UNDERSTANDING THE PRINCIPLES OF TERRORISM RISK MODELING FROM THE ATTACK IN WESTMINSTER

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March 27, 2017

Introduction

On Wednesday afternoon, March 22, Khalid Masood drove a rented Hyundai SUV off the Westminster Bridge Road in Central London, and accelerated at high speed into pedestrians walking across the bridge. Several of them were killed, one was thrown over the bridge, four dozen more were injured, some critically. The compact SUV then crashed into railings outside the Houses of Parliament, whereupon Khalid Masood ran through an open entry gate, and was confronted by an unarmed policeman, PC Keith Palmer, whom he stabbed to death. The terrorist was then shot dead by the bodyguard of the U.K. defense minister.

This was the most serious terrorist attack in U.K. since the London Transport bombings of July 7, 2005. Fifteen years after terrorism risk modeling began after 9/11, it is still suggested that the vagaries of human behavior render terrorism risk modeling an impossible challenge. RMS terrorism risk modeling is unique in being based on solid principles, which are as crucial as the laws of physics are to natural hazard modeling.

I explained these at the annual RMS client conference in New Orleans on March 22, in a talk on terrorist threat shifting. Coincidentally, the terrorist attack in London occurred mid-way during my talk: 2.40:08 pm – 2.41:30 pm London time. I was notified of the attack immediately I finished. The explanations in my talk so matched what transpired that someone suggested I had actually predicted the event. In jest, he advised against making any earthquake predictions. Earthquakes are of course unpredictable. But it is a measure of the sustained progress in terrorism risk modeling, that some degree of predictability is attainable for future terrorist attacks. This is because terrorism is a control process. Unlike natural hazards, which are unrestrainable, western counter-terrorism forces greatly restrict the domain of possible

actions that terrorists can undertake without being arrested. Terrorists can be brought to justice in a way that hurricanes, earthquakes, and floods cannot.

To avoid excessive abstraction, one of the best ways of learning the principles of any subject is through an exposition using illustrative real examples. Not far from Westminster is the British Museum, where the director, Neil MacGregor, has cleverly and succinctly explained the history of the world in 100 objects from the museum. Outside the classroom, the basic principles of hurricane, earthquake and flood risk analysis can be learned and comprehended from the study of any notable event. The purpose of this paper is to explain the basic principles of quantitative terrorism risk modeling, through one specific recent terrorist event. I first did this after the Charlie Hebdo attack in Paris on January 7, 2015, and I am repeating this here after the attack on its sister city of London on March 22, 2017.

Principle A: Terrorist Attacks Leverage Maximum Impact

Terrorism is a form of asymmetric warfare, where terrorist resources are a tiny proportion of those of a nation state. Accordingly, terrorist attacks aim to achieve maximum consequential impact for a finite input allocation of resources. 9/11 itself is the classic paradigm for maximizing attack leverage. According to the 9/11 Commission report, the Al-Qaeda attacks cost between $400,000 and $500,000 to execute. The direct economic losses were about 100,000 times higher. This does not include the $20 billion fall in airline revenue nor the multiple billions of dollars spent on homeland security.

The cost of Khalid Masood renting a Hyundai Tucson from Enterprise Car Rental in Birmingham, and staying overnight at the budget three-star Preston Park Hotel in Brighton, preparing for the attack, was a modest sum of about $200. The two long knives he could have taken from his kitchen drawer. His proficiency with using a knife as an offensive weapon dates back to when he slashed a man's face in a pub, a crime for which he served two years in jail. A later knife assault sent him back to jail for another six-month term.

The direct economic losses, taking account of the four fatalities and serious injuries, are again about 100,000 times higher. The indirect losses in London tourism are likely to be severe, as they have been in Paris, where hotel occupancy was down eight and half percent in the first half of 2016, following the marauding attacks in November 2015. Of those injured by the rampaging vehicle on Westminster Bridge, a sizeable proportion were foreign visitors, attracted to one of the most popular tourist venues in Britain.

