Sin cities

What makes some city districts so dangerous? It's not just the criminals, says **Mark Buchanan**

WHY does crime occur where it does? If you thought getting an answer to that question would mean getting inside the mind of the criminal, then you haven't met Kate Bowers. She is less interested in the psychology of criminality than in the mathematics of crime itself, and is convinced that this can shed light on patterns of crime. Take burglary at people's homes. Although the pattern of burglaries in a neighbourhood may appear random, Bowers and her colleagues at the Jill Dando Institute of Crime Science, University College London, have found through computer simulations that burglaries actually spread in a predictable way, similar to a contagious disease.

It may seem odd to look at the crime rather than the perpetrator, but Bowers believes crime often has less to do with deviant

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psychology than with utterly mundane human habits and the physical environment in which potential criminals find themselves. In her view, crime is a normal, if undesirable, outcome of ordinary social interactions.

This idea, known as routine activity theory, has been around for almost three decades. "It was considered kind of nutty when it was first proposed," says Marcus Felson of Rutgers University in New Jersey, who dreamed it up. Although still controversial, the theory is becoming increasingly influential as an explanation of how crime works, and in policing communities. Now Bowers and others are taking it to another level by showing how computational analysis can reveal patterns in criminal activity, and even predict where it might happen next.

Much as a biochemical reaction can take place when two suitable molecules meet in the presence of a catalyst, the idea goes, so crime results when potential offenders encounter targets in circumstances conducive to crime. In a classic study in 1994, criminologist Daniel Beavon of the Correctional Service of Canada, working with Paul and Patricia Brantingham of Simon Fraser University in Vancouver, Canada, compared rates of crimes against property on various streets in the city with the amount of traffic on them and the ease of access to them. They found compelling evidence for patterns that routine activity theory would predict: for example, of two similar houses, one on a main road and another on a smaller street requiring more turns to be reached, the former was generally more likely to be burgled. This makes sense, the researchers argued, because burglars spend most of their time on routine, non-criminal activities, and when they commit crimes they are likely to do so in places they are most familiar with.

"Computational analysis can reveal patterns in criminal activity"

Since then, criminologists have found countless cases where crime patterns can be interpreted in a similar way. For example, a disproportionate share of burglaries and violent assaults in any city take place near just a few tough bars or fast-food restaurants where potential offenders spend time planning criminal activities, which they then carry out close by.

Understanding the ubiquity of these patterns is transforming the way that police try to counter crime. Increasingly, police forces are realising that paying attention to simple factors which increase the likelihood of crime occurring can actually reap greater dividends than dramatic raids or arrests. For instance, following a wave of domestic appliance thefts from homes in Charlotte, North Carolina, studies by criminologists Ronald Clarke of Rutgers University and Herman Goldstein of the University of Wisconsin, Madison, found that most of the stolen appliances had been sitting in newly built premises that were waiting to be sold. The number of thefts dropped markedly once builders delayed installing the appliances until just before buyers moved in.

Finding solutions to crime is much easier once a trend has been identified, and now mathematically minded criminologists say that computer models based on routine activity theory have the potential to make sense of a far more complex mix of social and physical factors that may influence crime.

One of the earliest studies using this approach was led by Michael Batty of University College London. Since its inception in 1964, the Notting Hill carnival in London has grown to attract more than a million visitors each year. With vast crowds jammed into narrow streets, crime is inevitable – anything from pickpocketing and shoplifting to violent assault and worse. After three people were murdered at the event in 2000, the Greater London Authority commissioned a review of public safety and asked Batty to create a computer model of people's movements in an attempt to identify better crowd-management strategies. "We simulated the crowd movement around the parade and the exhibits," says Batty, "and used the model to test 'what if' scenarios for changing the parade route, or closing particular streets."

