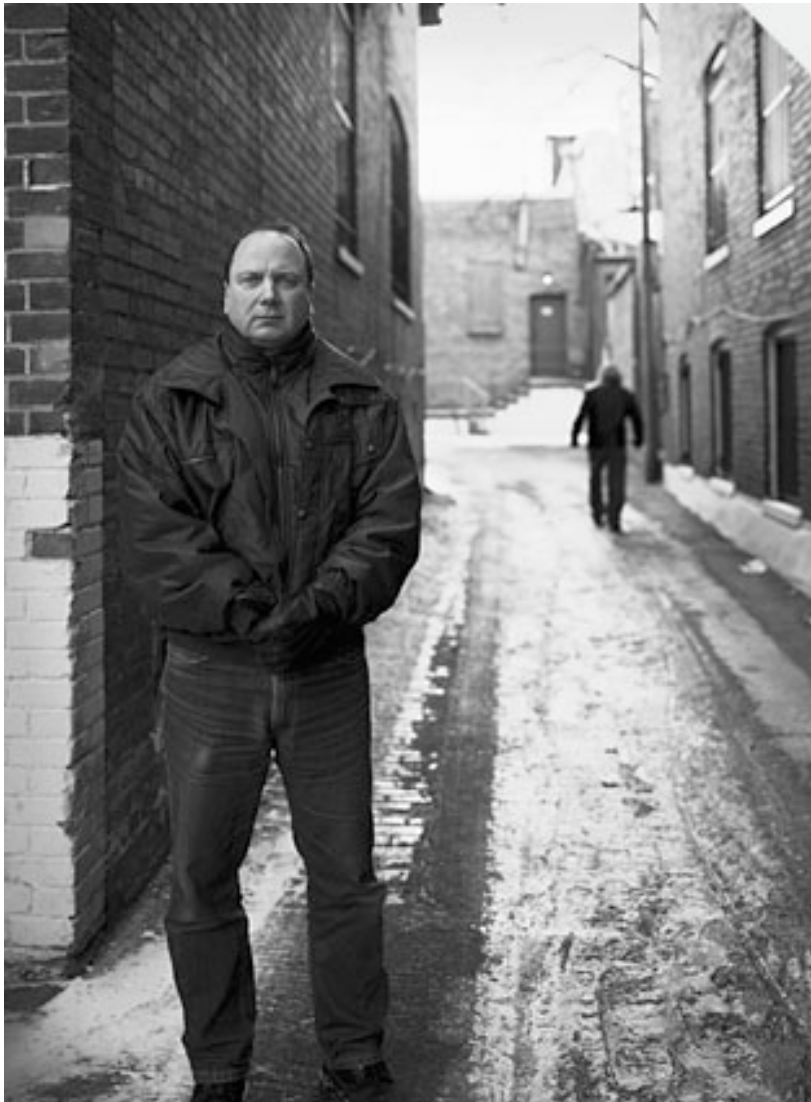


The Hound of the Data Points

by Bruce Grierson



Geographic profiling pioneer **Kim Rossmo** has been likened to Sherlock Holmes; his Watson in the hunt for serial killers is a digital sidekick — an algorithm he calls Rigel.

Photograph by Grant Delin

Until he was called in on the Beltway Sniper investigation, Detective Kim Rossmo's most confounding case was the South Side Rapist. For almost a decade, an unknown assailant, his face bandit-wrapped in a scarf, had been stalking women in quiet Lafayette, Louisiana, and then assaulting them in their homes. He remained at large in 1998 when Rossmo, then a detective inspector with the Vancouver Police Department in Canada, was called in to help. The police were under pressure. The town was hungry for an arrest. There was a glut of raw information. But after a couple of thousand tips and close to a thousand suspects — numbers that would be dwarfed by the 15,000 tips a day that the sniper case would generate, but a sea of data all the same — investigators were no further ahead.