Principle B: Terrorism is the Language of being Noticed

It was the British Prime Minister, Margaret Thatcher, that during the 1980s introduced the term "oxygen of publicity" to describe the opportunist use of IRA terrorism to publicize the Irish republican political cause. To maximize the impact of a terrorist attack, a terrorist target should be of sufficient value to western society as to create a large stream of domestic and international

publicity if attacked. The Baltic Exchange building bombed by the IRA in 1992 has been replaced by The Gherkin, now a landmark of the London skyline. Property can be replaced, but people cannot. In keeping with the newspaper adage that "if it bleeds it leads", attacks that cause casualties will be sure to attract widespread media coverage.

Terrorist organizations use such publicity as advertising to inspire their followers around the world, raise funding and enlist new recruits. Impressionable Muslims, marginalized in their home countries, may be enticed by the perceived success of the Jihadi community in promoting Islamist ideals and Sharia Law.

In 2002, Osama Bin Laden wrote in a letter addressed to Taliban leader Mullah Omar:

"The media war in this century is obviously one of the strongest methods; in fact, its ratio may reach 90 percent of the total preparation for the battles."

Three years later, his successor Ayman al-Zawahiri repeated this sentiment, reiterating that Al-Qaeda is in a media battle in a race for the hearts and minds of the Ummah. This is echoed in the more recent pronouncement of ISIS that "*half of Jihad is media"*. As the American writer, Don DeLillo, has astutely remarked, terrorism is the language of being noticed. The whole world has taken notice of the brutal terrorist attack at Westminster, in a way that would not have happened if the attack had taken place in some unrecognized location outside Central London, or had targeted property rather than people.

The RMS terrorism model has used international name recognition as a crucial factor in prioritizing target locations. This is in contrast with the so-called heartland theory, espoused by some terrorism analysts, which hypothesizes that terrorists will target towns in the middle of nowhere so that everyone will be fearful of an attack. This never happened during the IRA campaign on the British mainland, where IRA attacks were heavily concentrated in the major English cities. Terrorists generate greatest media impact by focusing attacks on the key centers of political and economic life.

The terrorist attack on March 22, 2017, was targeted directly at Westminster, the London center of British political power, as well as a major tourist attraction. Khalid Masood lived for some time previously in the south coast town of Eastbourne, and stayed overnight in the neighboring seaside town of Brighton on the eve of his attack. His SUV could have rammed people along the sea front, in the style of the attack in Nice in July 2016. Instead, he drove 50 miles to target Westminster. Terrorist targeting to achieve maximum notice is precise and logical. For the attack on the London Underground on July 7, 2005, Mohammad Sidique Khan and co-conspirators drove 200 miles from the northeast of England. Provincial towns like Leeds, where he lived, are far less noticed than capital cities.

Principle C: Target Substitution Displaces Terrorist Threat

The RMS terrorism risk model was architected to embody the key game theory principle of target substitution: terrorists will attack the softer of two similarly attractive targets. This is equivalent to a basic law of the natural world: predators will seek out weak members of a prey population. Unlike natural hazards, all terrorist targeting is relative, not absolute. The earthquake risk to one building is not dependent on the earthquake risk to a building across town. This may not be true of terrorism.

For example, a change in the security of a hotel across town can affect the threat level at other hotels. For his ambitious post-9/11 bomb plot in London, Dhiren Barot who was convicted in 2006, undertook reconnaissance of a dozen hotels in Central London, looking for security weaknesses. Accordingly, it is not possible to assess the likelihood of one risk being targeted, without taking into account the other risks that might also be targeted. This can bias the unstructured elicitation of target likelihoods from security experts.

This principle of target substitution can explain much about terrorist targeting. On an Amsterdam street in November 2004, the Dutch film-maker, Theo van Gogh, was murdered by Mohammed Bouyeri, a Dutch-Moroccan Islamist. This attack epitomizes the principle of target substitution. Impaled in the chest of Theo van Gogh with a knife was a warning letter - not addressed to him, but to Ayaan Hirsi Ali, the apostate subject of his film "Submission". She had police protection following the publication of her provocative book "Infidel". He declined extra security, and was a soft target for the Islamist assassin.

