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IMPROVISED EXPLOSIVE DEVICES

The Paradigmatic Weapon of New Wars

James Revill

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About the Author

James Revill is a Research Fellow with the Harvard Sussex Program, Science Policy Research Unit (SPRU), University of Sussex. Over the course of completing his PhD on the evolution of the Biological Weapons Convention with the University of Bradford, he worked as a consultant to the United Nations Institute for Disarmament Research and completed research fellowships with the Landau Network Centro Volta in Italy and the Bradford Disarmament Research Centre in the UK. Revill's research interests focus on the interplay between science and security.

Introduction

In the early twenty-first century, improvised explosive devices (IEDs) are most commonly associated with non-state actors, particularly violent extremists and insurgents who have employed IEDs of varying kinds in Afghanistan and Iraq with great "success". Indeed, as a result of a combination of social and technological factors, IEDs can be considered as the paradigmatic artefact of what Kaldor has termed the "New Wars".[1] Yet the use of IEDs is not—and has not been—constrained to the New Wars landscape. On the contrary, since the gunpowder revolution in the sixteenth century, different forms of IEDs have been used by a number of different actors to various ends. The current focus on IEDs masks a long history of IEDs being used in conflict by both non-state *and* state actors, for a variety of reasons.

This long history can provide important insights into the phenomenon of IEDs. The purpose of this Palgrave Pivot is, therefore, to excavate the past history of IED development and deployment and explore a number of key questions, such as what perceived utility did IEDs offer to different users; what pathways towards IED development and deployment have been taken and why; how have such pathways changed over time and in response to wider developments in different technologies; what sources of information informed the development of IEDs; and how were normative/ethical issues surrounding the use of improvised explosive weapons dealt with by different actors.

To achieve this, the Pivot begins with a definition of IEDs that attempts to bind the concept of IEDs, before proceeding to outline the methods and ethical issues presented in the process of researching and writing

about this sensitive topic. The text is then divided into two sections: The first is primarily historical and seeks to provide detail and data pertaining to salient episodes, or micro case studies, of IED use. The second seeks to both identify trends and themes from the historical analysis and explore the strategic governance of IEDs.

Accordingly, the first chapter traces the evolution of IEDs, broadly understood, from the emergence of gunpowder as a tool in warfare in China, through the "gunpowder revolution" during the fifteenth and sixteenth centuries, to the early use of improvised devices in, inter alia, the Crimean conflict and the American Civil War. This is followed in the second chapter with an outline of the emergence of dynamite terrorism over the course of the fin de siècle, paying particular attention to three groups: the Russian *Narodnaya Volya* group, extreme Irish nationalists, and European Anarchists. The third chapter focuses on the use of IEDs in the twentieth century, paying particular attention to five sets of actors: the Mujahedeen in Afghanistan; the Irish Republican Army; violent Middle Eastern extremist groups, including Hezbollah and the Popular Front for the Liberation of Palestine–General Command (PFLP-GC); the Liberation Tigers of Tamil Eelam (LTTE); and the use of IEDs by state actors over the course of the twentieth century. The fourth chapter looks at the role of IEDs in New Wars. It begins by outlining what is meant by New Wars, drawing on the work of Kaldor. It then proceeds to look at how and why different pathways to IED development and deployment have been pursued, paying particular attention to the use of IEDs in Afghanistan, Iraq, and Syria, along with other salient examples from other countries across the globe.

The fifth chapter draws together the micro case studies outlined in the previous chapters using literature from scholars of innovation, such as Everett Rogers, to develop a number of trends and themes in IED development and deployment. Specifically, it draws attention to the relative advantage calculus in IED innovations; the problems posed by the complexity of some IED technologies; the importance of compatibility of IEDs with both the norms and contexts of different groups; the significance of "trialability" in IED development and deployment; and the role of observability in influencing the diffusion of IED technology. In the final chapter, the IED governance regime and its limitations are laid out, drawing on the concept of a "web of prevention" to illustrate the various component parts that form the architecture for the strategic governance of IEDs.

In the concluding section, the text outlines how IEDs have become the paradigmatic weapons of New Wars, not because of any single technological change but rather a combination of incremental technological advances in a number of areas that have become much more readily accessible *and* broader changes in the security landscape that have shaped and been shaped by IED use. The conclusion further outlines some thoughts on the future of IEDs and the role of various actors in shaping such a future.

Defining IEDs

The term "improvised explosive device" is a relatively new addition to the modern-day lexicon.[2] There are several early references to "improvised explosives", including an article on "Backyard Explosives" in the November 1964 edition of *Police*, suggesting "improvised explosives are readily available in nearly every hobby shop or local hardware store".[3] However, the term "improvised explosive devices" appears to have emerged in the 1970s with early references to an "Improvised Explosive Devices School" evident in US Foreign Policy cables held in the US National Archives dated from March 1973,[4] and later a reference to an "Improvised Explosive Device" evident in a patented "Container for explosive device", filed in 1976, which stated, "Various bomb containers have been developed and used for carrying an IED or homemade bomb to a safe disposal area".[5] Yet, as subsequent sections illustrate, IEDs have a long history in which they have variously been labelled "mines", "backyard", "explosives", "subterras", "torpedoes", "infernal machines", "improvised sabotage munitions", or simply referred to as bombs.

In contemporary discourse, the IED label remains disparately conceptualised with significant differences in definitions depending on whether the focus is on "components, mode of delivery, initiation type, perpetrator identity, ingredient type, [or] what it is they are ultimately designed to do and also what it is that 'improvised' actually refers to".[6] The "perpetrator identity" factor is particularly salient in certain discourses surrounding IEDs in which the term sometimes appears as "a trendy new buzzword covering every type of bombing carried out by guerrillas, insurgents, irregulars, and terrorists".[7] For example, a joint Department of Homeland Security (DHS) and US National Academy of Engineering (NAE) definition describes IEDs as "the use of a homemade bomb and/or destructive device to destroy, incapacitate, harass, or distract. IEDs are used by

criminals, vandals, terrorists, suicide bombers, and insurgents"[8]; whereas the New York City Police Department defined IEDs as "conventional explosive devices used in terrorist attacks on buildings".[9]

Clearly, such definitions are written for a specific purpose and context in which they may have value; however, this narrow approach is not helpful in a broader appraisal of IEDs, which have been widely used by a number of different agencies—including state actors—over time, for a number of reasons and against a number of different targets. Accordingly, for the purpose of this Pivot, a broader definition is proposed in order to allow a more comprehensive exploration of the concept. Thus, this text draws upon the definition developed by Gill, Horgan & Lovelace and proposes:

> An explosive device is considered an IED when any or all of the following— explosive ingredient, initiation, triggering or detonation mechanism, delivery system—is modified in any respect from its original expressed or intended function. An IED's components may incorporate any or all of military grade munitions, commercial explosives or homemade explosives. The components and device design may vary in sophistication from simple to complex and IEDs can be used by a variety of both state and non-state actors. Non-state actors can include (but not be limited to) terrorists, insurgents, drug traffickers, criminals and nuisance pranksters.[10]

This definition is more consistent with that of the United Nations International Ammunition Technical Guidelines (IATG) in that it avoids defining IEDs in relation to non-state actors. Moreover, it usefully allows for the distinction between IEDs, including those sophisticated devices produced on a significant scale in countries, such as Iraq, on the one hand, and, on the other hand, the early systematic mass-produced land and sea mines that emerged from the Crimean War. As such Gill, Horgan & Lovelace provide a useful functional definition, although it is recognised that this—and indeed any definition of an IED—is ultimately going to be problematic as a scientific or academic concept with the term "improvised" particularly troublesome, inferring as it does, that such explosive devices are somehow "makeshift" or "underprepared", when in many cases they are not. Indeed, as Bale has suggested, the term IED perhaps does not really "add any precision or 'scientific' value to earlier ways of describing or characterizing such devices or attacks".[11]

The diverse array of IEDs and the range of delivery mechanisms and components that can be employed further limit scientific definitions. At its

most simple, however, contemporary IEDs can generally be broken down into five key components: a switch with which to trigger the device, a power source (i.e. some means of storing and releasing "electrical, mechanical or chemical energy to initiate an IED"), an initiator (i.e. some means of initiating the detonation of the main charge), a compartment or container, and an explosive charge.[12] There are various forms of explosive ingredients that can be used as the explosive charge, ranging from home-made explosives to commercial explosives, such as those used in mining, through to military explosives. There are, furthermore, a number of switch or trigger mechanisms ranging from victim-operated devices, time delay-triggered IEDs, to remotely triggered weapons. Finally, there remains a diverse array of delivery systems from vehicle-borne IEDs (VBIEDs; e.g. car bombs), to sea-borne IEDs (e.g. fire ships and submersibles), to air-dropped devices, to animal or human body-borne IEDs (e.g. suicide bombs or body cavity bombs), to roadside bombs and booby traps. Indeed, as subsequent sections illustrate, IEDs are diverse in design, and there is a multitude of routes or pathways to IED development against a diverse array of targets and to achieve a number of tactical and even strategic objectives.

This is not to suggest anything potentially explosive or fire producing falls within the rubric of an IED. An incendiary device, that is, a weapon employing combustible or flammable materials primarily designed to utilise fire and flame to destroy property or individuals, such as Molotov cocktails, is treated as distinct from *explosive* devices for the purposes of this text, although in other definitions such as those of The North Atlantic Treaty Organization (NATO), incendiary properties are included. Although they are touched upon in the first chapter in order to provide context for the early improvised use of explosives, incendiary weapons are not discussed further. Nor does the deliberate flying of planes into towers constitute an IED, although the employment of IEDs to destroy planes—which could subsequently cause harm on the ground—would constitute an IED.

A Note on Methods and Morals

This Pivot is based on open source materials available online or in hard copy. It contains no sensitive, "classified", or otherwise secret information that is not already publicly available in the open literature.

The text has been developed through an organic process of reading around the literature on selected vignettes or "micro-case studies" in

the history of IED development and deployment and teasing out certain themes and trends related to "the who, the what, the why and the how" of key phases in the evolution of IEDs. As such, this Pivot is driven less by the application of any form of established theoretical framework—although it draws on several—and, instead, reflects an approach in which a theoretical framework is found to fit the history, rather than the other way around.

It is argued that such an approach is important because, despite the significance of IEDs in contemporary conflicts, there remains a dearth of publicly available scholarship on this topic with few attempts to make sense of open source data on multiple IED campaigns or events over the course of history. There are, of course, several valuable sources on specific events or phases in the evolution of IEDs, and valuable academic research has been conducted on specific aspects of IEDs.[13] Moreover, it would be remarkable indeed if governmental departments around the world had not given such weapons significant attention. Yet, there is less evidence of attempts within the academic literature to draw together multiple events over the course of the last couple of centuries, and to seek to identify wider themes and trends, which could inform contemporary thinking about IEDs.

This can perhaps be accounted for by the opprobrium allotted to the study of military technology by some scholars. Certainly, Roland has stated there is "an aversion in scholarly circles to things military. This tendency is not peculiar to the history of technology; it is pervasive. Many scholars simply find war and its associated activities distasteful".[14] Although this may be an overstatement given the—albeit relatively small—number of academic institutions looking at weapons technologies, there are also practical reasons for avoiding military technology. One key reason being that through the process of collecting and collating information and then analysing certain phenomenon, such as IEDs, one runs the risk of potentially glamorising either the weapons or perpetrators, or worse still providing a broader audience with both the means and the motive to pursue such weapons.

As such, in writing this text, a conscious effort has been made to avoid either any focus on the details of contemporary bomb designs that could inform aspiring contemporary bomb makers or the glorification of IED innovation. Remarkable innovation is, however, acknowledged in the small number of cases where it is necessary if only to juxtapose this with a much greater number of categorical failures evident over the course of history. Moreover, obloquy or not, it is argued that an interdisciplinary

appreciation of IEDs, which draws on historical record, aspects of science & technology studies, psychology, and elements of security scholarship, remains important. In part, because of the richness of the field as an area of scholarship, but also, firstly, because of the normative role—perhaps obligation—of academics to explore the history in order to avoid skewed narratives which forget inconvenient truths and, secondly, because of the potential contribution of interdisciplinary studies in understanding security problems and perhaps even contributing to their mitigation. It is hoped this short text might make a small contribution to the mitigation of a darker IED future.

Notes

1. Kaldor, Mary. 2013. "In Defence of New Wars." Stability 2 (1): 1–16.
2. Gill, P, J Horgan, and J Lovelace. 2011. "Improvised Explosive Device: The Problem of Definition." Studies in Conflict and Terrorism 34 (9): 732–48. doi:10.1080/1057610X.2011.594946. Pg 733.
3. Lenz, R. R. 1964. "Backyard Explosives." Police: The Journal Covering the Professional Interests of All Law Enforcement Personnel 9 (2 (November/December).
4. US Department of State. 1973. "Protective Security Khartoum." Washington DC: U.S. National Archives and Records Administration. https://aad.archives.gov/aad/createpdf?rid=77268&dt=2472&dl=1345
5. Hickerson, Frederick R. 1977. "Container for Explosive Device", United States Patent 4,027,601.
6. For a useful discussion on IED definitions, see: Gill, Horgan & Lovelace, J. Improvised Explosive Device: The Problem of Definition.
7. See: Bale, Jeffrey M. 2012. "Jihadist Cells and 'IED' Capabilities in Europe: Assessing the Present and Future Threat to the West." doi:1-58487-554-2. Pg 4.
8. The National Academies [US], and Department of Homeland Security [US]. 2012. "IED Attack – Improvised Explosive Devices, Fact Sheet." https://www.dhs.gov/xlibrary/assets/prep_ied_fact_sheet.pdf
9. New York City Police Department. (2009). Engineering Security: Protective Design for High Risk Buildings. Retrieved from http://www.cs.auckland.ac.nz/~pgut001/pubs/book.pdf. Pg 11.
10. Gill, Horgan & Lovelace, J. Improvised Explosive Device. Pg 742.
11. Bale 2012. "Jihadist Cells and 'IED' Capabilities in Europe". Pg 5.
12. See: Wilkinson, Adrian, James Bevan, and Ian Biddle. 2007. "Improvised Explosive Devices (IEDs): An Introduction." In Conventional Ammunition in Surplus, edited by James Bevan, 136–44. Geneva: Small Arms Survey,

Graduate Institute of International Studies; UNIDIR. 2015. "Addressing Improvised Explosive Devices – Options and Opportunities to Better Utilize UN Processes and Actors." UNIDIR Resources, Pg 15.

13. See for example: Bale 2012. "Jihadist Cells and 'IED' Capabilities in Europe"; Jensen, Richard. 2004. "Daggers, Rifles and Dynamite: Anarchist Terrorism in Nineteenth Century Europe." Terrorism and Political Violence 16 (1): 116–53.
14. Roland, Alex. 1995. "Science, Technology, and War." Technology and Culture 36 (2).

CHAPTER 1

From the Gunpowder Revolution to Dynamite Terrorism

Abstract This chapter provides a short history of the early use of explosives in warfare beginning with the emergence of gunpowder and moving to the employment of dynamite, paying particular attention to the evolution of early improvised explosive devices (IEDs) in the USA and Crimea.

Keywords Gunpowder • Dynamite • Torpedoes • American Civil War • Crimea

The use of fire or flame in warfare dates back to ancient times, with early accounts of the use of fire weapons in the Vedic Indian literature[1] and later records describing the use of flaming hemp arrows by the Persians in 480 BCE.[2] However, it was in 673 AD that "incendiaries entered a new phase" with the employment of "Greek Fire" as an early form of "flame thrower" by the Byzantine Empire.[3] The details of Greek Fire remained a closely guarded secret which was subject to the official secrets act of the time; however, it is understood to have been primarily composed of Naphtha[4] and argued to have contributed to the "successful defence, against attacks from all quarters, for the next 800 years".[5] Certainly, Mayor describes Greek Fire as the "ultimate weapon of its time";[6] and Partington describes Greek Fire as being regarded as an "old fashioned atomic bomb".[7] Such was the horror generated by Greek Fire that European leaders eschewed such incendiaries as a tool in warfare, prohibiting their use against humans

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as part of an agreement emerging from the Second Lateran Council in 1139,[8] which was largely respected until the early twentieth century.

Over time, Greek Fire became replaced by gunpowder, the exact origins of which remain unknown,[9] although it is widely understood to have been produced in China by the mid-ninth century AD, where its earliest use was in fireworks and incendiary weapons. Indeed, Joseph Needham's seminal study of *Science and Civilization in China* suggests that low-nitrate gunpowder compositions intended to generate fire and flame rather than explosions predominated in the early military uses of gunpowder, where it was used as an incendiary in projectiles, such as *yao chien*: gunpowder carrying arrows, and *huo phao*: fire bombs hurled by trebuchets, which were designed with barbed hooks to attach the incendiary device to wooden structures or ship sails.[10] According to Needham, the first use of brisant high-nitrate gunpowder to generate explosions occurred with the "thunderclap bomb", which "became characteristic of the conflicts of the +12 century".[11] The effect of such weapons was more likely to have been psychological than physical; the gunpowder contained within a bamboo casing would have made a loud noise upon detonation, but had limited casualty causing explosive force. Nevertheless, some accounts suggest that the sound of the bombs was not militarily insignificant, with reports of the explosions causing confusion and panic amongst troops and horses.[12]

By the thirteenth century, however, Needham suggests that brisant high-nitrate gunpowder was more commonly encased in iron to generate what are translated as "heaven shaking thunder crash bombs", which appear to have been used in naval and land warfare with devastating effect.[13] Over the course of the thirteenth century, the size of weapons grew steadily and diversified with the emergence of several forms of early land mine evident in the Chinese literature, including the "invincible ground thunder mine", "self-trespassing mine", and the "stone-cut explosive land mine".[14] These early forms of improvised explosive devices (IEDs) were remarkable not only for their innovative employment of high-nitrate gunpowder, but also for the development of early improvised trigger mechanisms (albeit of dubious efficacy), with evidence of a form of victim-operated mine using flint and steel igniters dating back to the mid-fourteenth century.[15]

Gunpowder Goes West

Gunpowder is believed to have been introduced to Europe by Arab traders around 1240,[16] with the first written European record of gunpowder appearing in the 1267 treatise of Roger Bacon.[17] Accounts of the first use of gunpowder in European conflicts vary: Some commentators have suggested that gunpowder was used in Europe for the first time in 1262 in the siege of the city of Niebla, Spain.[18] However, according to Brown, the first use of a form of explosive rocket device in warfare in the West occurred in the siege of Chioggia in 1380, and subsequently a number of gunpowder rockets emerged as an early and primitive alternative to trebuchets.[19] Over time, gunpowder slowly became integrated into more and more state arsenals, to the extent that "by the fifteenth century, gunpowder was changing the relationship in the West between technology, the state, and war",[20] and generating what some have termed a "military revolution" over the course of the fifteenth and sixteenth centuries[21] with the emergence of early cannons, primitive portable firearms, mines, and military demolition technology.

Regarding mines, Mariano Taccola's text *De Machinis* from circa 1430 provides drawings of a "gunpowder mine" designed for deployment in attacks on castles[22]; however, the notion of mines did not gain significant traction until later with the work of the French Marshal, Sébastien Le Prestre de Vauban, who is of particular note for his pioneering use of explosives in both offence and defence during siege warfare, including through the development of early forms of mines.[23] The use of gunpowder in devices that were arguably "improvised" became prominent in a number of conflicts. Examples include events such as the, albeit contested, reported use of (counter) mines in the defence of Belgrade in 1439[24]; the employment of explosive mines by Pedro Navarro, a Spanish military engineer, in the destruction of the castle of Uovo in 1503[25]; the destruction of the fortress of Godesberg and garrison in Kameyana in Japan in 1583[26]; and the use of demolition mining in the wars of Dutch independence,[27] providing observable demonstrations of the potential of explosives in warfare.