Rossmo's job was to help direct the manhunt. If he couldn't find the needle, he hoped at least to radically thin the haystack. And he would do so through the careful application of that most powerful of investigative tools: a mathematics equation.

Rossmo, 47, is the inventor and most zealous proponent of criminal geographic targeting (CGT), more commonly known as geographic profiling. He uses CGT to hunt society's most dangerous game: violent serial criminals — arsonists, rapists and murderers whose taste for carnage seems only to sharpen with time, and who tend to programmatically continue their offenses until they are caught. There's no mistaking Rossmo for the FBI profilers down in Quantico's Behavioral Assessment Unit, the ones that movies like *The Silence of the Lambs* have turned into celebrities. He can't tell what kind of offender is terrorizing the town, how old or what race, whether he has delusions of grandeur or issues with Dad — nor does Rossmo particularly care about those things. His interest is in the most neglected of the Five W's: Where did the offender strike? From this Rossmo can usually calculate where, most likely, he lived.

In Lafayette, Rossmo and lead investigator McCullan "Mac" Gallien walked the city's streets for three straight days, revisiting the crime sites. Then Rossmo produced a computer-generated printout that resembled a tie-dyed shirt; its bands of color — from cool violet to hot yellow — told police, essentially, where to look first. That narrowed the hunting area to half a square mile, and reduced the pool to a dozen suspects who lived in that zone. Investigators were buoyed. But the bubble burst when, one by one, each of the suspects was cleared based on DNA evidence.

Then Gallien received an anonymous tip that he almost dismissed as a joke. The man the informer named was someone Gallien knew personally — another cop — Randy Comeaux, a pleasant-mannered Stephen King lookalike who was a sheriff's deputy in a department just outside of town. Idly curious, Gallien checked Comeaux's address and compared it to Rossmo's probability map. Not even close.

To be complete, though, Gallien fished out Comeaux's personnel file. At the time of the rapes, he discovered, Comeaux had resided someplace else. Gallien checked that address against Rossmo's profile and drew in a breath. The house fell right into Rossmo's "hot zone."

Gallien put surveillance on Comeaux. When Comeaux discarded a cigarette butt, agents recovered it and sent it to a lab — and got their DNA hit. Gallien confronted Comeaux on the street and said quietly, Joe Friday-like, "It's over."

The case intrigued just about everyone who heard about it. The notion of a master geographic profiler conjured those classic film scenes in which detectives gaze at a trail of red pushpins in a big map, then guess where the killer will strike next.

In fact, though, it's just the opposite.

"Geographic profiling isn't about prediction," Rossmo says. "Efforts to predict the location of crimes don't show a lot of focus." Instead of pushing forward into an unknown future, Rossmo's method pulls back to an origin, to the time and place the crimes were hatched. A center.

"You know those sprinklers where the little metal thing hits the water stream and it sprays around in a circle?" Rossmo asks. "You could look at that and say, 'There's a good probability that the next drop of water will land within this ring,' but it'd be hard to know precisely where. If you took the sprinkler away, though, and I looked at the pattern of water, I could tell you where the sprinkler was."

BACK IN VANCOUVER, WHEN ROSSMO WAS HEADING UP the world's first geographic profiling unit, a sign hanging on the office doorknob read "Bates Hotel: Please Make Up My Room." But the whimsy in his current office in D.C. is subtler: There's a replica Maltese Falcon on the windowsill; on the bookshelf, a copy of *Burnt Bones*, the Michael Slade novel in which Rossmo appears as a character.

When I arrive, he's scarfing down a bagel, which is breakfast and lunch and might just be dinner. His clothing palette suggests those spiritual mediums who hope to make themselves invisible to the phantom entities they're studying: black shoes, black slacks, black shirt. Impeccably shaved, with a cadaverous pallor, Rossmo is a wall with no handholds, a cipher. Even his accent is neutral (think Peter Jennings). If you ran into him at a bank or in an alley or at a crime scene you would never remember him later. (That said, a movie based on Rossmo's life is in the works,

and a casting notice in a trade publication took an uncharitable crack at a description: “Hey, actors, if you’re pudgy, 40ish and balding, maybe you’ll get to play Canada’s answer to Sherlock Holmes.”)