Aviation will always be a prioritized terrorist target, because a small bomb on board can leverage total destruction of a plane. On October 31, 2015, a Russian Metrojet 9268 was destroyed in this manner. An ISIS communiqué confirms this was a substitute target:

"*And so after having discovered a way to compromise the security at the Sharm el-Sheikh Airport, and resolving to bring down a plane belonging to a nation in the American-led Western coalition, the target was changed to a Russian plane.*"

Before the July 7, 2005 London transport bombings, a counter-terrorism detective at Scotland Yard expressed a view that he would rather that Big Ben were struck than many Londoners were killed on the subway. Almost twelve years later, in the shadow of Big Ben, terrorism struck Westminster; not the Prime Minister or any other politician, but the police and general public who were unfortunate substitute targets. Just as open crowded public places in railway stations, airports and shopping malls are very hard to protect against shooters and back-pack bombers, so streets are very hard to protect against vehicle ramming of pedestrians. Installing bollards on Westminster Bridge would just shift the ramming threat to neighboring streets. Pedestrians will always be soft targets for rampaging vehicles.

Principle D: Terrorists Follow the Path of Least Resistance in Weaponry

The 18th century French savant, Pierre de Maupertuis, can be regarded as one of the fathers of catastrophe risk modeling. He was the first to expound the following principle, which underlies the laws of physics that govern natural hazards. *"The great principle is that in producing its effects, Nature acts always according to the simplest paths."*

This principle applies to terrorism as well: terrorists follow the path of least resistance in their actions. This principle is reflected in military strategy dating back 2,500 years to Sun Tzu's master work, "The Art of War".

Following the path of least resistance means avoiding targets which have very high levels of security, instead seeking out softer targets, and attacking them with tested weapons known to be reliable. The optimal choice of terrorist weapon is one which uses technology already having a successful track record of being deployed by terrorist organizations. Terrorists learn adaptively from each other's experience.

Ever since 9/11, terrorism insurers have been apprehensive about innovation in the terrorist arsenal of attack weapons. All manner of sci-fi, high-tech ideas have been hypothesized as possible terrorist weaponry. But none of these "unknown unknown" weapons have even been close to becoming operational. There has not been a notable chemical terrorist attack since Aum Shinrikyo dispersed sarin gas on the Tokyo subway in 1995, a couple of months after the Kobe earthquake, which this millenarian sect had interpreted as an augury for the coming end of the world. A few years earlier, Aum Shinrikyo had despatched a medical team to the Congo to investigate the weaponization of Ebola, but failed. The development of innovative weapons presents daunting technical challenges, and has an extremely high logistical burden under sustained intense pressure of counter-terrorism surveillance and disruption. Unlike Afghanistan before 9/11, there is no failed state that provides a safe haven for terrorists to experiment on new weapons.

The vehicle bomb has been described as the terrorist's air force because of the scale of its potential impact as an improvised weapon. However, as restrictions on the purchase and manufacture of explosives become tighter, the deployment of vehicle bombs becomes more difficult, especially under an oppressive surveillance and intelligence environment. A shift in the terrorist threat from the use of chemical to kinetic energy follows the path of least resistance. Instead of packing a vehicle with explosives, the vehicle can be driven at high speed into pedestrians. The kinetic energy of a heavy vehicle traveling at high speed is about the same as the chemical energy of a back-pack bomb.

This attack mode was originated in 2008 by Palestinians in Jerusalem. On October 20, 2014, a lone wolf Islamist terrorist, Martin Couture-Rouleau killed one Canadian soldier and injured another in a car ramming incident in French-speaking Quebec. Psychologists suggested his action was a quest for significance. A few months later, on December 21, 2014, vehicle ramming reached mainland France when 13 people were injured during a half-hour van rampage in five locations in Dijon.

Vehicle ramming was taken to the next level in terms of vehicle size when on July 14, 2016, a 19-ton refrigerated truck ploughed into the crowd on the Promenade des Anglais in Nice, killing 86. The death toll would have been higher still if the truck had been allowed to carry on its rampage for a few hundred meters further, into the most crowded part of the beach zone.

A few months after the Nice truck ramming, another Tunisian, 24-year-old Anis Amri, killed 12 people and injured 48 others when he rammed a 40-ton truck into a Christmas market in the German capital Berlin on December 19, 2016. The truck was fortunately halted by its modern automatic braking system, bringing it to a standstill after about 80 meters.

