog up a more heavily used hallway or lead to traffic jams and dangerous situations in more crowded conditions, like a train station during rush hour.

"That's the beauty of this sort of experiment – it's recording from real life," says Toschi.

He says the model could be expanded to apply to more complicated crowd dynamics. The team has already collected six months' worth of data from a similar experiment in a train station. They are also collaborating with museums to optimise the flow of people visiting exhibits, and exploring ways to gently steer them along preferred routes, if, say, a particular exhibit is becoming too crowded.

"In general, I like very much the idea of trying to study the level of randomness in human walking patterns from data like this," says Brian Skinner of MIT, who co-authored a 2014 study on how pedestrians avoid collisions in crowded areas. But this model might make some overly generous assumptions, he says.

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