The office is near Dupont Circle — a ring within the bigger ring that is D.C. This is the headquarters of the Police Foundation, a private nonprofit agency that trains police departments in law enforcement strategies. Rossmo is director of research.

Phone messages cover the desk. They pile up while he is on the road, which is a lot of the time — though not nearly as much as in his previous job, where he logged 100,000 miles a year as a kind of Holmesian brain for rent, dropping into investigations from England to Australia. Now when he helps solve crimes, it’s on his own time.

The phone rings. Rossmo is quiet on the receiver for 30 seconds. “Oh wow,” he says finally. “Do they believe these are linked?” A breaking case, a series of rapes and sexual assaults in Europe: The FBI has suggested parachuting Rossmo in. He explains to the agent on the line how it usually works: He prefers to go with other profilers, sharing ideas. He’s going to need to be briefed, and he’s going to need maps of the area.

The Lafayette rape case was just one among a series of events that have slowly built the brand of Rossmo. Five years ago, as prostitutes began disappearing from Vancouver’s skid row at an epidemic rate, Rossmo was the first to suggest a serial killer might be at work. (He was ignored. Since then, the remains of some of those women have turned up on the property of a local pig farmer who stands charged with 15 counts of murder.) Two years ago, Interpol gave its stamp to geographic profiling; the international police agency now recommends the technique, where appropriate, to help focus DNA gathering from suspects. And last year the International Criminal Investigative Analysis Fellowship, the de facto league of psychological profilers, accepted geographic profilers into its ranks.

Indeed, the old guard from Quantico — not known for suffering fools — are among Rossmo’s fans.

“We have a mutual respect,” says Roy Hazelwood, the famed serial crimes investigator and former instructor at the FBI academy, who worked with Rossmo on the “Alphabet Murders,” a cold case re-opened at the behest of the Discovery Channel.

But it was in October, when Montgomery County police captain Barney Forsythe called Rossmo about a killing rampage — one that would become a daily deathwatch in the D.C. area covered by media around the world — that “geographic profiling” became a dinnertime buzz phrase.

THE MATHEMATICAL EQUATION AT THE HEART OF GEOGRAPHIC profiling came to Rossmo in a flash a little south of Tokyo as he rode the bullet train toward Nagoya one day in 1991. Gazing out the train window, into the slow strobe of the whizzing countryside, something began to gel.

Like Archimedes in his tub, Rossmo was sitting on an idea years in incubation. While studying criminology at Simon Fraser University in Burnaby, B.C., Rossmo had been mentored by the respected husband-and-wife team of Paul and Patricia Brantingham, who had already made big strides in crime-pattern theory. They’d taken two existing concepts in criminology and combined them to form what they hoped would be an effective predictive model. The first was the notion that offenders left “buffer zones” around their homes in which they avoided committing crimes, to protect their anonymity. The second was something called “distance decay,” a mathematical function that described the way offenders journey to commit crimes, venturing farther from home the bigger the potential payoff (which often means the more violent the act).

But the Brantinghams hadn’t cracked the nut. They hadn’t found the magic algorithm. What they had done was prepare the ground for an ambitious successor. Someone, say, who was such a math whiz that he asked to take his Grade 12 math final in the second week of class — and whose perfect score excused him for the year. Someone who knew crime patterns from two sides, having first walked the beat on Vancouver’s rugged skid row and then steeped himself in theory on the

way to becoming Canada’s first cop with a Ph.D. Someone smart enough to figure out that if you just flipped his mentors’ logic, you could calculate where a killer lived from where he traveled, rather than the other way around.