Media coverage can create a copycat spiral. As with crashing aircraft into skyscrapers, crashing vehicles into pedestrians harnesses the power of modern transport technology to cause harm. Khalid Masood's vehicle rampaged along Westminster Bridge, before he completed his attack on foot with two long kitchen knives in hand. In attacking with improvised weapons, he was abiding by the injunction of Abu Hamza, radical imam of the notorious Finsbury Park mosque in London, which schooled and gave refuge to a generation of terrorists:

"You can't do it by nuclear weapon, you do it by the kitchen knife, no other solution. You cannot do it by chemical weapons, you have to do it by mice poison."

This is an explicit embodiment of the adaptive principle that terrorists should follow the path of least resistance in weaponry.

Principle E: Too Many Terrorists Spoil the Plot

Spectacular terror attacks require diligent planning, reconnaissance and attack preparation, and a number of trained operatives - the more ambitious and extensive a terrorist plot is, the more operatives are needed. No person lives in complete isolation; every human being has his or her own social network. Social networks are amenable to a substantial degree of analytical characterization, providing a sufficient window on terrorist cell contacts for most plots to be interdicted. The various links between members of a social network provide key insight into the involvement of an individual in a terrorist plot. The singular achievement of the Western security services in interdicting more than 80 percent of significant plots since 9/11 is evidence of their command of terrorist communications networks.

Terrorist social network analysis by RMS in 2010 has shown that the likelihood of a plot being interdicted increases with the number of operatives as indicated in the table below:

Cell Size	1	2	3	4	5	6	7	8	9	10
Interdiction Probability	0.26	0.46	0.60	0.70	0.78	0.84	0.88	0.91	0.93	0.95

Highly elaborate ambitious plots capable of inflicting catastrophic insurance loss would typically involve so many operatives as to have a very high likelihood of interdiction. This would be wasteful of terrorist resources. Discouragement of Jihadi plots involving double-digit operative numbers came from Osama bin Laden himself in a message from his Abbottabad hideout in Pakistan: *"For a large operation against the U.S., pick a number of brothers not to exceed ten."* The more operatives there are, the greater is the chance that one of them will compromise the terrorist venture: too many terrorists spoil the plot.

Whereas a vehicle bomb would require a number of skilled and experienced operatives to enable a successful attack to be launched with confidence in its reliability and effectiveness, a vehicle ramming plot requires only a licensed driver: no experience or training are required. There is no need for operatives to procure and store explosive material or carry out target reconnaissance. Nor are the specialist skills of a bomb-making expert required. Khalid Masood was apparently good at chemistry at school, so might have been amenable to executing a bomb plot, if this had been a viable option.

With most terrorist attacks, some links with a terrorist organizational hierarchy may exist, but these would lack the intelligence communications detectability of links between operatives, and so do not figure in the probabilistic interdiction analysis. Acting as a lone operative, a terrorist can still expose an emerging plot through unwitting communication with others in his or her social network. Individuals vary in the extent of their personal social networks. In recent times, Khalid Masood appears to have been rather isolated within the Muslim community. Thus, he would have been less susceptible to plot compromise through a Muslim informant acting for British security service MI5, or through communication with Muslims on the currently active MI5 watch-list of persons of interest. But then he did not need psychological or logistical support from anyone. His Muslim faith he displayed openly in his traditional Muslim dress, and he had enough practical experience to have taught knife attack technique.

As its self-declared caliphate has shrunk, ISIS has increasingly emphasized the significance of its Western supporters carrying out attacks at home rather than traveling to the caliphate. In May 2016, Abu Muhammad al-Adnani, a close aide of the ISIS leader said lone actor attacks in the U.S. and Europe were dearer to ISIS than the biggest action in Iraq and Syria. No wonder that ISIS promptly claimed Khalid Masood as a soldier of the Islamic State, who had carried out his operation in response to appeals to attack Western powers, like the U.K., involved in military operations in the Middle East. He had no need of any logistical assistance from this terrorist organization. He needed no training for vehicle ramming or handling a blade, and the minimal cost of the operation could have come from the proceeds of his social security benefit fraud.