This led to the discovery that altering the parade route could significantly reduce the density of the crowds. "The circular parade route didn't let people easily cross it," says Batty. "This was the problem, as all the events were inside the route." Enlightened carnival organisers adopted the straighter route suggested by the computer analysis, and subsequent carnivals registered a big drop in both maximum crowd densities and the number of crimes committed. ▶

Both suburbia and inner-city estates can be environments conducive to crime


JASON HAWKES / CORBIS


SUE BARR / VIEW

JEROEN OERLEMANS / REX

What do London's Notting Hill carnival and a fast-food outlet have in common?

TOBY MELVILLE / REUTERS

Bowers's finding that burglaries spread like communicable diseases is another example of the power of computer modelling. It first emerged from work with her colleague Shane Johnson, completed four years ago. They studied data from the Merseyside region of the UK, containing information on locations and times of residential burglaries committed over 14 months within an area of about 26 square kilometres. This revealed that, following a given burglary, the likelihood of another was increased for the next two weeks for any house within about 200 metres, though the probability tailed off at greater distances and after that time had elapsed. This pattern of communicability of crime strongly mirrors the patterns that epidemiologists find with diseases that spread from one person to another. In the case of crime, Bowers and Johnson suspect, communicability arises simply because burglars have routines, and after one success they often continue in familiar territory nearby (*European Journal of Criminology*, vol 1, p 237).

To find out whether this trend was unique to the UK, last year Bowers and an international team of criminologists extended the study. They found much the same pattern in 10 different cities in Australia, New Zealand, the Netherlands, the UK and the US. Now, a few police forces in the UK have started to exploit the finding by adding patrols near recently burgled houses, or by installing temporary alarms in houses nearby, especially those with similar points of entry.

Though police have been making maps of crime hotspots for years, their predictions about crimes have been based on the assumption that the future will mimic the past. In an effort to improve on this retrospective approach, Bowers and Johnson are developing what they call prospective hotspot mapping (*Journal of Quantitative Criminology*, vol 23, p 201). Their computer model considers each recent burglary as a potential source of "infection" for future crimes. They can then estimate the likelihood of a subsequent crime in any given location by combining the risk associated with each of the previous burglaries – with those nearest making the strongest contributions.

The approach seems to work. In a recent study, Bowers and Johnson compared the predictive accuracy of their prospective

A question of scale

Cities are synonymous with crime, but could this simply be a factor to do with their size? Physicist Luís Bettencourt of the Los Alamos National Laboratory in New Mexico compared a variety of physical and social parameters in cities of different sizes – everything from the total length of electrical cable to the number of investors and the rate of crime. Naively, one might expect little regularity in these parameters given the wildly different political and economic systems, cultures and so on. Yet Bettencourt and colleagues found that cities in the US, Europe and China show stunning regularities.

Quantities related to physical infrastructure, such as the total length of pipes carrying water, seem to grow in proportion to the city population N raised to the power β, with β equal to 0.8. This implies that these quantities grow less quickly than the population, as cities benefit from certain economies of scale. Meanwhile, quantities related to social or economic development, such as the number of investors, total economic output or overall crime, all grow slightly faster than population, with β equal to 1.15, suggesting that cities also realise certain increasing returns associated with social interaction.

Admittedly, the pattern for different types of crime is not straightforward. Not all crimes grow with population in the same way – or at least that's what various FBI reports over the past few years indicate. While per capita rates of robbery, murder and car theft all strongly increase with city size, the incidence of other crimes, including rape and larceny, is approximately the same everywhere and may even be smaller in the largest cities.

Still, Bettencourt is struck by how remarkably universal these patterns are. "In some sense, it seems that small, medium and large cities are just scaled versions of one another," he says. As far as crime is concerned, he says, this robust pattern ought to stimulate some rethinking about what is normal and what is not.

We are used to politicians and the media complaining about high crime rates in cities, and comparing the "unwholesome" city to the supposedly more wholesome smaller town. That comparison may be misleading, as higher per-capita rates of crime may be an almost unavoidable consequence of people living in large settlements – a price we have to pay for higher rates of innovation and wealth creation. You can only complain that a city's crime rate is high, says Bettencourt, if it is high compared to the average for cities of the same size.

hotspot maps with those produced by more traditional methods. In a typical area of the English Midlands, where the retrospective technique identified the location of 50 per cent of burglaries one week in advance, the prospective technique captured close to 80 per cent. It also located these crimes more accurately, pinpointing hotspot areas down to half the size found by the standard method. "I'm a big fan of this work," says Gareth Hughes, an inspector with the Greater Manchester Police, which has been testing the new approach since 2006.