Beyond cannons, firearms, and mines, gunpowder was also innovatively used from an early stage in a variety of early ship-borne IEDs and other devices, frequently drawn from contemporaneous developments in fields, such as clock-making, milling, gun-making, and precision engineering techniques.[28] Over time, such ideas began to spread into both the

imagination and armamentarium of non-state actors, in part through the codification of ideas for "infernal machines" in a number of early texts. In addition to Taccola's early illustrations, Wulff von Senftenberg's 1568 work *Von allerlei Kriegsgewehr und Geschütz* refers to wagon-borne IEDs, clockwork IEDs, and victim-operated IEDs built into chests or boxes[29]; Samuel Zimmerman's text *Dialogus* is dated to 1573 and alludes to booby-trapped explosive chairs and explosive "purses of gold"[30]; whereas Jean Appier's 1630 text, *La Pyrotechnie de Hanzelet … où sont représentez les plus rares & plus appreuuez secrets des machines & des feux artificiels propres pour assiéger battre surprendre & deffendre toutes places*, includes a section on infernal machines that covers variously "an explosive basket of eggs … initiated by a wheel-lock gun mechanism",[31] an "explosive chest on a truck", and "an explosive cask of wine".[32]

There is also ample evidence to suggest that some such devices began to be explored by certain violent extremist groups of the time. Particularly salient examples of what can be seen as early non-state actors' use of gunpowder allegedly include—if one accepts the popular, established narrative[33]—the failed gunpowder plot to blow up King James the First and Parliament in 1605 using 36 barrels of gunpowder. This plot, which is celebrated in many parts of the UK on November the 5th of each year, remains deeply engrained in British cultural memory and can perhaps be seen as a pioneering example of religious extremists seeking to use explosives not just for the purpose of mere regicide, but "to erase the entire political nation, to destroy the buildings and the monuments that symbolise the power of the state".[34] The plot seemingly rested on the technical expertise of Guy Fawkes who was reportedly trained in explosives during his time in the Spanish Army in the Wars of Independence,[35] where, according to Davis' biography of Guy Fawkes, he:

> spent much of his time in service charged with the task of blowing up fortifications, making him an expert in the use of gunpowder. By the end of his time in service he was capable of firing a … trail of slow burning powder connecting to gunpowder in a barrel … and was also highly skilled in the art of the slow match, a technique used for firing military mines.[36]

Such expertise would have been important in such an ambitious plot. Research from 2003 by the Centre for Explosion Studies at the University of Wales posited that, had the group succeeded in exploding 36 barrels of tightly packed gunpowder as legend has it, the "explosion would have

destroyed Westminster Abbey and undermined buildings as far away as Whitehall".[37]

Lesser-known examples of early non-state use of gunpowder include what appears to be the first parcel bomb in 1581, when the Polish engineer Johann Ostromecki created a booby-trapped jewelled casket that was delivered to Ivan Petrovich Shujski[38]; the attempted assassination of the Prince of Orange in 1584 by Hans Hanzoon "by means of gunpowder, concealed under his house in that city, and under his seat in the church"[39]; and several attempted attacks on Oliver Cromwell in the mid-1650s. There are at least two accounts of attempted IED plots directed towards Cromwell. One account by Sir Reginald Francis Douce Palgrave refers to "a basket of wildfire made up of all combustibles, as tar, pitch, tow, gunpowder, &c., [sic] in little pieces" being placed in a Chapel of Whitehall Palace ostensibly to demonstrate that Cromwell's enemies were "not idle".[40] Another account appears to point towards efforts to set off roadside IEDs as early as 1655,[41] when disillusioned republicans allegedly conspired to blow up the Lord Protector through planting some form of explosive device (described as "most active flaming stuff") by the side of the envisaged route of Cromwell "which, being discharged, would have, upon occasion, torn away coach and person in it that should pass by".[42]

Frederigo Giambelli's ship-borne IEDs[43] are worth describing at length, not least as Giambelli remains responsible for what is perhaps the most deadly IED ever detonated and possibly even the first weapon of mass destruction, as well as providing an illustration of the terrorisation potential of IEDs. Born in Italy, Giambelli appears to have excelled in chemistry and mechanics and, after a period of service as an Italian military engineer, sought to sell a number of "ingenious inventions" to the King of Spain.[44] However, Giambelli was roundly rebuffed by the Spanish and, according to John Lothrop Motley's account, "vowed revenge" for being humiliated in the Spanish court by, subsequently, offering his services to the Senate of Antwerp in their War of Independence against the Spanish in 1585.

Although disinclined to meet all of Giambelli's demands, the Senate nevertheless provided Giambelli with enough resources to "give a demonstration of his power", and he set about devising a means of breaking the Spanish siege of Antwerp by reopening the Scheldt, a strategic waterway that had been closed by the Spanish construction of a fortified bridge. Drawing on his own skills and those of two others, a "clockmaker named Bory, and a mechanician named Timmerman",[45] Giambelli reportedly tried a number of methods of attacking the bridge[46] before settling on

the construction of two "fireships" or "hellburners" the *Hope*[47] and the *Fortune*. These ships consisted of a reinforced "crater" built on the keel that was then filled with "seven thousand pounds of gunpowder, of a kind superior to anything known and prepared by Gianibelli himself". The gunpowder-filled crater was then covered with a variety of heavy materials including "marble slabs… cannon balls, blocks of marble, chain shot…" and disguised.[48]

To detonate these ships, Giambelli developed two different trigger devices. On the *Fortune*, a "slow match" fuse was used; the explosives on the *Hope* were "regulated by an ingenious piece of clock-work, by which, at the appointed time, fire struck from a flint, was to inflame the hidden mass of gunpowder below". The *Fortune* failed to detonate; however, the clockwork device on the *Hope* triggered an explosion that is estimated as resulting in between 800 and 1000 deaths amongst the curious Spanish onlookers,[49] and leading Davies to suggest that the *Hope* remains the "IED that has killed the most victims in history".[50] Whilst the attack brought limited tactical gain, with Martin and Parker positing, the Spanish were able to recover and counter-attack, the "experience of exploding ships was not easily forgotten with the 'hellburners of Antwerp' entering the vocabulary, and the irrational fears, of every Spanish soldier",[51] as well as many in the Spanish navy.

Indeed, the novel means of attack also entered into the imagination of other great powers of the time, with the British Secretary of State, Francis Walsingham, reportedly employing Giambelli who allegedly "showed [the British] how to use them".[52] Several actors employed ship-borne IEDs in the coming centuries,[53] including, according to some sources, the British who employed fireships of one kind or another in the defeat of the Spanish Armada.[54] Whether ship-borne IEDs—as opposed to burning ships directed at the assembled Spanish forces and abandoned—were actually employed is unclear. What is apparent is that the threat of the Hellburners of Antwerp exerted a powerful effect on Spanish naval morale and resolve, something fuelled by rumours across the Spanish ranks that Giambelli had "been hired by the Queen to devise some new and devilish instrument of warfare".[55] As such, the appearance of a number of burning ships appears to have caused the Spanish to panic, thereby undermining the "close disciplined formation that had been the Armada's greatest strength".[56] Giambelli's hellburners, therefore, provide an early illustration of the value of IEDs, not only in terms of their explosive, casualty causing capacity, but also their psychological value as a tool of terrorisation.

There are a number of further scattered references to the use of infernal machines over the coming centuries. The German historian Franz Feldhaus alluded to how, during the Torstenson War between Sweden and Denmark–Norway (1643 to 1645), a box containing "valuable materials" purportedly from a "naval hero" was delivered to the Swedish Admiral Wrangel for storage in his cabin. Upon inspection, it was discovered that:

> In its middle it contained a (clockwork/movement), constructed thus that after calculated time a flintlock, of the common type of the time, would cause friction on a swiftly rotating steel wheel so as to spray many sparks into the surrounding gun powder, of which there was sufficient amounts to blow up the whole boat.[57]

Over the course of the eighteenth century, understandings of the process of preparing gunpowder were both improved and promulgated more widely. Certainly, the production process of gunpowder was further improved by individuals such as the renowned French Chemist, Antoine Lavoisier[58], whereas events such as the French Revolution reportedly led to the deliberate diffusion of information on the preparation of gunpowder, with the Revolutionary government of France actively printing and disseminating prescribed recipes for gunpowder that were developed "according to simple specifications", as well as sending regional representatives to Paris for training in, inter alia, the manufacture of gunpowder.[59]

With the diffusion of training and written instruction, it is perhaps little wonder that France exhibited a number of early IED attacks, including what was perhaps one of the first land-based vehicle-borne IED (VBIED) attempts, which occurred in France in December 1800 when royalist Breton Chouans attempted to assassinate First Consul Napoleon Bonaparte using a bomb hidden in a horse drawn cart.[60] For reasons that remain unclear, the "ill timed" explosion failed to kill Bonaparte, but succeeded in killing or injuring dozens of bystanders.

Prior to the wave of Anarchist terrorism in the Fin de siècle, Paris also witnessed the early use of impact-detonated bombs, such as those used by Felice Orsini in 1858 in an unsuccessful attack on Napoleon the Third. Employing the English gunsmith Joseph Taylor, "Orsini bombs" were designed to remove "the uncertainty of slow burning fused weapons" by employing highly sensitive fulminate of mercury triggers[61] of the sort that were increasingly used by gunsmiths in the early nineteenth century. Allegedly, Orsini spent nearly a year preparing and testing these devices, including on two occasions in Sheffield and Devon.[62]

Early Post-Independence America

On the other side of the Atlantic, it was in the Americas where IEDs began to gain momentum. Crude water-based mines, including attempts to employ victim-operated river mines,[63] had been employed in the American War of Independence along with submersible vessels, such as David Bushnell's *Turtle*, which provided a means of surreptitiously positioning mines on unsuspecting British naval vessels. In the early years of American independence, Youngblood suggests early American governments maintained a preference for a "porcupine-like coastal defence" augmented by sea-borne IED, a tactic which offered an alternative to significant naval power and which had the relative advantage of being a cheaper force equaliser.[64]

Pioneering work in this area was taken up by Robert Fulton, a junior acquaintance of Bushnell's who also developed the *Nautilus* (a submarine-like vessel for deploying mines), which was unsuccessfully demonstrated to the French, who compounding the failure of the demonstration, Youngblood suggests, maintained ethical reservations about this form of warfare.[65] Rebuffed, Fulton then sought to sell his devices to the British and, at the encouragement of William Pitt, successfully demonstrated an early clockwork sea mine in 1805 by sinking a French pinnace vessel.[66] Although Fulton succeeded in destroying the target vessel with his mine, at least some amongst the British establishment were cautious about such a technology, perhaps not so much because of ethical reasons, but because of the potential for sea mines to offset British naval supremacy.[67] With the conclusion of the conflict between the French and the British, Fulton's wares were again rebuffed, leading him to offer his services to the US government in 1810, who eventually provided him with the sum of $5,000 to explore the potential of mine warfare in order to avoid "the necessity of a navy to protect commerce on the ocean".[68] Fulton reportedly used some $1,500 in preparing demonstrations of his wares and offered to use the remaining money in support of an American mining strategy during the War of 1812.[69] Pre-empting any moral concern over the use of IEDs as a method of warfare, in his offer, Fulton acknowledged that the use of IEDs was "not honorable war" but, in a letter to the Secretary of the Navy, Paul Hamilton, stated that "the British by pressing American Citizens and compelling them to fight against their Brethren, have not consulted Honor, the Laws of Nations or humanity".[70] Although Fulton later abandoned work on mines, innovations in this field were picked up later by several

other American innovators, including Samuel Colt, who reportedly fired a gunpowder charge at a distance of ten miles, using a galvanic battery in an act observed by several future pioneers of the sea mine.[71]

The Crimean War

Although IEDs had clearly been used in asymmetrical conflicts, such as the Dutch Wars of Independence and early US skirmishes, it was the Crimean War that saw the first widespread systematic use of land and sea mines, both of which were developed by Immanuel Nobel.[72] Of particular note, in relation to land mines, was the emergence of the victim-operated land mine triggered by a chemical fuse. A description is provided in the *Report on the Art of War in Europe in 1854, 1855, and 1856*:

> On any slight pressure upon the board, such as a man treading upon it, the thin iron supports yielded, when the board came in contact with a glass tube … containing sulphuric acid, breaking it, and liberating the acid, which diffused itself within the box, coming in contact with chloride of potassa, causing instant combustion, and, as a consequence, explosion of the powder… This combination recommends itself to our attention, being certain in its effects.[73]

The use of this victim-operated type of mine, whilst more sophisticated, was not entirely distinct from the objective of earlier Chinese victim-operated mines. However, it would have perhaps represented a cheaper and more reliable step forward in IED technology and one which would have "removed the problem posed by the fougasse – that in the event of an attack, an operator might set them off too soon or too late".[74] What is clear is that the technology would be employed again in a number of IED events over the course of the nineteenth century. Indeed, such was the use of these mines that the Crimean War perhaps represents the first time in which both land and sea mines shifted from being "improvised" to systematically produced on a large scale, with some 1000 sea mines ordered by the Russian government.

The American Civil War

The evolution of mines during the Crimean War had significant implications for the evolution of IEDs with the development of Nobel's chemical fuse resonating around the world. This was most evident in the American

Civil War, which can be seen as a hothouse of innovation more generally and a proving ground for the development of a number of different IEDs particularly. Yet the integration of IEDs into military operations was not initially met with widespread support: Matthew Maury's early attempts to encourage the Governorate of Virginia to adopt torpedoes in the defence of its waterways was met with censure (including from his own family[75]), and the use of such "hidden weapons" deemed "uncivilized".[76] Maury's demonstration of the utility of sea mines employing percussion fuses appears to have been sufficiently effective to partially diminish any moral scruples over the use of such a weapon. Indeed, following the demonstration, Maury was promoted to Captain and provided with $50,000 to develop and deploy land and sea mines against Unionist forces.[77]

Maury subsequently developed a number of mines, most of which appear to have failed, seemingly in many cases because the powder became damp, before turning his attention to electric mines.[78] Electric mines were seen as promising "the best results" in part because mechanically activated mines that detonated upon impact "could be rendered harmless by the enemy".[79] However, the science of electricity was at the time in its infancy and available experts in the field, such as Dr William Norris, were initially critical of the scheme and unwilling to help (although he later provided much technical advice).[80] Moreover, materials such as insulated electrical cable were in short supply for Confederate forces, all of which severely constrained scientific research on mines. Accordingly, Maury was dispatched to England by the Confederacy, where he was responsible for several activities, including the development of a sophisticated system for electrical mining, something seemingly achieved through collaborations with a number of scientists, including the renowned English scientist, Sir Charles Wheatstone, and a period of testing in a field near Bowden, England.[81] However, by the time Maury embarked upon his return to the USA to deploy such mines, the Confederacy had fallen.[82]

General Gabriel Rains had greater success with early IEDs. After graduating from the US Military Academy, where he excelled in chemistry and artillery, Rains served in Indian Territory during the Semiole campaign (where he reportedly unsuccessfully attempted to build a booby-trapped explosive shell) and subsequently in Mexico, before being appointed the rank of Brigadier General by the Confederate forces.[83] His first posting to Richmond required undertaking defensive preparations of the city in the face of Unionist advances. However, upon realisation that Unionist forces were about to use artillery fire as part of a siege strategy in May 1862,

the Confederates opted to quietly slip away. In the ensuing escape, Rain's team placed a number of mines in the fortifications, as well as behind the retreating Confederate force, as part of a rear-guard action that Rains suggested "would have a moral effect in checking the advance of the enemy … [and serve] … to save our sick".[84]

Using buried mortars with friction fuses designed to explode "upon being trodden upon or otherwise disturbed". Confederate IEDs caused havoc with the advancing Unionists whose leaders declared the practice "the most murderous and barbarous conduct", at one point stating their intention to "make the prisoners of war remove them at their own peril". The letters and diaries of Unionist troops also reveal a sense of opprobrium and fear regarding mines, which Perry surmised as a "newfound fear – fear of a weapon they could not see or hear, a weapon that lay dormant and concealed, causing death at the slightest touch. This was different from battle… this was unknown".[85] Indeed, the fear of IEDs can be seen as feeding into a propaganda campaign reverberating around the Unionist media in which the use of "Satanic torpedoes"[86] was both overstated and condemned as "evidence of a barbaric people unschooled in civilised warfare and, perhaps worse, aristocrats whose manliness should be questioned".[87]

It is of note that even amongst some of the leadership of the Confederacy, mines were subject to ethical debate. General Longstreet, Rain's commanding officer, "forbade [Rains] laying additional torpedoes" which he considered as neither a "proper [n]or effective method of war", and even the Confederate soldiers decried the laying of mines as "barbarism".[88] However, Rains rejected this directive, claiming mines were as proper as ambushes and "masked batteries", resulting in the issue being escalated to the Secretary of War, George W. Randolph. Randolph adopted a pragmatic approach, which is reminiscent of some contemporary discussions on IEDs and declared thus:

> It is not admissible in civilized warfare to take life with no other object than the destruction of life… It is admissible to plant shells in a parapet to repel an assault or in a road to check pursuit because the object is to save the work in one case and the army in the other… It is admissible to plant torpedoes in a river or harbour, because they drive off blockading or attacking fleets… It is not admissible to plant shells merely to destroy life.[89]

The declaration served to legitimise Rain's activities; however, the impasse with his commanding officer meant that he was reassigned to the

defence of the James and Appomattox rivers, and he spent much of the rest of 1862 focused on the invention and testing of mines. In doing so, however, he was not alone. A Confederate law enacted earlier in the year offered a bounty for the destruction of enemy vessels resulting in "many an ingenious mind turn[ing] its attention to … inventing some *machine infernale*".[90] The law stated:

> The Congress of the Confederate States of America do enact, That the first section of the above entitled Act be so amended, that, in case any person or persons shall invent or construct any new machine or engine, or contrive any new method for destroying the armed vessels of the enemy, he or they shall receive fifty per centum of the value of each and every such vessel that may be sunk or destroyed, by means of such invention or contrivance.[91]

The incentive system led to what Von Scheliha, a Lieutenant Colonel in the Army of the Confederate States, described as the most "absurd schemes" for the time, including:

> torpedo twin boats, propelled by rockets; diving apparatus by means of which torpedoes might be attached to the bottom of the enemy's ships; balloons …[from which to] … drop some kind of torpedo on the deck of a ship; rotation torpedo-rockets to be fired under water.[92]

Such inventions were largely failures because of the difficulties in realising such ambitious proposals, and Von Scheliha went on to state that the most effective torpedoes "excelled in simplicity of construction and cheapness".[93] Indeed, although there were a number of creative ideas, the bulk of successful work on torpedoes appears to have been conducted by Confederate representatives working in three organisations authorised under 1862 legislation of the Confederate Congress intended to "centralize the experimentation, training and development of an efficient organization". These organisations were the Secret Service Corps, the Submarine Battery Service, and the Torpedo Bureau.[94]

With a centralised structure, the provision of time and space to develop torpedoes, as well as an incentive scheme for funnelling in new ideas, IEDs began to gain momentum in the American Civil War with a number of techniques explored, including the development of "Horological torpedoes" (time bombs); rigged artillery shells which functioned as mines; so-called Demijohn movement-sensitive initiation switches; and the use of "coal torpedoes" hollowed out coals filled with explosives, sealed, and

hidden in coal piles.[95] The most destructive, however, were those reportedly developed by Rains, whose period of development and testing appears to have provided space to begin a significant river mining campaign with the development of the Rain's fuse and two forms of torpedo: the frame torpedo and the keg torpedo. The latter was described by Perry as "cheap, easy and quick to make, and deadly efficient these caused more destruction than any other torpedo".[96]

Over the course of the conflict, "the Confederates had emplaced thousands of land torpedoes around Richmond, Charleston, Mobile, Savannah, and Wilmington, which produced hundreds of casualties".[97] In addition to which, some 34 Union ships were sunk or seriously impaired by Confederate torpedoes. What Perry describes as the "spectacular success" of such weapons had also caught the attention of European powers with any disdain associated with such weapons evaporating over the course of the American Civil War, to the extent that Union commanders had evolved from being outraged by the use of such weapons to begrudging acceptance of their use.[98] As the Civil War concluded, the use of such weapons spread beyond actions associated with either warring party and into petty feuding and personal rivalries in the USA. Thus, IEDs were employed in a "courtroom battle over patent rights", disagreements over "property titles", anti-corruption efforts, and insurance scams.[99] Indeed, Larabee goes so far as to suggest that the Confederate government "nurtured a culture of terrorist violence and technological development that would lead to infamous schemes to kill non-combatants and influence insurgent groups during and after the war".[100]

Notes

1. Butalia, Romesh C. 1998. The Evolution of the Artillery in India: From the Battle of Plassey (1757) to the Revolt of 1857. Allied Publishers. Pg 17.
2. Partington, J. R. 1960. A History of Greek Fire and Gunpowder. JHU Press.
3. Brown, G. I. 1998. The Big Bang – A History of Explosives. Stroud, Glos: Sutton Publishing Limited.
4. Mayor, Adrienne. 2003. Greek Fire, Poison Arrows and Scorpion Bombs: Biological and Chemical Warfare in the Ancient World. Woodstock, New York, and London: Overlook Duckworth.
5. Brown, G. I. The Big Bang.
6. Mayor. Greek Fire, Poison Arrows and Scorpion Bombs. Pg 242.
7. Partington. A History of Greek Fire and Gunpowder. Pg 26.