As the train raced, Rossmo began jotting an equation on a napkin. The equation was too long, so he continued it on a second napkin. After a few minor changes in succeeding months, it ended up looking like this:

$$p_{ij} = k \sum_{n=1}^c \left[\frac{\phi}{\left(|x_i - x_n| + |y_j - y_n|\right)^f} + \frac{(1 - \phi)(B^{g-f})}{\left(2B - |x_i - x_n| - |y_j - y_n|\right)^g} \right]$$

It seems impossibly complicated, but the equation is really expressing a couple of fairly basic principles. Along with a modification of the Brantinghams’ crime-pattern theory, Rossmo incorporated something called the “least effort” principle, which says that human beings don’t make a move before performing a little mental cost-benefit analysis. (You’re not going to go across town to buy milk, for example, but you might to buy snow tires.) Another key principle was “routine-activity theory,” which holds that crimes happen at the junction of familiarity and opportunity. For a crime to occur, “a motivated offender must encounter a victim in the absence of protection” (such as police, security or interfering witnesses). A criminal’s behavior is the product of the often mundane decisions he has previously made — and each of those was determined by where he happened to be when he made them.

Later, Rossmo tucked the napkins into his pocket. When he returned home he turned the equation into an algorithm, which would ultimately become a computer program — the same Rigel (pronounced rye-gel and named after a star in the constellation Orion, “the hunter”) loaded into this Dell Pentium 4 here in D.C.

Rossmo swivels his chair and, to demonstrate how Rigel works, pulls up on the screen a case from his files. It’s the story of Lee Marvin Payne, a serial sexual-assault felon who prowled Mississauga, Ontario, in the 1990s.

The sites where Payne attacked his victims appear as red points, superimposed on a map of the city. (Rigel is built like a sandwich, with code written in Vancouver by employees of Rossmo’s company — Environmental Criminology Research — as the base, then an interface, then Microsoft’s routing software, Mappoint.)

Rigel chews on the data points. What it’s doing is applying Rossmo’s algorithm to calculate, for each of the 40,000 tiny squares on the grid, a “hit score,” or probability that that very square is the rapist’s operational base, or “anchor point.” Rigel performs 440,000 calculations, and when it is done 10 seconds later, a graphic blooms on the screen. The profile looks a bit like a relief map. Toward one corner of the map, a fiery amoeba shape pops out, about 5 percent the size of the original search area — the “peak profile” area Rossmo has asked the computer to show him. “In this case the offender lived here,” he says, pointing to a spot on the yellow shoulder of the red “hot zone” in the middle. That’s a hit score of about 2 percent — meaning the police would have to search an area of only a few city blocks before they knocked on Lee Marvin Payne’s door. Rossmo punches in another command, and a sort of double-peaked volcanic cone rises from the plane. This is the “jeopardy surface,” a kind of topographical probability map, with the hot zone shown as the peak of the volcano.

“This gives you an optimal search strategy,” Rossmo says. “You search in the high areas first and then work your way downward.” He rotates the plane in space, flipping it 180 degrees. “We make jokes about the seamy underside of cities.”

The more data points — encounter sites, body dump sites — Rigel has to work with, the more accurate it is; which is to say, the smaller the impact of aberrations. Sometimes, when Rossmo is constructing a profile and the number of points climbs beyond a dozen or so, something interesting happens: The hot zone stops moving. It's as if Rigel has laid its money down on the table. For investigators, the value of a reliable hot zone is clear. If you can reduce a hunting area from, say, a hundred square blocks to two, all sorts of new strategies become available to the police: DMV checks of the cars in that neighborhood, door-to-door searches, even blanket collection of cheek swabs for DNA sampling. Flyers warning residents to be on the lookout are sometimes sent to all homes in the area. After they were convicted, the so-called Tag-Team Rapists of Surrey, Canada, admitted they actually received one, warning themselves about themselves.