Principle F: Terrorism is a Thinking Man's Game

Co-founder of the Popular Front for the Liberation of Palestine, Dr. George Habash, realized the importance of smart thinking in an asymmetric war:

"This is a thinking man's game. Especially when one is as poor as the Popular Front is. It would be silly for us to even think of waging a regular war."

This is mirrored by the reckoning of the IRA campaign in Ulster that terrorists are out-thought rather than out-fought. Terrorists need to be smart to coerce nation states to change their policies.

Khalid Masood, who had been regarded as bright at school, and did crossword puzzles, was smart enough to devise a highly effective attack plan to optimize media coverage, cause numerous casualties, and create widespread fear amongst Londoners. Westminster Bridge is the busiest tourist thoroughfare in Britain, connecting Parliament Square and Westminster Abbey with the London Eye and other South Bank attractions. Pedestrians on Westminster Bridge had no escape route from the oncoming speeding SUV. On one side, there was the river; on the other was heavy traffic. One pedestrian was thrown over the bridge into the river, where she was pulled out unconscious but alive. Another was thrown under a bus, where she was killed. The pedestrian death toll could have been an order of magnitude higher.

As he passed the entry gate into Parliament brandishing two large knives, Khalid Masood would have known he would not come out alive, but might have hoped to inflict harm on a senior politician. Indeed, had he not been shot, he might have gotten close to the Prime Minister, as she was rushed back to 10 Downing Street.

It is a common perception that terrorists who seek to die in the course of their operations are crazy or irrational. Such a perception is a form of mind blindness – failing to understand the mindset of others. The 17th century French philosopher Pascal proposed an argument, known as "Pascal's Wager", to justify sacrifice in the service of God. The probability that God exists is neither zero nor unity. Hence if the reward for sacrifice is everlasting paradise, as Jihadis are convinced, then the expected benefit, (i.e. the product of reward and likelihood), is infinite. As a Muslim convert, Khalid Masood would have been assured that a benefit of converting to Islam is that God promises paradise to the believer. Furthermore, as a Shaheed or martyr, he would have been granted seven special favors from Allah, the first being that his sins would be forgiven. For a devout Muslim who had led a profligate life as a youth, the expiation of his sins through martyrdom may have weighed on his mind.

We will never know his thoughts as he rented the Hyundai SUV in Birmingham, where he lived, or as he checked out of the small hotel in Brighton, before he embarked on his final journey to London. But he must have done a lot of thinking to have pulled off the most significant U.K. terrorist attack in a decade - terrorism is a thinking man's game.

He is known to have had a very violent criminal past, involving time in jail, where he may have become radicalized. He came under MI5 scrutiny for the first time in 2010, after he returned from Saudi Arabia, ostensibly teaching English there. A penchant for knife crime, a violent

temperament, and a belief in an extreme version of Islam, set him up for terrorism. In the persuasive words of an ISIS recruitment slogan: everyone has to die, why not die a martyr? With dangerous Muslim criminals being radicalized in western jails, many of whom, like Khalid Masood, are born and raised in democratic western countries, Islamist terrorism will not be eradicated from the face of the Earth, despite President Trump's inauguration pledge and efforts to restrict Muslim entry to the USA. What happened on the streets of London could happen on the streets of New York or Washington, D.C.

Principle G: Terrorism Insurance is Effectively Insurance Against the Failure of Counter-Terrorism

Whatever the behavior of terrorists, it is the responsibility of a counter-terrorism organization to maintain vigilance to detect plots as they form, and to break up plots before terrorists move towards their targets in readiness to strike. Intelligence officers cannot read human minds, but they hire informants, and they can track communications and online activities, albeit at the societal cost of infringement of civil liberties. The astonishing mass surveillance revelations of the ex-CIA whistle-blower Edward Snowden have come as no surprise to those who have analyzed the contact-chaining process by which the security services of the Western alliance have managed very capably to control terrorism since 9/11. The global geographical extent of the surveillance is made possible through the international collaboration of intelligence communication agencies, notably between NSA in the USA and GCHQ in the U.K.