8. Brown, G. I. The Big Bang.
9. Creveld, Martin L. Van. 1989. Technology and War: From 2000 B.C. to the Present. Collier Macmillan. Pg 82.
10. Needham, Joseph. 1986. Science and Civilisation in China: Volume 5, Chemistry and Chemical Technology, Part 7, Military Technology; the Gunpowder Epic. Cambridge University Press. Pgs 156–161.
11. Needham. Science and Civilisation in China. Pg 163.
12. Needham. Science and Civilisation in China. Pg 169.
13. Needham. Science and Civilisation in China. Pg 163.
14. Stone-cut explosive mines, for example, used carved stones, hollowed out and pack with gunpowder, and capped with a fuse. These devices would be "buried and hidden underground, and this is what can be used for ground thunder". Huo Lung Ching, cited in: Needham. Science and Civilisation in China. 196.
15. Needham. Science and Civilisation in China. Pg 199.
16. Youngblood, Norman. 2006. The Development of Mine Warfare: A Most Murderous and Barbarous Conduct. Westport CT: Praeger Security International.
17. Youngblood. The Development of Mine Warfare.
18. Beretta, Antonio Ballesteros. 1963. Alfonso X El Sabio. First edit. Salvat Ed. Pg 315.
19. Brown. The Big Bang.
20. Roland. "Science, Technology, and War." Pg 562.
21. Buchanan, Brenda J. 2006. Gunpowder, Explosives and the State: A Technological History. Ashgate Publishing, Ltd. Pg 2.
22. Iacopo, Mariano Di. 1430. "Underground Mine Causing a Fortress to Collapse." In De Machinis. Institute and Museum of the History of Science. http://brunelleschi.imss.fi.it/genscheda.asp?appl=LIR&xsl=manoscritto&lingua=ENG&chiave=100557.
23. Youngblood. The Development of Mine Warfare. Pg 10.
24. Several sources refer to this event as the first use of explosive mines, although this remains contested with Partington suggesting this was in fact misreported as an incendiary mine. Partington. A History of Greek Fire and Gunpowder. Pg 172.
25. Duffy, Christopher. 2013. Siege Warfare: The Fortress in the Early Modern World 1494–1660. Routledge. Pg 11.
26. See Duffy. Siege Warfare Pg 11 & 238; Turnbull, Stephen. 2012. Siege Weapons of the Far East: AD 960–1644. Osprey Publishing. Pg 44.
27. Motley refers to several examples of underground mining in efforts to destroy fortifications, including the sieve of Steenwyk in 1592 when "Four mines, leading to different points of the defenses, were patiently constructed, and two large chambers at the terminations, neatly finished off and

filled respectively with five thousand and twenty-five hundred pounds of powder". See Motley, John Lothrop. 1888. History of the United Netherlands from the Death of William the Silent to the Twelve Years' Truce--1609. New York: Harper & brothers.

28. Foley, Vernard, Steven Rowley, David F Cassidy, and F Charles Logan. 2015. "Leonardo, the Wheel Lock, and the Milling Process" 24 (3).
29. Partington. A History of Greek Fire and Gunpowder. Pg 170.
30. Samuel Zimmermann. 1587. "Dialogus." Augsburg.
31. Davies, Roger. 2013. "A Booby Trap IED from 1630." Standing Well Back. http://www.standingwellback.com/home/2013/1/5/a-booby-trap-ied-from-1630.html.
32. Partington. A History of Greek Fire and Gunpowder. Pg 176.
33. Many have questions whether this could in fact have been a conspiracy of the government *against* Catholics designed to discredit the Catholic community, and indeed there are a number of outstanding questions and holes which have yet to be addressed, such as where the group were able to acquire 36 barrels of gunpowder? Brown. The Big Bang.
34. As stated by Professor Mark Nichols IN: BBC. 2015. "Gunpowder 5/11: The Greatest Terror Plot." UK: BBC 2. http://www.bbc.co.uk/programmes/b04mhwfn.
35. Likar, Lawrence E. 2011. Eco-Warriors, Nihilistic Terrorists, and the Environment. ABC-CLIO. https://books.google.com/books?id=mAZYZgZTBBsC&pgis=1. Pg 59.
36. Davis, John Paul. 2013. Pity For The Guy: A Biography of Guy Fawkes. Peter Owen Limited.
37. Carrington, Damian. 2003. "Gunpowder Plot Would Have Devastated London." New Scientist, November.
38. See: Jones, Ian. 2004. Malice Aforethought: The History of Booby Traps from World War One to Vietnam. Greenhill. Pg 12; Partington. A History of Greek Fire and Gunpowder. Pg 170; Davies, Roger. 2014. "Things That Have Happened before." Standing Well Back. http://www.standingwellback.com/home/2014/6/18/things-that-have-happened-before.html.
39. Motley, John Lothrop. 1863. The Rise of the Dutch Republic: Complete in One Volume. Strahan. Pg 888.
40. Palgrave, Reginald Francis Douce. 1890. Oliver Cromwell, the Protector: An Appreciation Based on Contemporary Evidence. London: Sampson Low, Marston, Searle & Rivington. https://ia700508.us.archive.org/7/items/olivercromwellpr00palguoft/olivercromwellpr00palguoft.pdf. Pg 284.
41. Roger Davies has alluded to how, over the course of the Dutch independence wars, what is perhaps the first synchronised roadside bombing of a convoy occurred when Dutch rebels seemingly used a command-detonated

wheel-lock mechanisms to detonate a number of buried barrels of gunpowder decimating a passing Spanish troop convoy. Yet, as Davies notes it is difficult to verify this event with any certainty. Davies, Roger. 2011. "Complex IED Attack circa 1584." Standing Well Back. http://www.standingwellback.com/home/2011/10/4/complex-ied-attack-circa-1584.html.

42. Rutt, John Towill, ed. 1828. "A Brief Relation of the Late Dangerous Plot for the Destruction of His Highness's Person." In Diary of Thomas Burton Esq: Volume 2, April 1657–February 1658. London: H Colburn. http://www.british-history.ac.uk/burton-diaries/vol2/pp483-488.
43. Giambelli has been variously spelt "Gianibelli", "Genebelli", "Genibelli" or "Jenibell" in different texts.
44. Motley. History of the United Netherlands. Pg 190.
45. Motley. History of the United Netherlands. Pgs 190, 191.
46. Davis, Paul K. 2003. Besieged: 100 Great Sieges from Jericho to Sarajevo. Oxford University Press. Pg 120.
47. There is some disagreement over the whether the ship was named the "Hoop" or the "Hope".
48. Motley. History of the United Netherlands. Pg 191.
49. There are some discrepancies in relation to the number of deaths caused in the *Hoop* attack with numbers ranging from 800 to 1000.
50. Davies, Roger. 2011. "Hellburner Hoop." Standing Well Back. http://www.standingwellback.com/home/2012/10/2/big-ieds-in-ships.html.
51. Martin, Colin, and Geoffrey Parker. 1999. The Spanish Armada: Revised Edition. Manchester University Press. Pg 54.
52. The British Orders and Awards claim that Giambelli "showed us how to use them" see Gordon, Lawrence L. 1968. British Orders and Awards. Kaye & Ward. Pg 104.
53. Davies, Roger. 2014. "USS Intrepid – Another Ship-Borne Massive IED." Standing Well Back. http://www.standingwellback.com/home/2014/5/26/uss-intrepid-another-ship-borne-massive-ied.html.
54. Mattingly, Garrett. 1987. The Armada. Houghton Mifflin Harcourt. Pg 325.
55. Brodie, Bernard, and Fawn McKay Brodie. 1973. From Crossbow to H-Bomb. Indiana University Press. Pg 68.
56. Childs, David. 2009. Tudor Sea Power: The Foundation of Greatness. Seaforth Publishing. Pg 83.
57. See Feldhaus, Franz Maria. 1910. Ruhmesblätter Der Technik von Den Urerfindungen Bis Zur Gegenwart. F. Brandstetter. https://ia802706.us.archive.org/2/items/ruhmesblatterder00feldgoog/ruhmesblatterder00feldgoog.pdf. Pg 170–172. Thanks to Kai Ilchmann for assistance with translation.
58. Roland. "Science, Technology, and War."
59. Brodie & Brodie. From Crossbow to H-Bomb. Pg 107.

60. Simon, Jeffrey D. 2008. "The Forgotten Terrorists: Lessons from the History of Terrorism." Terrorism and Political Violence 20 (2): 195–214. http://www.tandfonline.com/doi/abs/10.1080/09546550801907599.
61. Davies, Roger. 2012. "The Felix Orsini Bomb." Standing Well Back. http://www.standingwellback.com/home/2012/12/30/the-felix-orsini-bomb.html. Cropley, David H., and Arthur J. Cropley. 2013. Creativity and Crime: A Psychological Analysis. Cambridge University Press. Pgs 182 & 183.
62. Cropley & Cropley. Creativity and Crime. Pgs 182 & 183.
63. See, for example, Bushnell's IED employed in August 1777 along rivers and developed with barrels of gunpowder, rope upon which a ship would snag itself, and gunlocks.
64. Youngblood. The Development of Mine Warfare.
65. Youngblood. The Development of Mine Warfare.
66. O'Connell, Robert L. 1989. Of Arms and Men: A History of War, Weapons, and Aggression: A History of War, Weapons, and Aggression. Oxford University Press, USA. Pg 188.
67. Earl St Vincent remarked that Prime Minster Pitt "was the greatest fool that ever existed to encourage a mode of war that which they who control the seas did not want and which, if successful, would deprive them of it". O'Connell. Of Arms and Men. Pg 188.
68. Youngblood. The Development of Mine Warfare. Pg 19.
69. British interest waned with the end of conflict with France, and sea mines, which had the potential to offset the British monopoly of control over the seas, were likely viewed with both disdain and trepidation.
70. Dudley, William S., and Michael J. Crawford. 1985. The Naval War of 1812: A Documentary History. Government Printing Office. Pg 147.
71. Lundeberg, Philip K. 1974. Samuel Colt's Submarine Battery – The Secret and the Enigma. Washington: Smithsonian Institution Press. Pg 22.
72. Youngblood. The Development of Mine Warfare. Pg 29.
73. Delafield, Richard. 1860. "Report on the Art of War in Europe in 1854, 1855, and 1856." Washington, DC. Pg 109.
74. Youngblood. The Development of Mine Warfare. Pg 31.
75. Maury's wife is reported as stating it was "barbarous to blow up men without giving them the chance to defend themselves". Betty Maury as cited in: Perry, Milton F. 1965. Infernal Machines. Louisiana State University Press. Pg 8.
76. Youngblood. The Development of Mine Warfare. Pg 38.
77. Perry. Infernal Machines. Pg 6.
78. Perry. Infernal Machines. Pgs 10–16.
79. President Jefferson Davis, as cited in Perry. Infernal Machines. Pg 14.
80. Perry. Infernal Machines. Pg 6.
81. Other duties included the purchasing of warships for the confederacy. Perry. Infernal Machines. Pgs 10–16.

82. Youngblood. The Development of Mine Warfare. Pg 38.
83. See the short bio of Rains in: Rains, Gabriel J., and Peter S. Michie. 2011. Confederate Torpedoes: Two Illustrated 19th Century Works with New Appendices and Photographs. Edited by Herbert M Schiller. McFarland. Pgs 4, 5, 6; Singer, Jane. 2005. The Confederate Dirty War: Arson, Bombings, Assassination and Plots for Chemical and Germ Attacks on the Union. McFarland.
84. Perry. Infernal Machines. Pg 24.
85. Perry. Infernal Machines. Pg 21.
86. "Torpedoes" was a term widely used for explosive devices and mines in the American Civil War and indeed in late nineteenth-century Europe but without necessarily any linkage with the concept of "torpedoes" as currently understood as maritime explosive weapons propelled towards their target.
87. Blair, William. 2000. "The Seven Days and the Radical Persuasion." In The Richmond Campaign of 1862: The Peninsula and the Seven Days, edited by Gary W. Gallagher. University of North Carolina Press. Pg 168.
88. Perry. Infernal Machines. Pg 25.
89. Perry. Infernal Machines. Pg 25.
90. Perry. Infernal Machines. Pg 25.
91. Confederate States of America. 1862. Public Laws of the Confederate States of America. Edited by James Matthews. Gale Cengage Learning. Pg 51.
92. Viktor von Scheliha. 1868. A Treatise on Coast Defence: Based on the Experience Gained by Officers of the Corps of Engineers of the Army of the Confederate States. London: E & F.N Spon. Pg 220.
93. Viktor von Scheliha. (1868) *Ibid.* Pg 220.
94. Perry. Infernal Machines. Pg 31.
95. Coal Torpedoes were developed by Thomas Courtenay and employed by the Confederate Secret Service to sabotage naval vessels and later by special operations personnel of various nationalities in the First and Second World Wars. United States. Naval War Records Office. 1914. "Official Records of the Union and Confederate Navies in the War of the Rebellion; Series I – Volume 26: Naval Forces on Western Water."
96. Perry. Infernal Machines. Pg 38.
97. Schneck, William C. 1998. "The Origins of Military Mines: Part I." Engineering Bulletin. http://www.fas.org/man/dod-101/sys/land/docs/980700-schneck.htm.
98. Perry. Infernal Machines. Pg 38.
99. Whelehan, Niall. 2012. The Dynamiters: Irish Nationalism and Political Violence in the Wider World, 1867–1900. Cambridge University Press. Pg 142.
100. Larabee, Ann. 2004. "A Brief History of Terrorism in the United States." In Technology and Terrorism, edited by David Clarke, 244. Transaction Publishers. Pg 25.

CHAPTER 2

Dynamite Terrorism and the Fin de Siècle

Abstract This chapter outlines how a number of technical and social changes combined to feed into the rise of dynamite terrorism in the late nineteenth century, something illustrated through three micro case studies looking at Irish nationalists, the Russian Peoples Will, and Anarchist groups.

Keywords Anarchist • Dynamite • Terrorism • Nationalism • *Narodnaya Volya* • Irish nationalists • Propaganda by the deed

The American Civil War can thus be seen as playing a significant role in the evolution of IEDs with the techniques and tactics of clandestine IED attacks that were pioneered in the conflict subsequently being employed in the settlement of petty feuds spreading from the USA across to Europe and beyond. However, it was not until later in the nineteenth century that IEDs or infernal machines began to take root on the other side of the Atlantic. This was a result of the increased attention to the perceived promise of science and technology along with the diffusion of materials, training, and information and the changing social, political, and economic context of the late nineteenth century, which generated somewhat of a technological-push and a demand-pull for early IEDs.

J. Revill, *Improvised Explosive Devices*,
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Diffusions of Materials and Technology

The discovery of the less volatile "Nobel's Blasting Powder" or dynamite in the late 1860s was swiftly seized upon by, amongst others, railway and mining companies seeking new and more effective blasting techniques. Such was the demand for new blasting capabilities that there was a massive increase in the production of dynamite around the globe, with Jorpes stating that "[d]uring the years 1867 to 1874 the world production of dynamite rose from 11 to 3,120 tons a year".[1]

The growth in the legitimate production of dynamite concurred with the development and diffusion of initiator technologies effectively forming "sequences of component innovations".[2] The Bickford safety fuse was patented in 1831 and made the detonation of explosives more reliable and less hazardous, and thereby more readily useable. Subsequently, the invention of the blasting cap by Nobel in 1863 further "revolutionized explosives technology" providing an effective means of initiating the main charge.[3] Such technological advances were undoubtedly significant in facilitating the rise of explosive violence amongst extremist groups of the time. However, there is a need for caution in seeing this as causing a "step change" in extremist violence within itself, and notably several IED events in the run up to the fin de siècle continued to use gunpowder in relatively crude improvised devices.