FLASHBACK TO 1991: AT THE MAMMAL HALL AT THE SMITHSONIAN NATIONAL MUSEUM OF NATURAL HISTORY in Washington, regular museumgoers have begun to notice a guy hanging around suspiciously in the lion exhibit. Rossmo comes here whenever he's in town. He is working on his criminology doctoral thesis. He's trying to establish that a violent offender's movements through the city are almost entirely predictable — and something he's learning here seems to help his case. Such “hunting patterns” seem to be universal. They even cross species boundaries. In the lion kingdom there are “residents” that roam within a tight, circumscribed home range, and there are “nomads” that venture farther. There are times when a lion will meditatively plan its hunts, and times when dinner is fortuitously presented, as when a hartebeest or a dik-dik happens to wander into its domain. There are even times a lion will engage in what look like senseless spree killings — charging and slaughtering as many as five animals in a single day, then leaving their uneaten carcasses to rot. The descriptions and m.o.'s fit almost perfectly with the typologies of human killers Rossmo was developing.

In *The Serengeti Lion*, which Rossmo had been reading, author George Schaller maps the travels of one nomadic male lion for nine days. The drawing looks vaguely like a daisy. The animal made foraging journeys in all directions, returning always to a tight cluster of rest sites — a home base — near the center. It brings to mind a geographic profile.

It was easy for Rossmo to jump cut, in the cinema of his mind, from the Serengeti plain to a quiet neighborhood in, say, Oak Park, Illinois. The killer driving past a row of apartment buildings looking for signs — the curtains, the music, the scent of perfume issuing from an open window — that this is the den of a single young female.

The lion migrates to a new area. It hunts down the length of a river course; its cover is the vegetation belt. The killer drives to downtown Chicago. He plies the “trapline” of the entertainment strip; his cover is the crowd.

Rossmo was learning that predators — of whatever stripe — have “mental maps,” an “awareness space” within which is a “focus of activity.” Looters, inner-city gang members and even shoppers are all hunters of a sort, and research has proven their predation patterns to be highly formatted. On the face of it, a psychotic serial killer would seem to be another matter. Someone like Richard Trenton Chase, the “Vampire Killer” who slayed six in Sacramento County in the late 1970s and drank their blood (believing his own blood supply was being siphoned off by aliens) would appear to pose an impossible challenge to a geographic profiler. And yet when Rossmo applied Rigel retroactively to Chase's case, while testing the algorithm for his doctoral thesis, it pegged Chase's home within 1.7 percent of the total hunting area.

A retroactive analysis Rossmo did of data points associated with the 1977-78 Los Angeles “Hillside Strangler” murders revealed similar correlations between the crime-related spots and the daily habits of the two cousins — Angelo Buono and Kenneth Bianchi — who were ultimately convicted of the crimes. “You can see the influence of their non-criminal activities,” Rossmo says. “The encounter sites are closer to their homes than the body-dump sites. And we have a cluster down where Angelo Buono used to go to make out when he was a teenager. I don't think that we've ever had a case where someone wasn't rational geographically.”

Rigel and the Rapist

How an algorithm ended an 11-year crime spree

A computer will never replace a human investigator, but it can help focus the search. In the South Side Rapist case, Kim Rossmo's Rigel program analyzed crime scene locations. His work narrowed the suspect list, which ultimately led to an arrest. Here's how it works.

1) Mark the Crime Sites

Rigel plots the crime scene

2) Mold the Profile

Offenders typically strike in familiar places, moderately close to their home or work, yet leave a "buffer zone" to protect their anonymity. Rigel expresses these tendencies with a probability function. The function decays with distance to reflect the reduced chance the offender lives far from a crime scene, and dips in the middle since offenders rarely live adjacent to the site.

