What’s the best way to plan if you don’t know how many people are coming to an event? We speak to crowd analysis expert Professor G. Keith Still, who says it only takes four questions:

1. **Route**: From which direction will crowds approach and leave? What are the transport hubs to and from the site?
2. **Area**: What is the event capacity? How much area is there and, importantly, how will it be used?
3. **Movement**: How quickly will the spaces fill? What crowd movements do you expect and over what period?
4. **People/profile**: What type of crowd are you expecting? What do you know about the audience demographics?

With this data, event organisers can examine where, when and how congestion might build up, where queues may be expected and where they need to position stewards and security.

"You can estimate area and density," explains Still, "and we already have a good idea how certain types of crowds fill and occupy space. For instance, with a popular boy band and a youthful audience, you generally get high density close to the front of the stage. Book signings will have a different type of crowd gathering, as will store openings, various other promotions or football matches.

"So we look at the areas they occupy and how the..."
CROWD ANALYSIS

profile fits various ground spaces, and we look at how movement over time occurs,” says Still. “We look at how people get to the site, such as the rate at which the car parks are filling over time. If you plot that and ask: Is it a flat line? Is it a rising straight line? Is it a growing curve? This gives you some idea, just by a simple extrapolation, of what it’s going to look like in the next half hour or so.” Public transport capacity can also be used: “We knew for example that certain London Underground stations around the royal wedding could deliver 40,000 people an hour, so we can use that information to look at the maximum load that can be pushed into the site and how we can monitor that,” Still explains.

All about the numbers

One of the reasons some controversy often follows a crowd count is that the count is generally realistic and produces lower numbers than hoped: “It’s essential to get this right however, because the reality is that if you don’t you could be putting lives at risk by under resourcing future events,” advises Still.

Another event where the crowd was probably hugely overestimated was the Eagles Victory Parade: “Three million people was the estimation by the organisers,” says Still. “We evaluated that 700,000 were actually there. You need to know what you’re looking for and to have the right angles and field of view. From the front, for example, if you’re low and looking through, it can look as if a crowd is disappearing over the horizon.”

Moving crowds need more space for safety than those that are standing, which makes it important to understand the difference between static and dynamic space requirements. A safe crowded space is normally estimated at two people per square metre, adjusted for areas of higher density (front of stage, for example). Where crowd density increases above five per square metre, the risks of slips, trips and falls, crowd surging and crowd collapse increase.

The relationship between crowd density (people per square metre) and crowd flow (people per metre per minute) is critical. In moving crowds, as density increases above a critical density (which is different for different crowds/events but typically 2-3 people per square metre), the flow rate begins to drop. Crowd flow also differs according to the degree of crowd order. Marching soldiers can achieve a higher flow rate at higher densities than a mixed crowd.

“Density and flow are related, which is obvious if you think about it,” argues Still. “If you’ve got people walking down a corridor, as the numbers increase the density increases and the space between them reduces. They can’t take whole passages, so they walk more slowly, the flow rate reaches a maximum and then drops off again.” High density crowds move more slowly and therefore any compression points very quickly become high-risk environments.

Victim of success

It is useful to track attendance at regular events and extrapolate. “For London New Year 2006, the site capacity was 180,000,” says Still, “but a quarter of a million turned up, which raised issues about what to do.” The following year, 360,000 came and the year after that 550,000. “It’s about understanding at what point the system breaks,” he says. “About understanding what your site capacity is and what the curves look like in terms of growth.

“It’s not complicated maths. It is complex, bringing several connected parts together, but once you’ve put those bits together, you’ve got crowd science”

“Free, non-ticketed events can often take on a life of their own, becoming a victim of their own success. That’s great if you are planning and anticipating but, if you’re not, the day that there are too many people on your site is the day that lives are at risk, so it’s always a question of being able to keep some eye on how the crowd momentum is building year after year. And that’s about basic data collection – basic statistics.

“We teach police officers and event organisers how to evaluate crowd numbers and make sure if they see numbers build up, they’ve got time to react and take remedial action, and how to plan for crowds that are 50%, 100%, 300% or 500% more than expected.”

This leads to the question of at what point it might be necessary to divert people elsewhere. “We advise shifting these kinds of events at 80% full, and then we evaluate what the next 20 minutes or half an hour are going to look like,” Still says. “We might have 50% of capacity at a particular flow rate. When you reach 50%, you go from green to amber; that’s your get ready, and then 80% is your lock down. If you lock down at 80%, you can inform the crowd, make decisions, look at what’s on route and what’s already in the spaces. Whereas if you shut something when it’s full, you build up pressure. You want to be shutting in advance and diverting people before pressure builds up – that’s how to mitigate risks.”

Early warning signals are crucial: “The disasters usually occur when there are too many people and not enough space,” says Still. “So you’ve got to have an understanding of the basic maths, and that’s something that seems to be lacking in many cases. But if you are from an operational research or safety background, you know how important it is to get these numbers right.

“It’s not complicated maths,” he emphasises. “Rather it is complex, bringing several connected parts together. But once you’ve put those bits together, you’re left with a very good idea of how to plan and manage safely, and that’s what we call crowd science.”