Explosives Information

In parallel, knowledge of the production process for dynamite, which for a short time was retained only amongst specialists, soon began to circulate more widely aided by cheaper and more readily available communications and printing technology in the latter half of the nineteenth century, which allowed the easier and faster dissemination of information.[4] Dissemination of information on explosives spread through two different channels. The first was instruction on explosives provided in the mainstream scientific literature, through periodicals such as *Scientific American* and *The Mechanics Magazine*. The former in particular featured a number of articles on dynamite and explosives which provided instruction on their creation and possible application in conflict, including titles such as the 1876 article *Infernal Machines*, which provides descriptions of a number of "diabolical" devices such as the "wooden rat" and "Orsini bombs", along with means of initiating explosions by clocks, matches, and springs.[5]

Following what was, at the time, reported as the "Crime of the century" in 1875, when Alexander "Sandy" Keith, a former Confederate secret agent allegedly involved in Civil War IED attacks, blew up the German émigré ship the *Mosul* at port in Bremhaven, killing 80 people with a time bomb,[6] the *Scientific American* appears to have reduced the detail in such articles. In an act that has parallels with contemporary editorial decisions related to dual use publications in the field of biotechnology, the *Scientific American* stated that:

> We had prepared some drawings of some of the ingenious machines which … have been applied to such diabolical uses … [however]… we, desiring above all else to avoid even the remotest probability of working evil, think best to deny our pages to the semblance of the means whereby crimes so horrible and atrocious have been committed, for the harm caused might vastly exceed the advantage of such knowledge as the pictures might impart.[7]

The second channel of information diffusion was a set of loosely connected networks of transnational extremist groups through which instruction on dynamite and bomb making was circulated, frequently alongside treatise on the justification for the use of such weapons and even poetry in praise of dynamite.[8] As such, this channel can perhaps be seen as paralleling contemporary networks circulating IED-making guidance—alongside incitement to employ such tools—through the Internet. Examples of such literature include the 1885 booklet produced by Johannes Most (who sought work in an explosives factory to inform his understanding of explosives) on *The Science of Revolutionary Warfare*, as well as materials produced—and frequently re-produced—in papers such as the *United Irishman*, *Dynamite Monthly*, the French periodical *le Dynamite*, or the German *Freiheit* as well as the 1880 texts: *La Revolution Social* and Mezzeroff's 23-page pamphlet on "Dynamite and Other recourses of Civilization".[9]

Explosives Training

Written material pertaining to explosives was complemented by a small number of taught classes and lectures in explosive handling, manufacture, and deployment. As Larabee notes, "entranced with science and technology as liberatory agents, nineteenth century revolutionaries sponsored bomb-making schools and circulated weapons instructions."[10] Perhaps

most eminent were lectures at the so-called Brooklyn Dynamite School taught by "Professor Mezzeroff", which was actively and publicly promoted in certain papers such as the *United Irishman*.[11] Mezzeroff, the "stage name" of Richard Rogers, became famous through his nihilistic, chemistry expert persona and reportedly made it his life's mission to teach Americans and Europeans "how to use explosives against autocratic governments".[12] A former soldier who claimed to have experience in the Crimean War, Mezzeroff offered a course that Whelehan states consisted of:

> thirty days' attendance at the dynamite school [which] was sufficient fully to train willing pupils: the course was free to those who agreed to travel as 'missioners' to Britain, otherwise the price was $30, including board and lodgings. Instruction included an introduction to clockwork mechanisms.[13]

Training was also provided at a second explosives school in Brooklyn under the charge of Dr Thomas Gallagher, a Scottish born physician who acted as an instructor, as well as at a third school based in Peoria, Illinois.[14]

Socio-Economic Context and the Failure of Insurrection

Finally, whilst technical advances such as the invention of dynamite and the spread of information and knowledge pertaining to it were important in feeding into the push of explosive technology in the run up to the fin de siècle, changing social, political, and economic conditions across Europe also played a role in pulling radical groups towards extreme acts of explosive violence. Economic disparity in countries such as France, Russia, and Britain had led to a wave of protest movements in the mid-nineteenth century. One factor that was common across several such movements was their failure in the face of bloody repression by states. There are several examples, including the 1848 revolutions, the failed 1867 uprising in Ireland, and the 1871 Paris Commune. For Niall Whelehan, the experience of 1848 was particularly significant as:

> these defeats led revolutionaries to regroup and reconsider their approaches to insurrectionary warfare. As a consequence, the emphasis shifted from programmes of insurrection to ideas of irregular warfare that incorporated

> the surgical use of violence against the state by individuals and guerrilla bands.[15]

Some such movements appeared to escalate in terms of their violent actions, and dynamite, "the premier scientific explosive of the time",[16] was perceived as providing such movements with "extraordinary power to execute their grandiose objectives".[17] Such expectations of science were consistent with a wider discourse on the promise and peril of science in the mid-to-late nineteenth century, which engaged many aspects of society through fact and fiction.[18] Yet for extremist groups—regardless of an anarchist, revolutionary, or nationalist persuasion—the proliferation of fact and fiction on the potential of science is likely to have been particularly captivating as it offered the dramatic—if frequently unfeasible—possibility of acting as a great equaliser in asymmetrical conflicts. Certainly, this appears to have been important for the three salient examples of early IED pioneers outlined below: Extreme Irish nationalists; *Narodnaya Volya*, the Russian Peoples' Will group; and Anarchist actors.

Extreme Irish Nationalists

Although *Narodnya Volya* is frequently considered the antecedent of contemporary terrorism, extreme Irish nationalists also played a significant role as progenitors of future extremist groups.[19] Indeed, Clutterbuck of the UK's Met Specialist Operations Department argues that nineteenth-century extreme Irish nationalists groups made a "seminal contribution to the development of terrorism in the twentieth century", including through the innovative use of explosives.[20]

Initially, dynamite was seen as inconsistent with some interpretations of the doctrine of Fenianism and notions of "honour and patient vigilance"; however, over time, the failure of traditional forms of force[21] and social protest led key figures to champion the argument that "for money to flow, blood to rise and men to volunteer… more urgent, brutal and pragmatic tactics were required".[22] The American Civil War had provided many Irish nationalists with first-hand experience of what form such brutal and pragmatic tactics could take; Whelehan estimates that "service in the American [Confederate or Unionist] armies would train 190,000 Irishmen in the 'arts of war' and the experience of fighting came to be understood as preparation in the event of a conflict in Ireland".[23] Thus, the tactics and

technology were drawn from the experience of senior Irish nationalists leaders in the American Civil War, who fought "on either the Union or Confederate sides and were aware of new covert bomb making technologies and ways of deployment".[24]

Despite the apparent experience and expertise of senior figures, it still took time to master the development and deployment of explosives in Britain, with early initiatives proving unsuccessful and/or unhelpful to the cause. The attack on Clerkenwell House of Detention on the 13th of December 1867, in an unsuccessful bid to liberate an incarcerated colleague of the Fenian Brotherhood, Richard Burke, went "horribly wrong".[25] Not only did the perpetrators appear to have miscalculated the effects of detonating a barrel of gunpowder next to a stretch of prison wall—inadvertently damaging a number of neighbouring houses—and failed in their objectives to free colleagues, but they ended up killing civilians and alienating many otherwise sympathetic individuals,[26] in an act the *Manchester Guardian* described at the time as a "diabolical outrage".[27] Similarly, the deliberate letter bomb campaign of 1867 failed when "the badly assembled packages caught fire prematurely in a Dublin post-box".[28] Yet, through such acts "a seed had been sown", and as *The Nation* reported in December 1867, "There is no blinking or denying the fact that the results which followed [Clerkenwell] show that the Fenian conspirators, without ships on sea or an army in the field, have it in their hands to deal a tremendous blow to England."[29]

It was a seed that began to germinate less than a decade later through extreme Irish nationalist factions, such as the Skirmishers and *Clan na Gael*. The Skirmishers are of particular note as an early example of a public crowd-funded revolutionary programme for what was described as "scientific warfare" designed to hasten Irish independence. Launched in 1876 through the paper, *the Irish World*, the campaign sought contributions from supporters with great success, accumulating some $90,000 by 1878.[30] As was the case with the American Civil War, there were a number of ambitious aspirations, including undertaking balloon-borne aerial bombing campaigns and submarine warfare; however, few of these were realised with the largely unsuccessful effort to build the "Fenian Ram" submarine, originally intended to "harass British shipping"[31] swallowing significant funds in efforts to overcome "mechanical problems".[32]

However, by the 1880s, the Dynamiters began to gain momentum with more than a dozen "successful" attacks between 1881 and 1885, including several attacks targeting landmarks or otherwise symbolic locations across England, such as the Salford Infantry Barracks (which was selected

as the location where the "The Manchester Martyrs" were executed),[33] the House of Commons, Scotland Yard, the Tower of London, and Westminster,[34] as well as the synchronised bombing of London underground stations in a manner which "echoes of London underground bombings by Al Qaeda and the IRA".[35]

Whilst both the Skirmishers and *Clan na Gael* are likely to have benefitted from knowledge transfer from the American Civil War, the employment of IEDs by these two groups evolved with distinctive characteristics. The IED development and deployment of the Skirmishers and *Clan na Gael*'s early campaigns exhibited a "typical 'signature' that set them apart as surely as did their target selection and attitude towards the potential deaths of others".[36] Clutterbuck is worth quoting at length in this regard:

> The Skirmishers most frequently used improvised explosive devices that were time delay in concept. Often the device was initiated by a mechanism of their own design and construction (generally a brass tube filled with acid), and the explosive was homemade lignine dynamite. The Clan na Gael versions were also time delay in concept and also initiated by a home-made device. Initially, they used the same brass tube mechanism but quickly introduced the idea of using a clock linked to a pistol to initiate the explosion. However, the dynamite they used was a commercial product.[37]

By the 1890s, however, the skirmishing campaign had stopped, ostensibly because of the countermeasures issued by the security community. However, Whelehan suggests the emergence of political possibilities in 1885 also had a bearing on the decision to shelve the dynamite campaign, which had undoubtedly made its mark by the mid-1880s. It is perhaps for these reasons that extreme Irish nationalist groups operating in the run-up to the Fin de siècle remain important in the history of IEDs and influential as a "model for aspiring insurrectionist and terrorist movements", that was taken forward in parts by, inter alia, early Indian Nationalists, whose leaders encouraged likeminded individuals to "Look to the examples of Ireland… and follow their methods", and the Irgun who later took up the tactic of timed IEDs in their post-Second World War campaign in Palestine.[38]

Narodnaya Volya

Narodnaya Volya, the Russian "Peoples Will", are widely seen as the progenitors of contemporary terrorist violence and accredited with pioneering the use of explosives by terrorists as a tool of the weak against the strong.[39]

Led by Andrei Zhelyabov, the group sought to challenge the Tsarist rule of Alexander II and what they saw as the "monstrous"[40] Russian imperial government through the liquidation of the most oppressive elements of the Tsarist regime. The group believed that such a process of assassinating key members of government would cause panic and, more importantly, educate the masses and serve "to stimulate them to action, and to draw them into the movement".[41]

In part to fulfil this objective of propaganda by the deed, the group went to great lengths to use dynamite in attacks, even in circumstances where pistols or other weapons may have been much more effective.[42] One factor in this decision could have been an awareness of the attention generated by the earlier Fenian bombings, but perhaps a more important factor was the availability of expertise provided by Nikolai Ivanovich Kibalchich, *Narodnaya Volya's* explosives expert. Kibalchich had studied the chemistry of demolition as part of his training in the Alexander I Institute of Transportation Engineers in 1871[43] and was one of the few pioneering nineteenth-century dynamiters capable of creating a bomb with both the necessary destructive power and mobility to be thrown. Moreover, Kibalchich along with one of the group's founders, Grigory Prokofievich Isaev, reportedly had time and space to test their IEDs, "sometimes going as far as the forests along the border with Finland" in order to trial devices.[44] Yet even with the considerable expertise of Kibalchich and, seemingly, time and space for testing, the handling of explosives frequently resulted in the death or impairment of members of the group.[45]

Despite such setbacks, a fixation with dynamite meant that *Narodnaya Volya* emerged as the "first to use dynamite on a wide scale" and bore responsibility for seven "carefully planned" yet unsuccessful attempts to kill the Tsar over the course of an eight-month period beginning in the autumn of 1879. Such attempts variously included using tunnel bombs, implanting a bomb in the Tsar's Winter Palace, attempting to blow up the Kamenny Bridge in St Petersberg,[46] and planting explosives along railway tracks. In the seventh attempt, a tunnel was dug under Malaya Sadoyova Street, St Petersberg, and mined with the intention of using dynamite to blow up the Tsar's carriage as it passed overhead. The mine went unused as the Tsars carriage was diverted; however, undeterred *Narodnaya Volya* forces were dispatched to wait along the new route, where they prepared to throw bombs developed by Kibalchich at the carriage. Details on the specifics of the bombs developed remain limited; however, it appears that

Kibalchich had built them on the principle employed in Nobel's land mines which relied on fragmented acid vials to act as initiators.[47] Certainly, Schaack's 1889 text described the bombs as follows:

> Metal tubes filled with chlorate of potash and enclosing glass tubes filled with sulphuric acid intersect the cylinder. Around the glass tubes are rings of iron closely attached as weights. The construction is such that, no matter how the bomb falls, one of the glass tubes is sure to break. The chlorate of potash in that case, combining with the sulphuric acid, ignites at once, and the flames communicate over the fuse with the piston, filled with fulminate of silver.[48]

The first bomb thrown stopped the convoy but failed to kill the Tsar. Accordingly, Ignnatei Grinevitski[49] stepped in and threw a second device between himself and the Tsar in what was, arguably, an early example of a form of "suicide"[50] bombing in 1881 that mortally wounded the Tsar.

Despite the operational success of *Narodnaya Volya's* 1881 attack, the movement failed in its broader objectives of liberating the Russian people from oppression and awakening the masses. Rather the assassination was met with the "unleashing of state terror", which smashed any revolutionary movement and triggered a bloody wave of pogroms over the next decade.[51] Nevertheless, the group is important in the history of IEDs with its methods and tactics serving as a model for future extremists groups, including Armenian revolutionaries[52] and various Anarchist groups, over the ensuing decades.[53]

Anarchists

As with the Fenian movement, it was the failure of past programmes of action—in the Anarchist case Bakunin's collectivism—combined with social and economic upheaval and the growing repressiveness of authorities that is argued to have contributed to pushing Anarchists (in different ways and at different times) in a new more radical and violent direction. Indeed, over the course of the 1870s, governments in Italy, France, Spain, and Germany cracked down hard on internationalists and labour movements with police forces acting increasingly repressively. Recognising the limits of past practices, the 1881 International Congress of Anarchists "officially adopted the policy of 'propaganda by deed', a policy of illegal acts… aimed against institutions and toward revolt and revolution

[which] were necessary since verbal and written propaganda had proved ineffectual".[54]

Neither propaganda by the deed nor explosive violence was, however, universally accepted by Anarchists. The founding father of anarchism, Pierre-Joseph Proudhon, proclaimed in 1848 that "killing people is the worst method for combating principles"; and following Ravachol's attack in 1892, Merriman has suggested that Anarchists were divided between "Associationists" who rejected Ravachol's violent acts and those "Individualists" advocating violence, with influential Anarchist thinkers, such as Kropotkin who had earlier encouraged propaganda by the deed, distancing themselves from violence in the early 1890s.[55] Nevertheless, the declaration of the International Congress of 1881 served as a call-to-arms for radicals and emerged contemporaneously with key figures in the movement advocating the study of explosives as a means to fight back and fulfil their radical objectives, something which gathered further momentum with publicity surrounding the assassination of Tsar Alexander in the same year.[56]

Moreover, it was a call to arms that was both further encouraged *and* made relatively more realisable through the Anarchist literature of the time.[57] Certainly, there is evidence of some Anarchists' cultural fixation with dynamite and the incitement to explosive violence in associated literature and song of the time.[58] In terms of realising such violent objectives, the dissemination of "how to or DIY-type manuals and publications of violence and mayhem", was, Hoffman suggests, "one of anarchism's flourishing 'cottage industries'".[59]

An early use of dynamite-based IEDs by Anarchists occurred in 1883 when they attempted to use 16 pounds of dynamite concealed in a drain pipe to assassinate the German Kaiser and assembled individuals of prominence, including the Crown Prince, along with many top generals, aristocrats, and government officials. The attempt floundered when the wet fuse failed to ignite and, with the perpetrators rounded up and executed, Austro-German anarchism went into decline shortly afterwards.[60]

In contrast, anarchism in Southern Europe appears to have flourished in countries such as France, Spain, and Italy with the 1890s recorded as "the era of the terrorist bloodbath, as Anarchists hurled explosive devices into crowded cafes, religious processions, and operatic performances".[61] Although at the time these attacks were believed by many to be the result of some form of shadowy coordinated international body—and indeed there were cases of transnational interaction between individual

Anarchists—most of these attacks appear to have been undertaken by lone individuals motivated by perceived injustice and sometimes supported by a few close friends.[62] This is to some extent reflected in both the diverse range of backgrounds and motivations of the individual perpetrators, and also the types of bombs employed. François-Claudius Koenigstein, known mononymously as Ravachol, sought to avenge the perceived mistreatment of three fellow Anarchists, the so-called Clichy three, who had been violently beaten in police custody in 1891. Variously described as a marginal criminal and a "brawler", Ravachol, who had earlier "tried without success to make explosive devices", used dynamite stolen from a quarry[63] in a short IED campaign against those involved in both the violent treatment and prosecution of the Clichy three. This culminated in his defiant arrest and execution in the summer of 1892, after which he became eulogised as a martyr in some parts of the Anarchist press.[64]

In 1893, Auguste Vaillant's attack on the French Chamber of Deputies reportedly used a relatively crude home-made bomb formed from using a kettle which was intended to draw attention to the plight of the poor.[65] In the same year, Santiago Salvador's attack on the Liceu Theatre in Barcelona employed an Orsini bomb to kill 22 theatre-goers, in an act of revenge for the execution of fellow Anarchist Paulino Pallás.[66] The next year, Émile Henry used a metal lunchbox filled with dynamite in an attack on the Café Terminus in Paris to kill one person and injure dozens more. This represented the culmination of a short IED campaign attributed to Henry that began in 1892 when he deposited a motion sensitive "reversible bomb" in the office of the Carmaux mining company.[67] The bomb was safely removed from the office and transferred to the police station where it was accidentally detonated killing three people. Henry, in contrast to Ravachol and Vaillant who were widely seen as "down and out",[68] was seen as part of the intelligentsia, and initially, he rejected Ravachol's methods but over time "concluded that words and speeches were not enough" and exploited information available through the subversive literature.[69]

These incidents were followed with hundreds of continental IED events over the course of the decade. This included a significant number of IED events in France (although many French IEDs appear to have been hoaxes with the exception of a small number of viable devices), and in Spain, there were a series of—largely harmless—attacks conducted by small *grupos de afinidad* using weapons "concocted from such objects as tin pans, coffee-grinders, metal boxes, and banister knobs that continuously rattled Barcelona and other Spanish cities".[70]

The diversity of IED approaches and the difficulty in policing and preventing lone individuals or small and unpredictable groups fed into the terror endured in the capitals of France, Spain, and Italy; something further compounded in the media of the time which played an important "role in whipping up hysteria" over dynamite terrorism. Yet as Jensen suggests, a "gap existed between the potent symbol and the mundane reality. Dynamite was much more powerful than previous explosives, but in practice it often proved less lethal and more cumbersome than expected".[71] Nevertheless, Anarchist bombings, particularly Émile Henry's bombing campaign, have also been highlighted as important antecedents of contemporary IED use. Certainly, John Merriman in his book, *The Dynamite Club: How a Bombing in Fin-de-Siècle Paris Ignited the Age of Modern Terror*, suggests that there is a "gossamer thread connecting" the attack by Henry with the current wave of modern Islamic terrorism[72], whereas James L. Gelvin, Professor of History at the University of California, has argued that "al-Qaeda does not represent a new or *sui generis* phenomenon, but rather fits squarely into the Anarchist mold".[73] However, as Jensen has argued there are also differences; "anarchism is less backward looking, less purely defensive, and less centrally organized than Al-Qaeda",[74] although the impact of late nineteenth-century IEDs on the twentieth century is nevertheless significant.

Notes

1. Jorpes, J Erik. 1959. "Alfred Nobel." British Medical Journal.
2. Geels, Frank W. 2006. "Major System Change through Stepwise Reconfiguration: A Multi-Level Analysis of the Transformation of American Factory Production (1850–1930)." Technology in Society 28 (4): 445–476.
3. Meyers, Sydney, and Edward S. Shanley. 1990. "Industrial Explosives – A Brief History of Their Development and Use." Journal of Hazardous Materials 23: 183–201.
4. This includes, for example, the completion of the transatlantic telegraph cable, the establishment of press agencies, and, later, the emergence in 1876 of the Universal Postal Union. See Whelehan. The Dynamiters. Pg 14.
5. Scientific American. 1876. "Infernal Machines." Scientific American 34 (5) (January 29): 65.
6. Larabee, Ann. 2005. The Dynamite Fiend: The Chilling Tale of a Confederate Spy, Con Artist, and Mass Murderer. Palgrave Macmillan.
7. Scientific American. "Infernal Machines."
8. Whelehan. The Dynamiters. Pg 170.