3) Copy and Paste

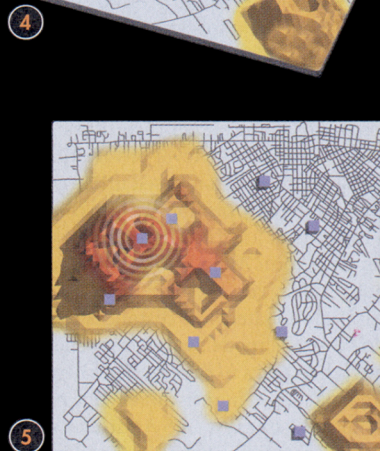
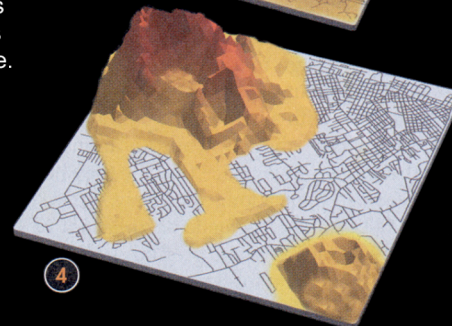
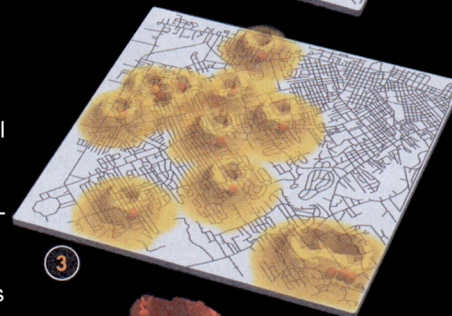
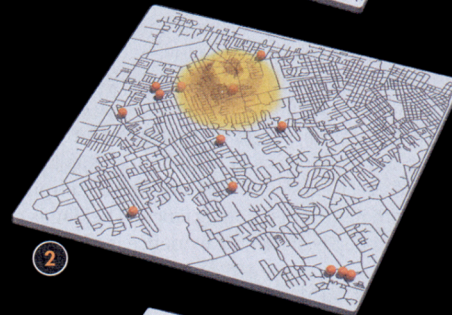
Rigel applies this function to the location of every crime. The profile grows more accurate as sites are added.

4) Sum the Data

By combining all these probability functions, Rigel creates a peaked map that highlights the area where the offender is most likely to live.

5) Overlay the Suspects

Investigators compare a list of suspects' homes and places of work against the probability map, and focus the search on suspects based near the peak of the curve. In this case, the rapist lived in the center of Rossmo's hot zone. He was positively identified using DNA and is now serving 3 consecutive life sentences.



A serial killer is scissored by competing forces whenever he leaves his home to hunt: the desire to remain within a kind of comfort zone and the desire not to be caught. The first force pulls him back home, and the second pushes him away. That relationship, expressed mathematically, is the very heart of Rigel.

What Rossmo hoped to do with his algorithm was to add rigor to the traditionally somewhat “soft” science of profiling, to create something that, once the crime sites were established, leaned more on deduction than induction. (Here’s the difference: When Sherlock Holmes notices that the tips of your fingers are yellow and concludes you are a smoker, he’s being inductive; when he concludes that if you are a smoker you cannot be the killer, because the killer is known to be fatally allergic to cigarette smoke, he is being deductive.)

“Induction is what most science is: You record observations and make generalizations about them,” Rossmo says. “The only true deductive system is mathematics.” You might think of Rossmo out walking his faithful hound, Rigel. Rossmo himself is “soft science” — a sleuth out gathering data from crime sites — while Rigel represents “hard science.” The dog is off like a shot, programmatically, when the evidence is placed under his nose.

ON THE SURFACE, THE BELTWAY SNIPER CASE SEEMED A perfect candidate for geographic profiling, if only by default. Here was a serial killer against whom the arsenal of high-tech forensic tools — the mass spectrometers and gas chromatographs and scanning electron microscopes that can practically pull a DNA sample from an errant thought — appeared useless; whoever it was seemed to glide across the landscape without leaving a trace. What the sniper was leaving, in every pool of blood in every suburban gas station or parking lot, were data points. And Rossmo knew what to do with those.