Since 9/11, the vast majority of major terrorist plots in North America, Western Europe and Australia have been interdicted. The Five Eyes English-speaking intelligence alliance of the USA, U.K., Canada, Australia, and New Zealand is extremely well funded and effective. Of those plots that are not interdicted, a proportion fail for technical reasons. Both the December 2001 aviation shoe and December 2009 underwear bombs failed technically, as did the London subway bombs of July 21, 2005, and the propane gas vehicle bombs in London in June 2007 and in Times Square, New York in May 2010. An important lesson to be gained from an analysis of the dozens of ambitious terrorist plots against the western alliance since 9/11 is the game theory observation that terrorism is as much about counter-terrorism response as about terrorist actions. A corollary is that terrorism insurance in the Western alliance is effectively insurance against failure of counter-terrorism.

This perspective on the nature of terrorism insurance risk is reinforced further by the following observation. Of the small number of plots that evaded interdiction and were technically successful, one or more of the operatives have often been known to the security services. This was the case with the July 7, 2005 London bombings, the April 15, 2013 Boston marathon bombings, the murder of British Army Fusilier Lee Rigby on May 22, 2013, the 2015 Paris attacks, and now also the Westminster attack of March 22, 2017.

It turns out that Khalid Masood had been a peripheral figure in relation to suspected Islamist terror threats. He lived for a while in Luton, some 30 miles from London, at a time when the banned al-Muhajiroun group, led by the radical Islamist Anjem Choudary, was active in

promoting extremist views, and supporting political violence. Masood was regarded as a subject of interest because he was loosely connected to people under investigation by the security services. For example, MI5 found that he was on the periphery of a plot to blow up an army base in Luton using a remote-control car. Also, when he was living in Luton, he became close friends with Iraqi-born Swedish citizen, Taimour Abdulwahab al-Abdaly, an Islamist extremist who blew up his car, then himself, in Stockholm, on December 11, 2010.

However, Khalid Masood was not named on an official list of 2,000 extremists at the time. Indeed, prior to the 2012 London Olympics, he was excluded from MI5's list of subjects of interest. His middle age may have been a factor: he was aged 52 at the time of the Westminster attack. But he was an active body-builder and was physically extremely fit. This is clear from his ability to sprint 150 yards, from where his SUV crashed, to the Parliament entry gate, and then stab PC Palmer through a protective vest. In profiling potential terrorist suspects, physical fitness should be taken into account. There is no retirement age for fit terrorists.

Khalid Masood had a lengthy criminal record, which is quite common with Jihadis, and hence was well known to the U.K. police. In Germany, two-thirds of foreign fighters have had criminal records and more than half of those from Belgium and the Netherlands had a similar background. Anis Amri, the Tunisian truck rammer in Berlin had convictions for theft and violence. Among the November 13, 2015 Paris terrorists, a number had previous convictions for robberies and drug dealing.

More than a thousand known extremists are currently jailed in U.K. Counter-terrorism officers can have as many as forty investigations running at any one time. Inevitably, this means they have to prioritize whom to watch. Clearly, this prioritization may allow some terrorists to slip through the counter-terrorism net. Whilst this poses a public safety issue, tightening of the counter-terrorism net might involve unacceptably draconian espionage measures such as deployed ruthlessly by the Stazi in the East German police state. The balance between preservation of civil liberties and security inevitably means acceptance of some residual risk. The occasional lapse in counter-terrorism is effectively what terrorism insurance is covering.

Principle H: Counterfactual Analysis Matters

Ever since 9/11, it has been evident that new types of lateral thinking are required for terrorism risk analysis. A key contribution comes from counterfactual analysis of the past. The American writer, Mark Twain, remarked, *'History doesn't repeat itself, but it does rhyme'*. Most events have either happened before, nearly happened before, or might have happened before. Conceptually, the historical past has a dense labyrinthine event-tree structure, and the domain of future possibility is mostly spanned by history, its perturbations, and variants. Yet, the past is typically perceived in a fatalistic way somehow as having been inevitable.

Counterfactual thinking sparks terrorist innovation. On October 31, 1999, an EgyptAir pilot, Gameel El-Batouty, flying out of JFK airport in New York to Cairo shut down the engines and crashed his plane into the Atlantic Ocean. What else might have happened to Egyptair 990?