9. See Laqueur, Walter. 1987. The Age of Terrorism. Little, Brown and Company.
10. Larabee. A Brief History of Terrorism in the United States. Pg 27.
11. (1882) United Irishman, 24 March 1882, as cited in Whelehan. The Dynamiters. Pg 161.
12. Laqueur. The Age of Terrorism.
13. Whelehan. The Dynamiters. Pg 158.
14. Whelehan. The Dynamiters. Pg 163.
15. Whelehan. The Dynamiters. Pg 26.
16. Garrison, Arthur H. 2004. "Defining Terrorism: Philosophy of the Bomb, Propaganda by Deed and Change through Fear and Violence." Criminal Justice Studies 17 (3) (September): 259–279.
17. Gill, Horgan & Lovelace, J. Improvised Explosive Device.
18. See R.L Stevenson's 1885 novel *The Dynamiter*.
19. Porter, Bernard. 1987. The Origins of the Vigilant State: The London Metropolitan Police Special Branch Before the First World War Bernard Porter. Boydell & Brewer Ltd.
20. Clutterbuck, Lindsay. 2004. "The Progenitors of Terrorism: Russian Revolutionaries or Extreme Irish Republicans?" Terrorism and Political Violence 16 (1) (January): 154–181.
21. Clutterbuck. The Progenitors of Terrorism.
22. McConville, Seán. 2003. Irish Political Prisoners, 1848–1922: Theatres of War. Psychology Press. Pg 338.
23. Whelehan. The Dynamiters. Pg 151.
24. Larabee. A Brief History of Terrorism in the United States. Pg 27.
25. Whelehan. The Dynamiters. Pg 58.
26. Whelehan. The Dynamiters. Pg 58.
27. Manchester Guardian on 14 December 1867.
28. Whelehan. The Dynamiters. Pg 58.
29. The nation, as cited in: Whelehan. The Dynamiters. Pg 72.
30. Whelehan. The Dynamiters. Pg 141.
31. Steward, Patrick, and Bryan P. McGovern. 2013. The Fenians: Irish Rebellion in the North Atlantic World, 1858–1876. Univ. of Tennessee. Pg 215.
32. Whelehan. The Dynamiters. Pg 141.
33. Clutterbuck, L. (2004). The Progenitors of Terrorism: Russian Revolutionaries or Extreme Irish Republicans? Terrorism and Political Violence, 16(1), 154–181. doi:10.1080/09546550490457917.
34. See Whelehan, N. (2012). The Dynamiters: Irish Nationalism and Political Violence in the Wider World, 1867–1900. Cambridge University Press. Pg 141.
35. Davies, R. (2012). C-IED AtN Comparisons. Retrieved from http://www.dtic.mil/ndia/2012global/Davies.pdf.

36. Clutterbuck. The Progenitors of Terrorism.
37. Clutterbuck. The Progenitors of Terrorism.
38. Clutterbuck. The Progenitors of Terrorism.
39. Gage, Beverly. 2009. The Day Wall Street Exploded: A Story of America in Its First Age of Terror. Oxford University Press. Pg 45.
40. Chaliand, Gérard, and Arnaud Blin, ed. 2007. The History of Terrorism: From Antiquity to Al Qaeda. University of California Press. Pg 134.
41. Fleming, Marie. 2008. "Propaganda by the Deed: Terrorism and Anarchist Theory in Late Nineteenth-century Europe." Terrorism 4 (1–4) (January 9). Pg 4.
42. Ronfeldt, David, and William Sater. 1981. "The Mindsets of High-Technology Terrorists : Future Implications from an Historical Analog." RAND Notes.
43. Croft, Lee B. 2006. Nikolai Ivanovich Kibalchich: Terrorist Rocket Pioneer. Lulu.com. Pg 25.
44. Croft. Nikolai Ivanovich Kibalchich. Pg 64.
45. See Laqueur, Walter. 2002. A History of Terrorism. Third Prin. Transaction Publishers. Pg 93; Porter, Cathy. 1976. Fathers and Daughters: Russian Women in Revolution. Virago. Pg 256.
46. Chaliand & Blin. The History of Terrorism. Pg 149.
47. Davies, Roger. 2011. "The Tsar and the Suicide Bomber." Standing Well Back.http://www.standingwellback.com/home/2011/11/7/the-tsar-and-the-suicide-bomber.html.
48. Schaack, Michael J. 1889. Anarchy and Anarchists: A History of the Red Terror and the Social Revolution in America and Europe. Communism, Socialism, and Nihilism in Doctrine and in Deed. The Chicago Haymarket Conspiracy, and the Detection and Trial of the Conspirators. F.J. Schulte. Pg 36.
49. There seems to be some disagreement as to who the second bomb thrower was, with some sources suggesting "Elnikoff" was responsible and other attributing this to Ignnatei.
50. This is only arguably an early case of suicide bombing because it remains unclear as to the extent to which the act can be seen as premeditated.
51. Chaliand & Blin. The History of Terrorism. Pg 151.
52. Laqueur. A History of Terrorism. Pg 43.
53. Jensen. Daggers, Rifles and Dynamite.
54. Jensen. Daggers, Rifles and Dynamite. Pg 125.
55. Merriman, John. 2009. The Dynamite Club: How a Bombing in Fin-de-Siecle Paris Ignited the Age of Modern Terror. Houghton Mifflin Harcourt Company. Pg 95.
56. Jensen. Daggers, Rifles and Dynamite.

57. Donghaile, Deaglán Ó. 2011. "'The Doctrine of Dynamite': Anarchist Literature and Terrorist Violence." In Blasted Literature, 136–178. Edinburgh University Press.
58. See, for example, "Lady Dynamite" and "La Ravachole". Merriman. The Dynamite Club.
59. Dolnik, Adam. 2009. Understanding Terrorist Innovation: Technology, Tactics and Global Trends. Routledge. 156.
60. Jensen. Daggers, Rifles and Dynamite. Pg 18.
61. Jensen. Daggers, Rifles and Dynamite.
62. Jensen, Richard Bach. 2008. "Nineteenth Century Anarchist Terrorism: How Comparable to the Terrorism of Al-Qaeda?" Terrorism and Political Violence 20 (4): 589–596.
63. Merriman. The Dynamite Club. Pgs 73 & 76.
64. Merriman. The Dynamite Club. Pgs 70–83.
65. BBC. 2009. "Was This Man the First Terrorist of the Modern Age?" *BBC Magazine*. http://news.bbc.co.uk/1/hi/8263858.stm.
66. Whelehan. The Dynamiters. Pg xiv.
67. Reportedly Henry saw the company as responsible for the quelling of the miners' strike. See Donghaile. Blasted Literature. Pg 96.
68. BBC. Was this man the first terrorist of the modern age.
69. Merriman. The Dynamite Club. Pg 94.
70. Jensen. Daggers, Rifles and Dynamite.
71. Jensen. Daggers, Rifles and Dynamite.
72. Merriman. The Dynamite Club.
73. Gelvin, James L. 2008. "Al-Qaeda and Anarchism: A Historian's Reply to Terrorology: Response to Commentaries." *Terrorism and Political Violence* 20 (4): 606–611. doi:10.1080/09546550802257390.
74. Jensen. Daggers, Rifles and Dynamite.

CHAPTER 3

IEDs in the Twentieth Century

Abstract This chapter looks at the rise of IEDs over the course of the twentieth century and illustrates how IED component technology and information further diffused around the globe over the course of a number of conflicts endured during the last century.

Keywords IED • Booby traps • Galleanist • Special forces • Mujahedeen • Northern Ireland • Provisional IRA • Middle East • Hezbollah • Tamil Tigers

Despite the gap "between the potent symbol and the mundane reality" of dynamite terrorism, by the early years of the twentieth century, explosive extremism undertaken by non-state actors had become a readily observable practice. The use of improvised explosive devices was also a practice that continued to be employed by states, with the British using "roughly improvised" land torpedoes in Sudan[1] and fougasses in the Boer War.[2]

A variety of IEDs, some employing newly discovered forms of explosives and including mechanical time delay, victim-operated, and electrically initiated IEDs, were employed over the course of the First World War as a means of "slowing advancing troops and covering German withdrawals",[3] but particularly during the withdrawal from the Somme in 1917, wherein German forces are recorded as using hidden bombs in the scorched earth retreat.

J. Revill, *Improvised Explosive Devices*,
DOI 10.1007/978-3-319-33834-7_3

There are also reports of a number of First World War sabotage networks employing IEDs. Certainly, Henry Landau's 1937 account of German sabotage activities identifies dozens of explosions and fires at factories and on ships during the First World War which were believed to be caused by German saboteurs using incendiary pencils and so-called cigars, metallic tubes containing potassium chlorate and sulphuric acid separated by a metal disc, which corroded over time leading to a dangerous chemical reaction.[4] In the Middle East, Lawrence of Arabia's campaign was aided by the bomb-making expertise of, inter alia, Major Herbert Garland[5] who developed the "Garland mine", and successfully explored the use of electrical detonators—which had the advantage of triggering the detonation at a precise point in time—in sabotage activities which formed part of the Arabian campaign against the Ottoman Empire.[6] Notably, several sources—including Lawrence himself—suggest that bomb-making skills employed by Garland were passed on to various Arab groups,[7] including what became anti-British gangs who later appear to have employed small amounts of explosives in roadside bombs and attacks on oil pipelines in the inter-war period. Interviews by the staff of the Imperial War Museum with Patrick Norman, a British officer who commanded a Royal Naval Armoured Car squadron in Palestine in 1936, describe how the

> Arabs were able to lay their hands on an enormous quantity of explosives. They were Turkish shells in the main left there from the war… and the Arabs were quick to make use of these shells. They used them for road mines, they extracted the explosives … they were very cunning indeed and made some pretty big bangs so one had to be alert for road mines. Usually wire tripped by a vehicle [they] would leave a mine on the inner side of a mountain bend in the road so that when a vehicle tripped the wire which went across the road … the drivers instinctive action was to turn his wheel away from the bang and over the edge of the road.[8]

Also of particular note are the Anarchist Galleanist group, because of their early efforts, both "to introduce on a wide scale the use of package bombs" and pioneering early VBIEDs in the USA.[9] Driven by the notion of "propaganda by the deed", the Galleanist orchestrated a parcel bomb attack in 1919 in which

> thirty identical packages containing sophisticated homemade bombs arrived at or were intercepted on their way to their intended targets throughout the nation. The targets included members of President Woodrow

> Wilson's administration, federal law enforcement officials, members of Congress, judges, mayors, governors, local police officials, and prominent businessmen.[10]

Of greater significance was the use of a horse-and-cart bomb in 1920, which killed 33 people and injured some 200 others. This early VBIED consisted of "100 pounds of dynamite and 500 pounds of … heavy, cast-iron slugs, exploded from a horse and cart parked on the corner of Broad and Wall Street in the heart of the financial district".[11] The attack appears to reflect the innovative capacity of the group, and further provided a prophetic glimpse as to the diversity of IED delivery methods available to non-state actors. Yet the use of the horse and cart was likely to have been driven as much by pragmatism as anything else; previous delivery methods, such as letter bombs, would have aroused suspicion, whereas a seemingly innocuous horse and cart would have seamlessly blended in whilst providing a cost-effective means of delivering such a heavy device to the target.

Second World War

As Van Creveld notes, the Second World War was a point at which two trends intersected, the first "leading toward increasingly larger-scale regular warfare" and the second "emerging out of the shadows and often employing very few weapons".[12] Both such trends and associated collectives of actors employed IEDs. In the case of the former, IEDs assumed a—albeit secondary—role in the arsenal of state forces, where they were opportunistically exploited by both Axis and Allied forces. Indeed, IEDs were prepared and used by a number of different countries over the course of the Second World War, even appearing in literature such as the Home Guard field manual. For the Allied forces and the various associated resistance movements,[13] a number of bombs, including coal torpedoes, explosive booby traps and roadside bombs were employed over the course of the Second World War. On the side of the Axis powers, explosive booby traps employing grenades, mines, and demolition charges were used extensively along with more novel devices, including an "exploding chocolate bar… a Thermos flask, an army mess tin with a bomb hidden beneath the bangers and mash, and a high-explosive device concealed in a can of motor oil".[14]

Concerning those emerging out of the shadows, IEDs were an important component in the activities of groups, such as the Soviet partisans and

the "Jeds". Concerning the former, groups such as the Belarusian guerrillas destroyed swathes of strategically significant railway lines in coordinated IED attacks over the course of the Belarusian 'Rail War'. The Jeds, that is, "American, British, French, Belgian, and Dutch Special Forces personnel" who took part in Operation Jedburgh to support resistance in the territories occupied by the Nazis, were trained in the use of explosives and detonating cord and were involved in acts of resistance against Nazism, including the demolition of rail and road transportation, telecommunications systems, and enemy headquarters, frequently using improvised munitions.[15]

The immediate post-Second World War period also saw the growing use of IEDs by other groups emerging out of the shadows, something apparent in the Middle East, with Irgun and, later, Stern Gang[16] IEDs innovatively and effectively employed against both the Palestinians and the British, thereby undermining efforts to govern Palestine.[17] Such groups explored a number of innovative approaches to increasing the efficacy of IEDs, reportedly coating shrapnel in acid or anti-coagulants (the latter presumably designed to prevent clotting of injuries sustained)[18] and the, largely unsuccessful, use of letter bombs. Yet whilst letter bombs may have proved ineffective, the Irgun's success with IEDs in events, such as the King David Hotel bombing in July of 1946, reconfirmed the relative advantage of IEDs in asymmetrical conflicts, something not lost on the Palestinians. Indeed, not only did the Palestinians learn to use IEDs from an early stage, potentially drawing from experiences with roadside bombs during the inter-war years, but Palestinians innovated and developed Stern Gang techniques, with individuals such as Fawzi el Kuttub, a Palestinian bomb maker allegedly trained by the Nazis,[19] along with British Army deserters undertaking what is an early example of a synchronised, multiple VBIED attack in the Ben Yahuda Street bombing of 1948.[20]

Algeria

IEDs were also fervidly exploited by the *Organisation d'Armee Secrete* [Secret Army Organisation] (OAS) during the Algerian War, with some 48 bombings occurring between the 15 and 28 January of 1962,[21] and the reported killing of as many as 230 Muslims in one week in May of the same year.[22] The terror campaign directed towards "Muslims in Algeria" by the OAS was intended to ferment tension and provoke a violent response that would "force the army to reassert French control".[23] Led by "disaffected

French soldiers and some intelligence officers",[24] the campaign is of particular note for the use of, what were then, new plastic explosives,[25] but also the blind and deadly character of bombings that included attacks on civilians, which alienated many sectors of the French population, and contrary to the aims of the OAS, their actions may have facilitated Algerian independence.[26] Certainly, the disfigurement of a four-year-old girl, Delphine Renard, as a result of an OAS bomb served as a trigger for mass protest, whereas Beckett suggests that "the death of a number of French conscripts in OAS bomb attacks in March 1962 … lost it the support of even those officers who regarded an independent Algeria as a sell out".[27]

States and IEDs

IEDs also continued to retain a role for state actors, specifically Special Forces and guerrilla forces on both sides of the Iron Curtain. Indeed, over the course of the Cold War, IED knowledge, training, and use were widely reported. On the side of the Soviets, there are several allegations of Soviet Committee for State Security (KGB) bomb plots, including the revelations in the papers of the Russian defector, Vasili Mitrokhin, that amongst other things, the KGB plotted to "disrupt the Investiture of the Prince of Wales in 1969" with an aborted bomb plot.[28] Such allegations remain difficult to substantiate, yet with Soviet Special Forces—like their counterparts in other countries—trained in, inter alia, "sabotage using explosives, incendiaries, acids, and abrasives",[29] it would be remarkable, indeed, if IEDs were not used by Soviet Special Forces.

As to training guerrilla forces, changing Soviet foreign policy over the course of the 1970s is argued to have resulted in an expansion of military support and training for allied communist forces around the globe, part of which reportedly included training allied groups in explosives for use in the proxy conflicts of the Cold War.[30] Certainly, defectors and US intelligence estimates have been explicit in their allegations of Soviet support in training radical groups in explosives: for example, General Jan Šejna, one of the highest ranking Communists defectors, provided accounts of Soviet supported terrorist training camps in Czechoslovakia[31]; whereas a US Special National Intelligence Estimate concluded that "thousands of Third World revolutionaries have been provided military training, within the USSR and Eastern Europe … most of the instruction focuses on paramilitary/guerrilla-type activities. Sources describe instruction in … the use of explosives".[32]

Beyond defectors and intelligence sources, there are a number of other reports suggesting Soviet training of insurgent groups, particularly the Palestinian Liberation Organisation (PLO).[33] Indeed, in 1981, Brig. Mohammed Ibrahim al-Shaier, head of the Palestine Liberation Organization's office in Moscow, is reported as stating that "Scores and hundreds of Palestinian officers eligible to command major sectors, such as brigades, have graduated from Soviet military academies" adding that such training was "mostly in scientific and technical fields"[34]; whereas Adnan Jaber, who was accused of involvement in the killing of six Jews in 1980, described the training he underwent in a camp outside Moscow as consisting of instruction in inter alia, the use of explosives.[35]

Regarding the US, the 1975 Senate Select Committee to Study Governmental Operations with Respect to Intelligence Activities (aka the "Church Committee") provides insights into various US Central Intelligence Agency (CIA) plans to assist certain actors in the use of IEDs, for example, through "the delivery … of an electronic detonating device with remote control features, which could be planted by dissidents in such manner as to eliminate *certain key Trujillo henchmen*".[36] It remains less clear whether such technology was delivered yet alone used by the USA; however, with several technical manuals designed to increase the potential of Special Forces through detailing methods for the development of improvised munitions and booby traps, it would be remarkable, indeed, if IEDs had not been used by Special Forces or intelligence operatives of the USA over the course of the Cold War. Moreover, there are several examples in which the USA has been implicated in IED attacks, including more recently, the alleged car bombing of Hezbollah's international operations chief, Imad Mughniyah, by the CIA and Mossad, although this remains difficult to verify.[37]

There is more evidence of the role of the USA in facilitating IED training and the provision of support for the employment of improvised explosive devices. At the so-called Bomb School in Los Fresnos, Texas, selected recruits from foreign countries were trained in "terrorist devices; fabrication and Functioning of Devices; [and] Improvised Triggering Devices". Whilst officially presented as necessary because of the need to train police to deal with bombs, there was, however, "no instruction in destroying bombs, only in making them".[38] More germane to the contemporary context was the reported promulgation of IED training as part of a package of measures in support of the Mujahedeen in Afghanistan in their efforts to repel the Soviets. Through directives such as National Security Decision

Directive 166,[39] in which the Reagan Administration sought to challenge the Soviets "by all means available", there was a concerted effort on the part of the USA to improve "the military effectiveness of the Afghan resistance" including through the provision of Stinger missiles.[40] Yet in addition to more high-tech support, there are also claims of US assistance in the training of the Mujahedeen in bomb making, specifically in "the use of sophisticated fuses, timers and explosives… remote control devices for triggering mines and bombs".[41] Certainly, Mike Davis has described US support for the Mujahedeen as the "greatest transfer of terrorist technology in history" in which the CIA supported an "urban sabotage course" for an estimated "35,000 foreign moslems", a figure which concurs with claims made by Rashid.[42] However, there is a need for caution with such figures and others have suggested the number of foreign fighters was considerably less[43] and/or that bomb making was not a topic of primary importance in Afghan training camps until much later with the beginning of the conflict in Iraq in the twenty-first century.