And yet: Early on in the rampage, Rigel guessed the sniper’s anchor point to be somewhere in the northern suburbs of D.C. (It turned out, in fact, that the killers may have had no anchor point at all.) It’s tough to say whether it hurts or helps Rossmo’s cred to point out that every pseudo-profiler who went on a TV news show with a half-cocked opinion was spectacularly wrong. In any case, though, when an anonymous tip attributed to the snipers gave police the clue they needed, the solution still seemed to be a long way away, buried deep in those 15,000 daily tips and an armada of irrelevant white vans.

“There are instances where profiling will probably be quite helpful, and there are a lot where it doesn’t work at all,” says Keith Harries, a professor of geography at the University of Maryland Baltimore County and a pioneer in “geography of crime” research. “In the sniper case, [Rossmo’s algorithm] was just not able to handle the level of variation in the data.”

As Ned Levine, a Houston-based urban planner who himself developed a geographic profiling model called Crimestat for the National Institute of Justice, points out, the two men arrested in the sniper case, John Allen Muhammad and John Lee Malvo, never kept a home base for long. (They had lived most recently in Washington state.) The distances they traveled were so large as to make the models imprecise. They killed not in areas they knew, but in areas like areas they knew. Which, in increasingly homogeneous America, can encompass quite a lot of real estate. Itinerant assassins like Andrew Cunanan and Aileen Wuornos have resisted accurate geoprofiling. (Evidence shows that U.S. serial killers are almost twice as nomadic as serial killers from elsewhere.) The increasing mobility of offenders and the increasing complexity of travel patterns could, Levine suggests, create ever-larger problems for geoprofilers.

Rigel retails for around \$55,000. Two full years of study directly under Rossmo or someone he has trained are required to use it. That’s why an exclusive club of only seven agents in the world, within the Royal Canadian Mounted Police, the Bureau of Alcohol, Tobacco and Firearms, Scotland Yard and the Ontario Provincial Police force, are certified to handle Rigel. The premise is that, as with fingerprint analysis, the interpretation is only as good as the interpreter. The raw algorithm can be quite far off, but a properly trained profiler can account for vagaries of terrain and travel methods and criminal behavior. That’s the art. And that, Rossmo might say, is what

separates his system from the cruder, plug-in-the-numbers-and-let-rip alternative models that have sprung up since Rossmo's company patented Rigel in 1996.

Rossmo's competitors assert Rigel hasn't yet proven itself. In the long run, they believe, Rossmo's model will reveal itself as no more accurate than their own — indeed no more accurate than straight centrophraphy, the old pushpin method. "The business of the training is a way of making it seem terribly special and exotic, and imply that there are all sorts of skills that they can charge a lot of money for," says David Canter, director of the Center for Investigative Psychology at the University of Liverpool, who sometimes makes his own program, Dragnet, available free to researchers as open-source software. No one has ever done a head-to-head comparison of all the competing models, but, says Levine, "it's certainly overdue."

Rossmo says he can't discuss the Beltway Sniper case in any detail, in part because he doesn't have all the details about the suspects' movements throughout the killing spree. But he is pretty sure that Rigel wasn't as wrong-footed as it appeared. "Based on everything I know, the patterns of their behavior seemed, geographically, to be what we expected. That's all I'll say. I didn't find anything very surprising." In any case, he says, with any methodology there are assumptions and limitations. "I'd say of the requests I've received, 85 percent of the time we could provide some help," he says.

Back in Rossmo's office, the phone rings again: It's a request for him to speak at a university. It's not hard to imagine Rossmo standing in front of the students and driving home a key point: Remember, folks, how probabilities work. Bet with the odds but put a fifty in a coffee can. There are times when insurance companies have to fork out a big settlement. There are days when it does rain in Southern California, and moments when broken clocks tell Greenwich Mean Time. There are stories where the Mounties don't always get their man.

Bruce Grierson lives in Vancouver and has written for numerous publications, including The New York Times Magazine.