Counterfactually, the passenger jet could have been deliberately crashed into a Manhattan skyscraper. This may appear fanciful, but a terrorist mastermind had such a counterfactual thought: Osama bin Laden. Less than two years later, the World Trade Center Twin Towers were struck by passenger jets.

Substituting New York for Paris, a deliberate terrorist plane crash into an iconic western structure almost happened six years before 9/11, when terrorists hijacked Air France AF8969 at Algiers airport on December 24, 1994. Fortunately, the French authorities had an informant within the Algerian terrorist organization, GIA. Warned of the true intent of the hijackers to crash the plane into the Eiffel Tower, the French authorities despatched commandos to storm the plane whilst refueling in Marseilles.

The South of France features in the next paradigm of terrorist counterfactual thinking. On New Year's Eve 2015, a car driver apparently under the influence of drink lost control, left the road, and hit a restaurant terrace in Nice. This accident, which claimed the life of a dog and injured a customer, was reported in the local *Nice Matin* newspaper. This unassuming article was kept on the cell phone of Tunisian Mohamed Lahouaiej-Bouhlel. But for what purpose? The Tunisian terrorist reasoned counterfactually that the accident in Nice on an evening of celebration could be repeated as a deliberate malicious act of political violence. This took place on the Promenade des Anglais during the next major public French festival: Bastille Day in 2016.

Whenever a surprising event occurs, questions are asked how it might have been anticipated, and the risk mitigated. It is unusual for questions to be asked how the event might have been worse. To ponder what would have happened if things had turned for the worse is called by psychologists a *downward counterfactual*. By contrast, an *upward counterfactual* considers what would have happened if things had been better. It is a facet of human nature that upward counterfactual thoughts are much more common than downward ones.

In the construction of stochastic event sets for terrorism risk modeling, maximum use needs to be made of the historical record of terrorist plots, few of which in the Western alliance turn out to be successful. Consider the scenario of aircraft impact. Although there has yet to be a successful terrorist aircraft attack on an iconic U.K. building, in 2003, terrorists planned to hijack a plane at London's Heathrow airport, stun the crew, and fly the plane into the Canada Tower in the London Docklands financial district. Plot details were found on a computer of an Al-Qaeda operative seized in Lahore in Pakistan. Furthermore, the Al-Qaeda training manual includes a specific threat against Big Ben, the iconic clock tower at Westminster.

According to the principle of following the path of least resistance in weaponry, the threat to Westminster has shifted from aircraft impact to vehicle impact. We know what happened as a result of Khalid Masood's attack, but what are the downward counterfactuals? This is a question which should be asked of any significant hazard event, either natural or man-made.

Of the terrorist plots that MI5 managed to interdict in the period leading up to the Westminster attack, some involved firearms. The large, popular Westfield shopping mall in West London has been identified as one possible crowded target. Since the Mumbai multiple shooter attacks

of November 26, 2008, there have been Islamist terrorist threats of repetition in Europe. The U.K. security service has been alert to the style of armed attack that struck Paris in January and November 2015, and British Jihadis returning from fighting for ISIS in Syria are known to be trained in firearm usage.

With the open border between Belgium and France, weapons are readily transported to France from Belgium, which is a hub of the illicit trade in AK47s and other light military weapons. The Kouachi brothers assassinated the committee of the Charlie Hebdo satirical magazine on January 7, 2015 using AK47s. Counterfactually, if Khalid Masood had an AK47 in his SUV, rather than just a pair of long kitchen knives, his intrusion into the Palace of Westminster might have been deep enough to pose a serious threat to members of Parliament. Furthermore, if he had a similarly-armed accomplice, then, like the Kouachi brothers in Paris, they could have caused deadly mayhem in and around Parliament. However, given the past MI5 file on Khalid Masood, either of these counterfactuals would have had him back on MI5 radar.

The seriousness of the Westminster terrorist attack on March 22, 2017 is not measured only by what the actual loss turned out to be, but what might well have happened. Such thinking will help reduce future terrorist surprise. Following the November 13, 2015 multiple Paris attacks, magazine Charlie Hebdo commented that the brain is the best counter-terrorism weapon. The brain is also the best tool for terrorism insurance risk analysis, and counterfactual thinking is an essential part of the armory.