Afghanistan and the Soviet Invasion

Regardless of any direct link between the USA and the Mujahedeen, over the course of the Mujahedeen's repulsion of the Soviets in Afghanistan, both sets of combatants, the Soviets and the Mujahedeen, are reported to have used "booby traps and explosive devices disguised to look like everyday objects".[44] For the Mujahedeen, there is little to suggest that there was any form of moral debate about the use of IEDs against the Soviets, with regional ethical codes, such as the Pashtunwali, somewhat moot in the face of Soviet aerial bombardment.[45] However, both sides used allegations of IED employment to vilify "the other" in propaganda campaigns. For example, much was made of the statement in the 1985 UN report on Human Rights in Afghanistan, on children "with hands or legs blown off, either by handling booby trap toys or by stepping on mines",[46] with *The New York Times* headline describing these weapons as "Soviet Toys of Death"[47] and Soviet propaganda countering this with claims that these were Mujahedeen weapons.[48]

As to Mujahedeen IEDs, there appears to have been several different pathways towards IED development. This perhaps reflects the different connections and resources of the émigré subgroupings that made up the Mujahedeen, but equally the context of actors and the nature of available materials and targets would have played a role. Certainly, there appears

to have been a distinction between more bespoke devices designed for assassination of political and other targets in urban areas on the one hand, and the use of improvised mines in rural guerrilla operations on the other. With regard to the use of IEDs in urban assassinations undertaken by the Mujahedeen, Haji Mohammad Yakub, an "urban guerrilla in Kabul" has recollected how IEDs were used to "create fear and take out selected individuals" using timed explosive devices, seemingly acquired from Pakistan and smuggled into Soviet facilities or hidden in areas known to be frequented by Soviet personnel.[49]

Regarding the use of IEDs in rural combat, although a number of foreign mines and explosive devices were provided to the Mujahedeen,[50] writing in *The Other Side of the Mountain: Mujahideen Tactics in the Soviet-Afghan War*, Jalali suggests that "many Afghans are inveterate tinkerers and they preferred to make their own anti-tank mines from unexploded ordnance and other anti-tank mines".[51] These grassroots innovations and "tinkerings" are drawn out in a number of first hand vignettes from Mujahedeen commanders that variously describe uses of local, readily available materials in the development and deployment of IEDs. For example, Jalali's text illustrates how the Mujahedeen used household items such as cooking oil containers[52] and water vessels in the development of their devices, and readily available materials, such as manure, to disguise the mines.

Yet, whilst many of the IEDs described were relatively crude unsophisticated devices developed with rudimentary materials, they were remarkably innovative in their deployment, with individuals even devising a form of discriminatory victim-operated mine. Commander Mullah Malang's vignette in *The Other Side of the Mountain* on Demolition Methods provides a number of remarkable insights into improvised Mujahedeen explosive devices and is worth quoting at length:

> The Mujahideen would move heavy unexploded bombs (250–500 kilograms) at night by tractors … and bury them… The bombs were remotely controlled, usually by home-made detonators…If remote-control detonation was unfeasible, the Mujahideen used another method to selectively attack the tracked armored vehicles. The Mujahideen would stretch two metal wires across the paved road. The wires were spaced close together and hooked to an electric battery. The rubber tires of civilian and military vehicles would pass over the wires, but the metal tracks of tanks and BMPs would close the electrical circuit and set off the explosion…. Abdul Wali strapped a 250 kilogram bomb onto some truck tire inner tubes. He measured the

> distance from the outpost to his release point upstream where he would launch his floating bomb. The bomb was hooked to a wire whose length was the length from launch point to outpost. Once the floating bomb stretched out the full length of the wire, it was exactly under the outpost. Abdul Wali remotely-detonated the bomb and destroyed the outpost.[53]

It is of note that many of the experiences and lessons learned from the Afghan–Soviet jihad were reportedly captured for future generations in texts, such as the *Encyclopedia of Jihad*,[54] which is reported to contain a chapter on "explosives" and "bombs & mines". Moreover, following the withdrawal of the Soviets, knowledge transfer on explosives, amongst other things, was conducted through a series of training camps along the Afghan/Pakistan border, at which bomb instructors' taught students bomb-making skills.[55] The Afghan case can therefore perhaps be seen as a case of the darker side of grassroots innovation, with intermediary actors subsequently collecting information and "connect[ed] specific and often isolated local innovation projects with one another and with the wider world".[56]

Northern Ireland and "the Troubles"

Improvised explosives were used by both sides during the "Troubles" in Northern Ireland generating more than 10,000 bomb explosions between 1969 and 2003.[57] Of this number, some 5461 IED events have been attributed to the Provisional IRA (PIRA),[58] who, Horgan et al. suggest, were "responsible for the greatest innovations and the deepest expertise in the construction and deployment of IEDs by any non-state militant group".[59] However, despite later success, early IRA bomb makers relied on commercially available explosives from quarries, home-made explosives, or donations and were plagued with "premature explosions and poor workmanship or untested designs" frequently drawn from US training manuals.[60] Indeed, based on the Sutton Index of deaths during the conflict, there is evidence of more than 100 accidental deaths or "own goals" caused by premature bomb explosions between 1971 and 1975,[61] with Asal et al. stating that "on many occasions at the beginning of the conflict, the sole victim was the IED planter who died due to a premature explosion".[62]

In response to such initial difficulties, the PIRA decided to "loosely centralise bomb development" initially using off the shelf materials both in

order to avoid being compromised in the acquisition or transfer of materials but also to facilitate the replication of devices independently.[63] It was only later that the IRA began to acquire more sophisticated explosives. These were provided by Libyan forces who maintained "large stockpiles of the Czech plastic explosive Semtex, whose most valuable characteristic is that it is odourless, thus making it difficult to trace", a development that led the British to request "the Czechs 'fingerprint' the explosive by including a taggant detectable by scanners".[64]

Under the control of the Engineering Department, over the course of "the Troubles", the PIRA were able to refine bomb designs and develop innovative firing switches, roadside bombs, and mortars using comparatively more secure facilities for development and testing in secluded locations in the Republic of Ireland and away from the border.[65] As to firing switches, early IEDs employed a range of triggers frequently improvising with available materials, such as clothes pegs, mousetraps, and condoms, in the production of time delayed IEDs. The process of centralisation, and the time and space provided to those in the engineering department, enabled a shift from cruder mechanical triggers to command wire switches and later in 1972 (remote) Radio Controlled IEDs and more effective time delay switches. Devices including the latter, "timer and power unit", enabled greater reliability and safety, as well as facilitating operational requirements.[66] The Brighton bombing, for example, employed relatively simple "long-delay timers from video recorders" which nevertheless invited the possibility of installing the device well in advance of the targeted Conservative party conference.[67] Radio control IEDs were particularly important in enabling quicker emplacement and a smaller counter IED forensic footprint,[68] however, radio controlled IEDs were somewhat of a risky incremental innovation, which was initially vulnerable to unanticipated radio signals. Over time, however, radio controlled IEDs became refined by the IRA, leading to a game of cat-and-mouse between the IRA and the British security apparatus, in which electronic countermeasures developed in advanced government facilities countered—and were later countered by—revisions in electronic switches improvised in basements and backrooms in the Republic of Ireland.[69]

In relation to roadside bombs, a number of early efforts such as the nail mine, shotgun mine (a variant of the *fougasses* used in Vietnam), and improvised claymores were rendered ineffective against the armoured cars that were employed by 1972. Accordingly, alternative blast mines and drogue grenades were developed to attack armoured vehicles used by the

army or police[70] along with new approaches to deploying and emplacing such mines that eventually resulted in the army "banning all non-essential vehicle movements".[71] It is also worth noting that a number of improvised mortars were developed by the IRA beginning with relatively crude mortar weapons before advancing to the "barrack buster". The latter weapons, an example of which was the Mark-15, were capable of firing large amounts of explosives from a relatively safe distance and were used to attack British bases. Such weapons served not only to kill and maim but also as both a means to enhance the morale (and recruitment) of the IRA by demonstrating technological prowess, and conversely demoralise the British army and generate media attention to undermine the British campaign.[72]

The use of IEDs thus became more refined over the course of the Troubles, as Kopp has suggested, "the unfortunate historical reality is that the conflict between the IRA and Britain brought about a significant evolution in IED technique",[73] enabling a number of tactical and strategic victories for the IRA. Such IED technique has allegedly been shared with several other actors around the globe, including the Revolutionary Armed Forces of Colombia (FARC)[74] and *Euskadi Ta Askatasuna* (ETA), the Basque separatist group.

However, it was also apparent that the use of IEDs required a delicate balance between drawing attention to the cause and pressuring the British on the one hand, and alienating potential supporters on the other. In some early incidents, the IRA appears to have transgressed what was, in the eyes of some of its sympathisers, a hitherto acceptable level of violence. For example, the group is estimated as conducting some 1300 bomb attacks in 1972,[75] including the simultaneous detonation of more than 20 bombs on Bloody Friday on 21 July 1972; an event that "killed 9 … and injured a further 130",[76] creating what Dingley describes as "a massive wave of anti-IRA revulsion".[77] This was followed by a dip in IED use from 1972 to 1975 in part because of British security countermeasures, but also because the PIRA strategy shifted to a war of attrition in which the "scale and intensity of IED attacks began to decrease in lethality but increased in frequency through the late 1970s" causing the "maximum economic damage" but minimal civilian casualties.[78] The PIRA use of IEDs ebbed and flowed over the course of the conflict with the group able to seemingly "turn… bombings on and off like a tap". Ultimately, it was recognised that the British could not be "bombed out of Ireland",[79] yet the ability to increase bombing attacks at a given point was seen to "strengthen their

position at the bargaining table while keeping active supporters and rank and file recruits happy".[80]

Middle East

For a significant part of the twentieth century, the Middle East has endured a number of IED attacks conducted by a number of different organisations to differing ends. Of particular note in relation to moderns IEDs are the Popular Front for the Liberation of Palestine—General Command (PFLP-GC) and Hezbollah. As to the PFLP-GC, the militant splinter group of the PFLP, there was little evidence of ethical deliberation over the use of violence with the formation of the group, the result of its leader, Ahmad Jabril, reportedly seeking to "focus more on fighting and less on politics".[81] The PFLP-GC gained notoriety as early "technoterrorists", following the bombing of Swissair Flight 330 in February 1970, using an IED detonated by a barometric pressure trigger. The trigger is reported to have been designed by Marwan Kreeshat, a Jordanian who served as the PFLP-GC's "master bombmaker", as a means to detonate a bomb at a specified altitude enabling the destruction of the flight and any evidence.[82] Kreeshat reportedly prepared the bomb over "several months in a Sophia safehouse", before testing the device in a German mountain range.[83] Once validated, the altimeter bomb was disguised as a transistor radio and air-mailed from Germany to Israel when it blew up Flight 330, killing all 47 passengers and crew on board. The group is also of note for Operation Kibya, otherwise known as the "night of the hang-gliders", in which four PFLP-GC members crossed the Lebanese–Israeli border on hang-gliders with an assortment of weaponry, reportedly including booby-trapped gear designed to explode in the event the terrorist were brought down.[84]

The Islamic militancy that followed the Israeli invasion of Lebanon in 1982 spawned a wave of violence from which Hezbollah emerged. From the outset, the group is reported to have received "critical financial support and training from Iran's Revolutionary Guards", including training in "ambush technique [and] concealment and detonation of roadside bombs" in a number of Hezbollah camps in the Bekaa region east of Beirut.[85] Some have gone further, the Swedish expert on Islamic militant groups, Magnus Ranstorp, has argued that the Iranian military were actively involved in major Hezbollah bombings, including both the 1982 bombing of Israeli military headquarters in Tyre when Ahmad Qassir killed 75 soldiers, and the Beirut barracks bombing of 23 October 1983 in

which two truck bombs destroyed the US Marine Corps base near Beirut airport and the "Drakkar" building housing French paratroopers, killing nearly 300 French and US servicemen.

Both attacks are significant. The 1982 attack elevated Ahmad Qassir to legendary status in some quarters. Ranstorp described the event as:

> pioneering, as it represented the first official suicide attack launched by the organisation. More importantly, it symbolically represented the "spirit" of martyrdom in showing and the paving the way for future Hizballah resistance against its enemies. As such, 11 November of every year is designated "Martyr's Day" by the Hizballah movement.[86]

The latter barracks bombings have been argued to have demonstrated the efficacy of terrorism in expediting the expulsion of foreign powers. Certainly, the 9–11 Commission Report stated, "In 1983 came Hezbollah's massacre of the Marines in Beirut. President Reagan quickly withdrew U.S. forces from Lebanon—a reversal later routinely cited by jihadists as evidence of U.S. weakness"[87]; whereas John Lehman, US Secretary of the Navy in 1983 allegedly stated in 2003, "There's no question it [the attack on the US Marine Corps base] was a major cause of 9–11; we told the world that terrorism succeeds."[88]

Over time, Hezbollah became inventive in their use of IEDs, combining high technological sophistication with innovative and effective uses of simpler technology. Thus, on the one hand, Hezbollah have integrated photocells and mobile phone technology into IEDs[89] and developed electronic interference capabilities with which to "jam Israeli radar and closed-circuit television monitors".[90] On the other hand, they have been imaginative with simpler technology, for example, concealing roadside bombs in "fake plastic rocks, which could be bought in Beirut garden stores for $15",[91] "hanging IEDs on tree branches because the Israelis came to expect them to be on the ground",[92] or "fusing suicide attacks into a synchronised mode".[93] Hezbollah also appear to have cleverly exploited the media as a means to relay its victories and inspire potential recruits and demoralise enemies. In 2000, the *New York Times* quoted one Hezbollah commander, Sheik Nabil Qaou, as stating thus: "The use of media as a weapon had an effect parallel to a battle… By the use of these films, we were able to control from a long distance the morale of a lot of Israelis."[94]

Whilst the extent of Iranian patronage remains somewhat murky, what is clear is Hezbollah have become highly innovative in IED construction and

deployment. As one Obama administration official testified, "Hizballah remains the most technically-capable terrorist group in the world,"[95] a label that is of particular concern given the reports of Hezbollah's knowledge transfer to groups with similar objectives. Byers reports, "In the 1990s, Hezbollah was training members of the terrorist groups Al Qaeda, Hamas, and the Palestinian Islamic Jihad in the use of explosives,"[96] as well as allegedly providing support to other organisations operating in Latin America[97] and Sri Lanka.

Sri Lanka

Several sources have claimed Hezbollah provided training to recruits of the Liberation Tigers of Tamil Eelam (LTTE) over the course of the early 1980s,[98] and certainly, the LTTE's first major bombing attack was reminiscent of the first Hezbollah attack.[99] However, the 1999 *Landmine Monitor* suggested a role was played by India, stating the "LTTE were originally trained in use of mines and IEDs by Indian security forces".[100] Whatever the origins of LTTE capabilities, the group have since demonstrated a number of remarkable indigenous tactical and technological innovations with IEDs and are variously accredited by the US Federal Bureau of Investigation (FBI) with the invention of the suicide belt, the perfecting of the use of suicide bombers and the pioneering use of women in suicide attacks.[101]

The LTTE were born out of institutionalised discrimination under the Silhanese dominated governmental structures of Sri Lanka. Although initially responding through non-violent protests or a policy of *satyagraha*, the failure of peaceful protests led to growing violence in the 1970s from which emerged several insurgent groups, including the Tamil National Tigers (TNT) led by Prabhakaran.[102] Fuelled by grievances generated through an aggressive counter insurgency strategy of the Sri Lankan security services, Prabhakaran consolidated his role and that of the TNT, later renamed the LTTE, by adopting a policy of targeted assassination and explosive violence seemingly beginning in 1978 when the Tamils placed a time bomb on an Air Ceylon passenger jet which fortunately detonated whilst the plane was still grounded.[103] In the ensuing conflict, Christine Fair suggested the group made "heavy use of improvised mines on tactically valuable roads to deter the initiatives of the [military]" reportedly "burrowed holes under the road surface" and implanting explosives that were detonated using a multitude of trigger devices.[104]

What makes the LTTE of particular note, however, is their use of suicide bombers. In 1987, in response to the "intensification of the Sri Lankan government's military and economic campaign",[105] the LTTE adopted "suicide" IED tactics when Captain Miller of the LTTE drove a truck filled with explosives into a military camp in Point Pedro, killing between 39 and 100 soldiers and facilitating the subsequent incursion into the camp by LTTE forces.[106] Although the anniversary of Miller's death, not unlike Ahmad Qassir, is celebrated in some quarters on "Black Tigers Day", Hopgood suggests the attack may not have been intended as a suicide attack, but rather "Miller was unable to get clear and was also killed in the blast`".[107] Nevertheless, the attack demonstrated the role of suicide bombings—deliberately or accidentally—as serving a role equivalent to "a massive artillery shell" with which to augment commando assaults, albeit a role which requires considerable resources to "build and then maintain a culture of martyrdom".[108] As Hopgood has written, the elite Black Tiger suicide battalions that emerged following Miller's death served two purposes: "first, to compensate for a lack of heavier weaponry; and second, to engage in commando-like actions to secure inaccessible or difficult targets, including assassinations."[109]

Over the course of the ensuing decades, the LTTE have become adept and innovative in IED development. Figures of LTTE suicide attacks are difficult to accurately gauge with certainty; however, Hassan estimates that the Black Tigers "carried out ninety-three suicide bombing missions which caused 1,172 deaths" between 1986 and 2006, the majority of which were targeted at security forces and officials[110]; whereas Fair has suggested, "The LTTE executed 168 of the 271 known suicide attacks carried out by all groups throughout the world between 1980 and 2000."[111] Indeed, over the course of the campaign, the LTTE have become well organised and competent in IED development and deployment, conducting extensive target surveillance and analysis of their own attacks "for post-mission debriefings and for planning future attacks".[112]

The group are of further note for their exploitation of sea-based IEDs, specifically explosive-laden speedboats,[113] underwater demolition teams,[114] and the use of home-made submersible and semi-submersible "human torpedo" craft. The development of the sea-based suicide division, the Black Sea Tigers, reportedly emerged as a means to "counter the success of the Sri Lankan and Indian navies in denying sea-based supply routes to the LTTE",[115] and has since proven successful with boat-borne suicide attacks being mirrored elsewhere, including by Al Qaeda in its attack on

the USS Cole. Human torpedo craft are understood to be prepared for use in suicide attacks, presumably for use against very high-profile targets. Whilst relatively crude compared with modern military submersibles, the indigenous development of submersibles suicide craft by the LTTE nevertheless demonstrates a degree of sophistication in IED delivery on the part of group,[116] and suggests the provision of not inconsiderable time and resources. Indeed, as Kennedy-Pipe has stated, the LTTE had the advantage of a "long period to develop such capability; a well-financed organisation; [and] relatively secure territory".[117]

Notes

1. Sale R. E. 1886. "On Land Mines." *Journal of the Royal United Services Institution* 30 (133): 95–106. doi:10.1080/03071848609416365. http://www.tandfonline.com/doi/abs/10.1080/03071848609416365.
2. Griffiths, Hugh, and Alastair McAslan. 2009. "Low Frequency Radar for Buried Target Detection." *NATO Science for Peace and Security Series B: Physics and Biophysics*: 125–140. Pg 2.
3. Litowitz, Jason A. 2011. "The Infernal Machine: The Use of Improvised Explosive Devices, IED, Against U.S. Forces." Marine Corps University.
4. Landau, Henry. 1937. *The Enemy Within*. New York: Van Rees Press. Pg 45.
5. Alleyne, Richard. 2010. "Garland of Arabia: The Forgotten Story of TE Lawrence's Brother-in-Arms." *The Telegraph*, July 30. http://www.telegraph.co.uk/news/uknews/7918929/Garland-of-Arabia-the-forgotten-story-of-TE-Lawrences-brother-in-arms.html.
6. Boyce, Frederic, and Douglas Everett. 2014. *SOE: The Scientific Secrets*. Ebook edit. Vol. 8. History Press Limited.
7. In Chapt. XVII of the *Seven Pillars of Wisdom*, Lawrence states that "Garland single-handed was teaching the Sherifians how to blow up railways with dynamite, and how to keep army stores in systematic order". See Lawrence, T.E. 1926. Seven Pillars of Wisdom. Reproduced by Project Gutenberg.
8. Imperial War Museum. 1980. "Norman, Compton Patrick (IWM Interview)." UK. http://www.iwm.org.uk/collections/item/object/80004589.
9. Simon. "The Forgotten Terrorists.
10. Simon. "The Forgotten Terrorists. Pg 199.
11. Simon. "The Forgotten Terrorists.
12. Van Creveld, Martin. 1994. "The Rise and Fall of Military Technology." *Science in Context* 7 (02) (September 26): 327–351. doi:10.1017/S026988970000171X. http://www.journals.cambridge.org/abstract_S026988970000171X. Pg 343.