Understanding space

Taking a different approach to tackling urban crime patterns, Bill Hillier at University College London is mapping the physical environment in which crimes occur, and has developed a way of seeing cities that he calls "space syntax". The idea is that cities are ultimately built up from elements of space – roadways, buildings, parks and so on – and the way these elements fit together exerts a huge influence over where and how people move around, transact business, and generally live their lives. In several studies, Hillier's group has shown how a detailed consideration of space and its influence on people can explain a lot of human interactions, including crime.

In the early 1990s, for example, just a few years after the Maiden Lane housing development in Camden, London, had won awards for its innovative architecture, it became a rat's nest of social problems, a transformation that baffled researchers. By examining the layout of the development and comparing its character with that of residential areas around it, Hillier and colleagues found that the low-rise, high-density Maiden Lane design (pictured on page 37) had effectively isolated it from surrounding streets. "As a result," says Hillier, "people in the centre rarely encountered any other human activity." This physical isolation matched residents' reports of feeling cut off and vulnerable, especially after dark.

Hillier realised that, with further computer modelling, this same approach could help explain otherwise unpredictable patterns of crime. Over the past three years, he and his colleagues have been exploring how residential burglaries and street robberies in London link to other factors, such as geometrical features of the road network and the architectural properties of buildings. They began by analysing every road segment in a large borough in terms of its attractiveness as a route for getting from A to B. Each stretch of road was given a "betweenness" weighting – a measure of its usefulness for people moving through the city. The result is a map

UNLAWFUL PLACES

Aspects of the physical environment help explain the distribution of crime during a one-year period in part of a new town in the UK (left map). Often major roads tend to be crime hotspots, but here the properties on such roads are highly visible, reducing opportunities for burglary. Instead, most crime occurs on the least accessible streets

Burglary · Car crime · Footpath · Green area

EASE OF ACCESS: Low – High

SOURCE: B. HILLIER

with bright lines showing paths where one should expect large flows of people, either in vehicles or on foot (see Diagram).

While this showed that street crime tends to cluster on these natural paths as criminals seek targets, the pattern of residential burglary was more confusing. For example, Hillier's team found that maps of burglary locations often reveal sharply delineated adjacent areas of high and low burglary rates, for which there is no obvious explanation in terms of factors such as income levels.

> **"Simple physical and spatial factors interact in complex ways"**

Closer numerical study of the 100,000 dwellings in the area, however, revealed a strong pattern linked to the physical characteristics of the properties: what matters most, it seems, is the type of dwelling.

In particular, detached houses tend to be at a higher risk of burglary than apartments. Indeed, this reflected a more general pattern, in which the risk to any dwelling increased with its "exposure", that is, the number of its sides not directly connected to neighbouring structures. It also emerged that dwellings in areas of lower-density housing were at greater risk. Simple physical and spatial factors are crucial, Hillier says, yet they often interact in complex ways.

Hillier's as-yet unpublished findings could add an extra layer of information to the prospective crime hotspot maps that Bowers is working on. Meanwhile, other researchers are using massive data sets of human activities within cities to develop simulations capable of following the movements and habits of millions of people, in the hope of learning more about how crime and other social outcomes emerge out of normal human interactions. Gabriele Istrate and colleagues at the Los Alamos National Laboratory in New Mexico, for example, think this might ultimately be the best way to understand how different human activities feed together in complex ways to produce opportunities for crime, and to learn through virtual experiments how different measures might succeed in reducing them.

Nobody expects any of this work to put an end to crime, but it should help us understand more about where and how it occurs. On a practical level, such objective modelling techniques are likely to provide anti-crime strategies that genuinely work. "If we learn to think this way," says Felson, "we can get a lot of mileage without really trying to catch all the criminals, or even to make everyone good."

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