13. See Irwin, Will. 2005. *The Jedburghs: The Secret History of the Allied Special Forces, France 1944.* Public Affairs. Pg 65.
14. Higham. N. 2015. "Drawings reveal Germans' World War Two boobytrap bombs", *BBC News*, 30 September 2015.
15. Irwin, Will. 2005. *The Jedburghs.* Pg 65.
16. Charters, David A. 2007. "Jewish Terrorism and the Modern Middle East by." *The Journal of Conflict Studies* Winter: 80–89.
17. Hansard. 1947. "PALESTINE (JEWISH TERRORISM)." http://hansard.millbanksystems.com/commons/1947/jan/31/palestine-jewish-terrorism.
18. Davies, Roger. 2014. "Things That Have Happened before." *Standing Well Back.* http://www.standingwellback.com/home/2014/6/18/things-that-have-happened-before.html.
19. LeBor, Adam. 2014. "Zion and the Arabs: Jaffa as a Metaphor." World Policy Journal 24 (4): 61–75; Davies, Roger. 2014. "1948 Truck Bombs by British Army Deserters." *Standing Well Back.* http://www.standingwellback.com/home/2014/8/10/1948-truck-bombs-by-british-army-deserters.html.
20. Davies. Things That Have Happened before.
21. Evans, Martin. 2011. "17 October 1961: Fifty Years on." OUP Blog. http://blog.oup.com/2011/10/17october1961/.
22. Townshend, Charles. 2011. *Terrorism: A Very Short Introduction.* Oxford University Press. Pg 50.
23. Beckett, Ian. 2001. *Modern Insurgencies and Counter-Insurgencies: Guerrillas and Their Opponents since 1750.* Routledge. Pg 167.
24. Gregory, Shaun. 2003. "France and the War on Terrorism." *Terrorism and Political Violence* 15 (1) (March): 124–147.
25. Townshend. Terrorism. Pg 50.
26. Chaliand, Gérard, and Arnaud Blin. 2007. "The Invention of Modern Terror." In *The History of Terrorism: From Antiquity to Al Qaeda*, 474. University of California Press. Pg 206.
27. Beckett. *Modern Insurgencies and Counter-Insurgencies.* Pg 167.
28. BBC. 1999. "Prince of Wales 'Bomb Plot' Revealed." *BBC News.* http://news.bbc.co.uk/1/hi/wales/446072.stm.
29. Boyd, Robert S. 1986. "SPETSNAZ Soviet Innovation in Special Forces." *Air University Review* November. http://www.airpower.maxwell.af.mil/airchronicles/aureview/1986/nov-dec/boyd.html.
30. Shultz, Richard. 2007. "The Role of External Forces in Third World Conflicts The Role of External Forces in Third World Conflicts." *Comparative Strategy* (October 2013): 37–41.
31. Gerringer, Arthur E. 2002. *Terrorism: From One Millennium to the Next.* iUniverse.

32. CIA. 1981. "Soviet Support For International Terrorism and Revolutionary Violence, Special National Intelligence Estimate." http://www.foia.cia.gov/sites/default/files/document_conversions/89801/DOC_0000272980.pdf. Pgs 8 & 10.
33. Rubinstein, Alvin Z. 1990. Moscow's Third World Strategy. Princeton University Press.
34. Reuters. 1981. "P.L.O. Says 'Hundreds' Were Trained by Soviet." *The New York Times*. http://www.nytimes.com/1981/02/18/world/plo-says-hundreds-were-trained-by-soviet.html.
35. Hiro, Dilip. 2013. Inside the Middle East (Routledge Revivals). Taylor & Francis.
36. The Church Committee. 1975. "Interim Report: Alleged Assassination Plots Involving Foreign Leader." http://www.aarclibrary.org/publib/church/reports/ir/html/ChurchIR_0105b.htm. Pg 196.
37. Goldman, Adam, and Ellen Nakashima. 2008. "CIA and Mossad Killed Senior Hezbollah Figure in Car Bombing." *The Washington Post*, January 30.
38. "During congressional investigations, led by Senator James Abourezk in 1973, AID officials admitted that the Los Fresnos sessions—what the press would call the "Bomb School"—offered lessons not in bomb disposal but in bomb making: "The thrust of the instruction … introduces trainees to commercially available materials and home laboratory techniques…in the manufacture of explosives and incendiaries… Different types of explosive devices and 'booby-traps' and their construction and use by terrorists are demonstrated" Letter of Matthew J. Harvey to Senator Abourezk, 25 September 1975 (photocopy)" as cited in: McClintock, Matthew. 1992. *Instruments of Statecraft: U.S. Guerilla Warfare, Counter-Insurgency, Counter-Terrorism, 1940–1990*. Pantheon Books. Also note that Blum suggests "A discussion of various weapons which may be used by the assassin" is how Office of Public Safety (OPS) put it; and instruction on the design, manufacture, and employment of bombs and incendiary devices taught at "Bomb School" in Los Fresnos Texas. The Official OPS explanation for the bomb bourse was that policemen needed such training in order to deal with bombs placed by terrorists. There was however no instruction in destroying bombs, only in making them. Blum, William. 2006. *Rogue State: A Guide to the World's Only Superpower*. Zed Books.
39. The White House. 1985. "U.S. Policy, Programs and Strategy in Afghanistan, National Security Directive Number 166." http://fas.org/irp/offdocs/nsdd/nsdd-166.pdf.
40. Wogan, Chris. 2004. *AmIraqa and the New American Century*. Lulu.com; Kuperman, Alan J. 1999. "The Stinger Missile and U.S. Intervention in Afghanistan." *Political Science Quarterly* 114 (2) (June 15): 219–263. doi:10.2307/2657738. http://doi.wiley.com/10.2307/2657738.

41. Cooley, John K. 2002. *Unholy Wars: Afghanistan, America and International Terrorism*. Pluto Press. Pg 72.
42. Davies, Mike. 2008. *Buda's Wagon a Brief History of the Car Bomb*. Verso Books. Pgs 94–95 notably Ahmed Rashid reaches the same figure in his claim that "between 1982 and 1990 the CIA working with the ISI and Sauid Arabias intelligence service, funded the training, arrival and arming of some thirty five thousand Islamic militants", Rashid, Ahmed. 2008. *Descent into Chaos*. Allen Lane. Pg 39.
43. Jason Burke, the renowned investigative journalist with the Guardian, reported in 1999 that "American officials estimate that, from 1985 to 1992, 12,500 foreigners were trained in bomb-making, sabotage and urban guerrilla warfare in Afghan camps the CIA helped to set up" Burke, Jason. 1999. "Frankenstein the CIA Created." *The Guardian*, January 17. http://www.theguardian.com/world/1999/jan/17/yemen.islam. This is however acknowledged to be an overestimate.
44. Braithwaite, Rodric. 2011. *Afgantsy: The Russians in Afghanistan, 1979–89*. Profile Books.
45. As Jalali's text states "Many people find such bombing attacks morally reprehensible, yet have no qualms when much larger bombs are dropped from aircraft. Neither type of bombing attack is surgical and both types kill innocent bystanders." See the commentary on Pg 370 of Jalali, Ali Ahmad, and Lester W. Grau. 2012. *The Other Side of the Mountain: Mujahideen Tactics in the Soviet-Afghan War*. Tales End Press.
46. United Nations Economic and Social Council. 1988. "Report on the Situation of Human Rights in Afghanistan Prepared by the Special Rapporteur, Mr. Felix Ermacora, in Accordance with Commission on Human Rights Resolution 1985/38." http://www.refworld.org/pdfid/482996d02.pdf. Pg 30.
47. The New York Times. 1985. "Soviet Toys of Death." *The New York Times*, December 10. http://www.nytimes.com/1985/12/10/opinion/soviet-toys-of-death.html.
48. Braithwaite. *Afgantsy*.
49. Jalali & Grau. *The Other Side of the Mountain*.
50. Jalali & Grau. *The Other Side of the Mountain*.
51. "Mining Attacks Near Mehtar Lam" by Commander Sher Padshah and Sheragha IN Jalali & Grau. *The Other Side of the Mountain*. Pg 143.
52. Jalali & Grau. *The Other Side of the Mountain*. Pg 143.
53. Jalali & Grau. *The Other Side of the Mountain*. Pg 141.
54. Stenersen, Anne. 2013. "'Bomb-Making for Beginners': Inside Al Al-Qaeda E-Learning Course." *Perspectives on Terrorism* 7 (1): 25–37. http://www.terrorismanalysts.com/pt/index.php/pot/article/view/241/pdf.
55. Stenersen. 'Bomb-Making for Beginners".

56. Hargreaves, Tom, Sabine Hielscher, Gill Seyfang, and Adrian Smith. 2013. "Grassroots Innovations in Community Energy: The Role of Intermediaries in Niche Development." *Global Environmental Change* 23 (5): 868–880. doi:10.1016/j.gloenvcha.2013.02.008. http://dx.doi.org/10.1016/j.gloenvcha.2013.02.008.
57. This is based on data available from the University of Ulster maintain "CAIN" project. http://cain.ulster.ac.uk/ni/security.htm#06
58. Asal, Victor, Paul Gill, Karl Rethemeyer, and John Horgan. 2013. "Killing Range: Explaining Lethality Variance within a Terrorist Organization." *Journal of Conflict Resolution* 00 (0): 1–27. doi:10.1177/0022002713508927. http://jcr.sagepub.com/cgi/doi/10.1177/0022002713508927.
59. Horgan, John, Paul Gill, Sam Hunter, and James Piazza. 2013. *"From Bomb to Bomb-Maker"*, International Center for the Study of Terrorism.
60. Allison, John. 2008. "Terrorist Weapons and Technology." In *Combating Terrorism in Northern Ireland*, edited by James Dingley, 308. Psychology Press. Pg 103.
61. This is based on the data provided through the Sutton Index of Deaths which provides data from the conflict in Ireland between 14 July 1969 and 31 December 2001.
62. Asal et al. Killing Range.
63. Allison. Terrorist weapons and technology.
64. Charters, David. 1994. *The Deadly Sin of Terrorism: Its Effect on Democracy and Civil Liberty in Six Countries*. Greenwood Publishing Group. Pg 298.
65. Examples of such bases include farm near Clonaslee, Co Laois, See Allison. Terrorist weapons and technology. See also, for example, Cusack. J. 1996 "Six arrested as gardai find IRA bomb factory at Co Laois farm", *The Irish Times*, http://www.irishtimes.com/news/six-arrested-as-gardai-find-ira-bomb-factory-at-co-laois-farm-1.60269.
66. Allison. Terrorist weapons and technology.
67. English, Richard. 2013. "Terrorist Innovation and International Politics: Lessons from an IRA Case Study?" *International Politics* 50 (4). Nature Publishing Group: 496–511. doi:10.1057/ip.2013.18. http://www.palgrave-journals.com/doifinder/10.1057/ip.2013.18.
68. Allison. Terrorist weapons and technology.
69. Hoffman, Bruce. 1998. *Inside Terrorism*. London: Victor Gollancz. Pg 183.
70. Clutterbuck, Richard. 2007. "Trends in Terrorist Weaponry." *Terrorism and Political Violence* 5 (2): 37–41.
71. Allison. Terrorist weapons and technology.
72. Allison. Terrorist weapons and technology.
73. Kopp, Carlo. 2007. "Technology of Improvised Explosive Devices." *Defence Today* 6 (3); Or as Kenney suggests "Effective lesson drawing, as practiced by the IRA in their decades-long conflict with the British authorities, requires a sustained campaign of operations, whereby violent practitioners draw on

their bloody experience to improve their attacks and avoid repeating earlier mistakes" Kenney, Michael. 2008. "Organizational Learning and Islamic Militancy." https://www.ncjrs.gov/pdffiles1/nij/grants/226808.pdf.

74. This remains contested, however see Murphy, John F. 2005. "The IRA and the FARC in Colombia." *International Journal of Intelligence and CounterIntelligence* 18 (1): 76–88. doi:10.1080/08850600590905753. http://www.tandfonline.com/doi/abs/10.1080/08850600590905753; Cragin, Kim, Peter Chalk, Sara A. Daly, and Brian A. Jackson. 2007. "Sharing the Dragon's Teeth Terrorist Groups and the Exchange of New Technologies." RAND Corporation.
75. O'Brien, Brendan. 1999. *The Long War: The IRA and Sinn Féin*. Syracuse University Press. Pg 119.
76. Asal *et al*. Killing Range.
77. Dingley, James. 2012. *The IRA: The Irish Republican Army*. ABC-CLIO. Pg 99.
78. Asal et al. Killing Range.
79. Allison. Terrorist weapons and technology.
80. Asal et al. Killing Range.
81. Office of the Coordinator for Counterterrorism (US). 1999. "Background Information on Foreign Terrorist Organizations October 8, 1999." *Foreign Terrorist Organisations*. http://www.state.gov/j/ct/rls/rpt/fto/2801.htm.
82. Katz, Samuel M. 2004. *Jerusalem Or Death: Palestinian Terrorism*. Twenty-First Century Books. Pg 37.
83. Dolnik, Adam. 2009. *Understanding Terrorist Innovation: Technology, Tactics and Global Trends*. Routledge. Pg 82.
84. Dolnik. *Understanding Terrorist Innovation*.
85. See: Erlanger, Steven, and Richard Oppel. 2006. "A Disciplined Hezbollah Surprises Israel With Its Training, Tactics and Weapons." *The New York Times*, August 7. http://www.nytimes.com/2006/08/07/world/middleeast/07hezbollah.html?pagewanted=all&_r=0; Addis, Casey L, and Christopher M Blanchard. 2011. "Hezbollah: Background and Issues for Congress." *Congressional Research Service*, 1–33; Kagan, Kimberly. 2013. *The Surge: A Military History*. Encounter Books. Pg 32.
86. Ranstorp, Magnus. 2005. "The H Hizballah Training Camps of Lebanon." In *The Making of a Terrorist: Volume II Recruitment*. Praeger Security International. Pg 250.
87. National Commission on Terrorist Attacks Upon the United States. 2004. "The 9/11 Commission Report." Washington DC. Pg 98.
88. As cited in Dodd, Scott, and Peter Smolowitz. 2003. "1983 Beirut Bomb Began Era of Terror." *Knight Ridder Newspapers*. http://www.deseret-news.com/article/515039782/1983-Beirut-bomb-began-era-of-terror.html?pg=all.
89. Ranstorp. The Hizballah Training Camps of Lebanon. Pg 255.

90. Kifner, John. 2000. "In Long Fight With Israel, Hezbollah Tactics Evolved." *The New York Times*, July 14. http://www.nytimes.com/2000/07/19/world/in-long-fight-with-israel-hezbollah-tactics-evolved.html.
91. Kifner. In Long Fight With Israel, Hezbollah Tactics Evolved.
92. Gleis, Joshua L., and Benedetta Berti. 2012. *Hezbollah and Hamas: A Comparative Study*. JHU Press.
93. Ranstorp. The Hizballah Training Camps of Lebanon.
94. Kifner. In Long Fight With Israel, Hezbollah Tactics Evolved.
95. Feltman, Jeffrey D. 2010. "Assessing the Strength of Hizballah."
96. Byers, Ann. 2003. *Lebanon's Hezbollah*. The Rosen Publishing Group Inc. Pg 49.
97. Ranstorp. The Hizballah Training Camps of Lebanon.
98. According to Pape, professor of political science at the University of Chicago and director of the Chicago Project on Suicide Terrorism, "several Tamil Tiger cadre … were training in some Hezbollah terrorist camps right at the moment that there was that spectacular suicide truck bombing of the U.S. Marines in Beirut". Neary, Lynn. 2009. "Tamil Tigers: Suicide Bombing Innovators – An Interview with Robert Pape." *NPR*. http://www.npr.org/templates/story/story.php?storyId=104391493.
99. Hassan, Riaz. 2014. *Life as a Weapon: The Global Rise of Suicide Bombings*. Routledge. Ehud Sprinzak. 2009. "Rational Fanatics." *Foreign Policy* November(120):66–73.http://foreignpolicy.com/2009/11/20/rational-fanatics/.
100. International Campaign to Ban Landmines. 1999. "Sri Lanka." *Landmine Monitor Report 1999*. http://www.the-monitor.org/index.php/publications/display?url=lm/1999/sri_lanka.html; Fair, Christine. 2004. *Urban Battle Fields of South Asia: Lessons Learned from Sri Lanka, India, and Pakistan*. RAND Corporation. http://www.rand.org/content/dam/rand/pubs/monographs/2004/RAND_MG210.pdf.
101. FBI. 2008. "Taming the Tamil Tigers – From Here in the U.S." http://www.fbi.gov/news/stories/2008/january/tamil_tigers011008.
102. Hassan. *Life as a Weapon*. Pg 150.
103. Dissanayaka, T.D.S.A. 2005. *War Or Peace in Sri Lanka*. Popular Prakashan. Pg 36.
104. Fair. *Urban Battle Fields of South Asia*.
105. Hopgood, Stephen. 2005. "Tamil Tigers, 1987–2002." In *Making Sense of Suicide Missions*, edited by Diego Gambetta, 16:301–15. Oxford University Press. doi:9780199276998.
106. Hassan. *Life as a Weapon*. Pg 156.
107. As cited in Hopgood. Tamil Tigers. Pg 50.
108. Burke, Jason. 2015. *The New Threat: From Islamic Militancy*. Random House. Pg 99.

109. Hopgood. Tamil Tigers. Pg 46.
110. Hassan. *Life as a Weapon*. Pg 159.
111. Fair. *Urban Battle Fields of South Asia*. Pg 44.
112. Hassan. *Life as a Weapon*. Pg 157.
113. Kennedy-Pipe, Caroline. 2010. "The Historical Use Of Maritime Improvised Explosive Devices." *Hull University Centre for Security Studies IED Project Occasional Paper No. 1*. Hull University Centre for Security Studies IED Project Occasional Paper No. 1 THE. http://www2.hull.ac.uk/fass/pdf/CSSOccasionalPaper1.pdf.
114. Hashim, Ahmed. 2013. *When Counterinsurgency Wins: Sri Lanka's Defeat of the Tamil Tigers*. University of Pennsylvania Press.
115. Fair. *Urban Battle Fields of South Asia*. Pg 39.
116. Hashim. *When Counterinsurgency Wins*.
117. Kennedy-Pipe. "The Historical Use Of Maritime Improvised Explosive Devices."

CHAPTER 4

IEDs in "New Wars"

Abstract This chapter looks at the role and rise of IEDs in the New Wars of the twenty-first century, paying particular attention to Afghanistan, Iraq, and Syria, but also looking across the globe at how IEDs have emerged as the paradigmatic weapons of asymmetrical conflicts.

Keywords IED • New wars • Afghanistan • Taliban • Iraq • Syria • Al Qaeda

The concept of New Wars has been developed by Professor Mary Kaldor and others to denote a form of organised violence that remains markedly different to the state-centric conflicts that characterised the nineteenth and twentieth century. By Kaldor's admission, "New Wars" are not entirely new, with precedents in a number of past insurgency movements. Yet the actors, the objectives of the conflicts, the forms of financing, and—perhaps most significant for this text—the methods of war *are* different in conflicts such as those which are ongoing in Iraq, Afghanistan, and Syria,[1] and in which IEDs have become much more widely diffused and employed to the extent they can be considered paradigmatic weapons. They have become paradigmatic in New Wars not because of a breakthrough in any single technology or as a result of socio-political change but rather a combination of factors. This includes a sequence of innovations in—and the growing availability of—various component technologies of IEDs, the swelling

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of accessible information, and changes in the broader environment that have created windows of opportunity for IED use.

Such a trend is particularly evident in the case of Iraq, discussed below, wherein a combination of several factors created fertile terrain for the use of IEDs. The first was the ready availability of military grade explosives acquired by Sunni groups by the pilfering of the former regimes caches of explosive materials. Second was the prevalence of other IED components, such as switches and power sources, that were relatively easy to acquire from commercially available electronics and communications technology. Third, the ready supply of relevant expertise for IED development, in part as a result of the demobilisation of Baathist regime forces including those with expertise in IEDs but also as a result of the availability of information on the Internet. Fourth was the windows of opportunity for IED attacks generated by the nature of the conflict and the availability of targets within; both in the form of coalition troops engaged in more population centric security measures or indeed, institutions of the embryonic Shia-dominated state. Fifth was the general breakdown of law and order following the invasion of Iraq; and sixth was the long-term influence of more puritanical forms of Islam which, for some, were interpreted as justifying the killing of apostates.[2] The outcome of this milieu can be seen as fuelling the emergence of IEDs as paradigmatic weapons; a development that has broader implications for contemporary approaches to security and the configuration of armed forces.

Afghanistan

In 1998, landmine-like IEDs were initially denounced by Taliban leader Mullah Omar as "un-Islamic" and "anti-human"[3]; however, any such criticism appears to have eroded over the course of the last decade with estimates of more than 4,866 civilian casualties, including 1,480 civilian fatalities, caused by IEDs in Afghanistan between 2009 and 2010 alone.[4] The extensive use of IEDs in the ongoing conflict in Afghanistan has been justified in statements from the Islamic Emirate of Afghanistan on the grounds that "our defenseless nation has very limited tools to counter the advanced and indiscriminate weapons deployed by the enemy".[5] Over the course of the more recent conflict in Afghanistan (and Iraq), IEDs have become increasingly salient in the security discourse as a result of the severity and frequency of their use in these conflicts, with some

suggestion that IEDs are the largest threat to coalition forces[6] and civilians in Afghanistan.[7]

In the case of Afghanistan, post-2001, IEDs—at least in the earlier years of the twenty-first century—are reported to have typically consisted of home-made weapons produced using calcium ammonium nitrate (CAN) fertiliser, which is produced in Pakistan, and employing victim-operated pressure plates.[8] However, recent efforts to tighten controls over CAN, including a prohibition on the import, production, transportation, use, sale, and storage of ammonium nitrate fertiliser in Pakistan, have led to a number of alternative pathways to IED development.[9] Indeed, indicators suggest that Afghan insurgent groups have now adopted a number of different pathways. Some have turned their attention to IEDs "manufactured from conventional ammunition, explosives, and other items diverted from military stockpiles".[10] Others appear to be using potassium chlorate—which has been widely used in IEDs—as a substitute to home-made CAN devices,[11] possibly as a result of the growth in influence of the Haqqani network and their ability to provide the Taliban and other actors in Afghanistan with alternative IED materials to CAN.[12]

Afghan IED networks are frequently based around family or clan ties with funding—and perhaps skills[13]—coming from the drugs trade,[14] and information feeding into a network from both the wider community and higher-level actors in the insurgency.[15,16] Such horizontal and vertical support has ensured a degree of dynamism in the operational environment.[17] Clan-based relationships between actors of different generations are likely to have facilitated the transfer of both recipes and tacit knowledge applied in other past conflicts, such as the Kashmiri conflict and the Mujahedeen repulsion of the Soviets a decade earlier. Such knowledge has further been institutionalised in the curriculum taught in training camps that have existed for decades in one form or another. There is little concrete information on these training camps or the nature of the training, but what can be gleaned from accounts such as Nasiri's *Inside the Jihad*, outlines how explosives experts, such as the Algerian, Assad Allah, were brought in to train recruits who were required to learn how to make homemade explosives from scratch using household materials and equipment which could be easily stolen from school laboratories.[18]

The linkages with more senior operatives in the insurgency, however, suggest that the transfer of knowledge from the Mujahedeen to its contemporary manifestation in the form of the Taliban has been augmented

by information sharing between groups active in other conflicts. For example, Johnson suggests that in late 2005, Iraqi insurgents met with Afghan counterparts to share "the latest IED technology and suicide-bomber tactics".[19] Some have suggested this meeting resulted in "new weapons and techniques… [for the Taliban]… bigger and better IEDs for roadside bombings, and suicide attacks",[20] and indeed this trend is reflected in the growing sophistication and lethality of Afghan IED attacks. However, there are many other sources of information available and Taliban IEDs have nevertheless retained a "distinctly local version of an international trend",[21] and one that has evolved in tandem with the Coalition's efforts to respond to the IED threat.

Indeed, whilst coalition forces have attempted to counter IED innovations, there remains a situation of cat-and-mouse between the military and insurgents; as coalition forces respond to one trend through, for example, improved detection and deactivation capabilities, insurgents have counter-innovated with photosensitive triggers, reducing the metallic content of IEDs to make them harder for coalition forces to detect,[22] rotating or integrating multiple triggers which are initiated by attempts to deactivate IEDs, placing a "second bomb … hidden directly beneath the first", and even targeting softer options to avoid coalition electronic countermeasures.[23] As the US National Academies study indicates, insurgents are able to adapt comparatively quicker than coalition forces are able to "develop and field IED countermeasures"; in addition to which, insurgent groups are also able to innovate with operational tactics and targeting, with evidence of insurgent groups moving the field of operation, for example, from Kandahar to the Helmand River Valley "apparently as a result of the increased deployment there of NATO forces".[24]

IEDs serve a number of functions in the Afghan conflict and the utility of IEDs is not constrained to their physiological effect, significant as it has been. At the strategic level, IEDs have had a profound effect on efforts by coalition forces to expel the Taliban from population centres as it requires coalition forces to be more mobile, and thus "inescapably more vulnerable to the IED attacks".[25] In contrast to Iraq, however, this has largely been done less through the spectacular (at least in early stages of the conflict), as much as the "steady attrition of security forces".[26] Such an approach may have drawn from past experience of wearing down technologically and numerically superior enemies during the Soviet occupation.

Iraq

Although Western governments increasingly recognised the changing nature of warfare and identified IEDs as a possible tool of insurgents, "neither the U.S., Australian, nor United Kingdom (UK) militaries commenced operations in Iraq in 2003 with a mature counter-IED (CIED) capability; nor, apparently, did they anticipate the emergence of a significant IED threat".[27] The extent of IED usage in Iraq is thus likely to have proven a dangerous surprise for the Coalition,[28] with IEDs emerging as "the single most effective weapon against [coalition] deployed forces"[29] and a significant number of sophisticated devices constructed using huge quantities of ordnance pilfered from unsecured and perhaps un-securable "Iraqi ammunition stockpiles and pre-war established caches" distributed across the country.[30] The use of such military ordnance has several advantages as it comes tried and tested, with devices readily optimised for fragmentation, less vulnerable to leakage, and more resistant to environmental degradation providing them with a long shelf life.

In addition to the abundance of materials, there is also evidence of significant expertise amongst some insurgent groups, potentially exploiting the experience of former regime elements, particularly those in the Baathist Iraqi Intelligence Services,[31,32] and those working on the Al Ghafiqi Project[33] under Saddam. The latter project is of particular note as it is reported to have "designed a number of clever ways to conceal explosives, including in books, briefcases, belts, vests, drink containers, car seats, floor mats, and facial tissue boxes".[34] Furthermore, McFate reports that those involved in the Al Ghafiqi Project "also produced manuals on how to conduct roadside ambushes using IEDs; how to construct IEDs from conventional high explosives and military munitions; and how to most effectively take out a convoy by disguising an IED".[35] The availability of such tacit and explicit knowledge is likely to have facilitated the comparatively rapid process of innovation in Iraqi IEDs as well as other Middle Eastern flashpoints, with information being digitised, and further circulating across insurgent networks and websites, effectively providing open access to guidance on IEDs.

IED attacks on coalition forces began in late March 2003, when 100 pounds of C-4 plastic explosive packed in the boot of a car was detonated at a US Army checkpoint.[36] Since 2003, the use of IEDs has increased significantly with more than 100 attacks occurring a month from the end of 2003. By April 2005, this number increased to more than 1,000 attacks

a month, before plateauing at a figure of more than 2,500 IED attacks a month from the summer of 2006,[37] to autumn 2007 subsequent to which the frequency and efficacy of IED events fell away sharply.[38]

The insurgent groups behind such attacks in Iraq are not monolithic, with different groups adopting different pathways depending on their resources, objectives, and patronage. Amongst different Shia groups, IEDs have generally been used less frequently and in a manner that is less spectacularly apocalyptic than Sunni groups. This is perhaps, in part, because of the political context and more modest state building-orientated objectives of key Shia groups that lend themselves better to the use of smaller IEDs or other means of violence. For example, the breakaway factions or "Special Groups" of the *Jaysh al-Mahdi* militia enjoy limited logistical support from foreign patrons and have less sophisticated capabilities. More importantly, they also have less to gain from using IEDs and, indeed, have made comparatively little use of such weapons (although there are allegations of improvised rocket-assisted mortars being used by "special groups" in attacks on Sunni areas).[39] Even factions such as the Badr brigade, which has a long history of conducting IED attacks on Baathists during the Saddam regime and has experience and expertise with IEDs (in part derived from Iranian patronage during the Saddam regime era), largely appear to eschew explosives in favour of small arms and torture in its violent actions in the post-Saddam era.

In contrast, Sunni insurgent groups, such as *Ansar al-Sunna* and other Al Qaeda affiliated groups in Iraq have ruthlessly exploited IEDs, in particular vehicle-borne bombings, with Al Qaeda affiliates claiming responsibility for massive suicide VBIED attacks on various ethnic or sectarian enemies through the targeting of inter alia, government recruiting or training academies and institutions of the new Shia-dominated Iraqi state (such as buildings of the Financial Ministry, the Supreme Court, and the Ministry of the Interior). Whilst there are clearly religious or political drivers behind such attacks, the development and deployment of IEDs has also become a highly professionalised activity, with Iraqi IED cells, comprised of a team of "six to eight people, including a financier, bomb maker, emplacer, triggerman, spotter, and often a cameraman",[40] hiring themselves out to insurgent groups over the Internet. In 2007, there were an estimated 160 such cells,[41] and whilst of varying levels of competence, many appear to be adaptive, decentralised, and professionalised: "with membership based on recommendations, trust and performance".[42] Although the number of cells remains alarming, the fact that

the design and construction of IEDs "has become a specialized function within the insurgency, rather than a dispersed function" perhaps suggests that there are "relatively few expert bombmakers".[43] However, it would also be remarkable if there had not been any knowledge transfer between individuals in a cell and correspondingly a growing number of individuals capable of replicating—if not innovating with—IEDs, something potentially incentivised by the economic value of bomb-making skills as a means to prosper in such a war economy.

The professionalization of IED cells has perhaps facilitated the exploration of different pathways towards IED development, with Iraq functioning as a testing ground for a number of developments in Iraqi insurgent IEDs, including both the growing integration of electronics and information and communications technology (ICT); and the development and deployment of chemical IEDs. Concerning the latter, there have been several attempts to integrate toxic industrial chemicals (TICs), such as chlorine, into IEDs with limited effect.[44] Such chlorine-based IEDs have largely proved no more effective vis-à-vis fatalities and injuries than comparable explosive bombs, yet perhaps have additional value in "headline grabbing",[45] something which raises concerns if there are observable relative advantages to TIC-based IEDs in the future. It is also of note that there has been one case in which an IED was rigged to a 155-millimetre artillery round containing the precursors for the chemical agent sarin.[46] This binary munition was believed to be a prototype used in the 1988 Iraqi chemical weapons tests, and converted into an IED by insurgents who were "unaware that it contained the nerve agent".[47]

With regard to the former, electronics and ICT have been pervasive and multifaceted in its integration with IED activities, particularly in the context of Iraq. Cell phones, whilst not new, have proved particularly significant in IED deployment, enabling the remote detonation of bombs without line-of-sight of the device. However, other means of low (and later high) frequency radio controlled detonation have also been woven into IEDs, including car key fobs, wireless doorbell buzzers, and radio controls from toy cars, essentially any available means of remotely triggering bombs.

ICT, particularly social media, has also been exploited not only as a means of circulating IED information but also as a tool for the sharing of propaganda footage of IED events. Indeed, the purpose of the cameraman employed in many IED teams is both as a means to feed back into the production and placement process, but also serving to capture footage of the event with which to inspire likeminded individuals. This

principle of propaganda by the deed is not new, as the above section indicates. However, in contrast to the tools of dissemination available to nineteenth-century anarchists or twentieth-century extremists, social media and cell phone cameras form a readily accessible, rapid, cheap, and powerful means of disseminating tailored messages to specific networks. This is a particularly significant development in modern extremist movements, which can be used to polarise populations, appalling many and enthralling some.

The power of IEDs—and IED related propaganda—and the emergence of professional cells perhaps led to the desire of some Al Qaeda affiliated groups "for continuous conflict and disorder, seeking to take the battle to apocalyptic levels".[48] However, akin to the OAS use of IEDs (see above), in seeking to escalate to apocalyptic levels, they have alienated "large and important segments of the Sunni population" with tactics that were so aggressive they undermined the broader objectives of the group and resulted in local citizens providing Coalition forces with tip offs "on al-Qaeda locations and hideouts".[49]

Syria

In the case of Syria, regime opposition innovations appear to be an eclectic mix of elementary low tech IED tactics, such as the use of home-made slingshots to launch "explosives-filled bottles"[50]; and explosive-packed tunnels[51]; and, seemingly, high-tech integration of advanced ICT, for example, the use of driverless-booby-trapped cars.[52] With the possible exception of the remote-controlled driverless car, none of these are truly innovative in the sense of being "untried" IED tactics, yet they provide an indicator of how Syria has become a new testing ground for IEDs with tactics from past conflicts, but particularly Iraq, recycled and updated using available materials, equipment, and skills. Reporting of events in Syria further suggests that like Iraq, groups such as the *Al Nusra Front* appear to be aiming for the spectacular. It would be unsurprising were *Daesh* (the Islamic State) to follow suit, although *Daesh* seems to have found a number of other means of other taboo-breaking acts through which to conduct propaganda by the deed related activities.

It is also of note that the case of Syria illustrates the continued value of IEDs to state actors as well as non-state actors with widespread use of Barrel bombs, effectively containers such as oil barrels or fuel tanks, packed with explosives and shrapnel and thrown out of regime helicopters

to explode on the ground below. Amnesty International estimates that such devices were responsible for more than 11,000 deaths in Syria between 2012 and May 2015,[53] despite UN Security Council Resolution 2139 (2014) which "Demands that all parties immediately cease all attacks against civilians, as well as the indiscriminate employment of weapons in populated areas, including shelling and aerial bombardment, such as the use of barrel bombs".[54]

Use of IEDs Outside Afghanistan, Iraq, and Syria

Although IED use in Afghanistan and Iraq dominates the headlines, their use has been significant in a number of other countries, including Algeria, Colombia, India, Indonesia, Nigeria, Nepal, Pakistan, and Turkey.[55] Indeed, the Joint Improvised Explosive Device Defeat Organization (JIEDDO) estimates "there have been more than 17,000 global IED events in 123 countries executed by more than 40 regional and transnational threat networks" between January 2011 and May 2013.[56] Groups operating in these countries have frequently been able to innovate with IEDs considerably quicker than their predecessors, and Jones and Johnston have posited thus:

> It took the Irish Republican Army about 30 years to progress from command wire improvised explosive devices (CWIEDs) to remote-controlled improvised explosive devices (RCIEDs) and then to shaped charges. By contrast, it took about six years for Chechen insurgents to make the same improvements, three years for fighters in Gaza, and about 12 months for insurgents in Iraq. In Afghanistan and Pakistan, fighters began with RCIED technology in hand, and quickly progressed to innovations such as diamagnetic, low-metal switch components.[57]

The Halo Trust has estimated that locally manufactured mines and IEDs have caused "more than 10,900 recorded deaths and injuries" in Colombia since 1990. This figure is consistent with claims of the Colombian Presidential Program for Integral Action Against Antipersonnel Mines, which has calculated that between 2002 and 2007, IEDs "inflicted a minimum of 2,000 casualties and an additional 300 victims in the first nine months of 2008". Attribution of responsibility for the use of IEDs largely rests with groups such as the FARC, which has developed a variety of IEDs typically using home-made explosives and materials locally available

to the primarily rural based insurgent group.[58] The trigger devices of Colombian IEDs have evolved over time from first generation victim-operated IEDs, to command wire IEDs (CWIEDs), to radio and now cell phone detonated weapons and over the course of this evolution, a variety of different devices have been employed from mines, to car bombs to "donkey bombs", at one point even gluing a collar bomb to the neck of an unfortunate victim.[59] Ostensibly, the FARC IED campaign has been variously designed to "counter the advance Colombian Armed Forces… protect coca crops, and to frighten the population that may collaborate with the government forces"[60]; however, cases such as the use of a collar bomb appear to have been part of an extortion campaign.[61]

Mexico also faces a growing IED problem, with several different groups ranging from transnational criminal organisations to left-wing extremists exploiting IEDs. Such different groups have exploited markedly different pathways to IED development. *Los Zetas*, a cartel which emerged in the late 1990s, when the Gulf Cartel leader Osiel Cárdenas Guillén began to recruit from the Mexican Army's *Groupo Aeromovil de Fuerzas Especiales* (GAFE), elite airborne Special Forces, appear to have opted for improvised use of more sophisticated military components, such as claymores and plastic explosives.[62] The pathway perhaps reflects the background and military training of the group as well as the extent of access to military materials.[63] In contrast, the left-wing Zapatista Army of National Liberation (EZLN) appear to have used home-made explosives and innovated with bamboo, gas drums, and book containers.[64]

In other contexts, information sharing on IEDs in conjunction with indigenous knowledge has proved important, for example, in facilitating the rapid evolution of IED technology, something evident in countries such as Nigeria and Indonesia,[65] where radical Islamic groups such as Boko Haram and Jemaah Islamiyah respectively have embarked upon advanced IED campaigns, purportedly with assistance from factions of Al Qaeda who have freely transmitted "Doctrines, manuals and invocations to fight".[66,67]

IED use is not constrained to the Global South. There have been a number of examples of IED construction in the Global North, complete with its "unusually rich" range of targeting options.[68] Such incidents are informative in understanding the evolution of IED technology and the limitations of the governance regime. In the context of Norway, Anders Breivik killed 8 people with a bomb placed under a Norwegian government office before massacring 69 people on the island of nearby Utøya. Breivik is of particular note for the development of an elaborate set of front companies

that enabled the acquisition of CAN fertiliser, the creation of "a credible cover story", and the completion of "due diligence and research [on] basic farming methods and similar knowledge". Indeed, Breivik's case illustrates the sort of determination required for the development of IEDs seemingly from scratch and his manifesto, *2083: A European Declaration of Independence* suggests that he spent 200 hours locating bomb-making recipes on the Internet and a further two months manufacturing IEDs, as well as spending significant time devising techniques for disguising the intent of his activities.[69]

Spain has also been a victim of IED attacks by Basque separatists and more recently Islamic extremists. The latter were responsible for the Madrid train bombings in 2004, an attack understood to have been perpetrated by a team comprised of two key groups, the operatives who carried out the attacks and a logistics contingent responsible for providing the necessary resources. The latter group included individuals with links to "Spanish petty criminals in Asturias … [who] provided the cell with Goma-2 ECO and industrial detonators that they had pilfered from a mine".[70] The Madrid train bombings killed more than 250 people, in addition to which they can be seen as having a strategic impact: as Lt Gen Thomas Metz, director of the Joint Improvised Explosive Device Defeat Organization (JIEDDO) stated, "That explosion occurred on a Thursday and affected the course of a government. An election took place on Sunday, and a new government was in place on Monday."[71]

A number of events over the course of the last decade have illustrated the threat posed to the UK by IEDs. However, such events also suggest that IED innovation has been comparatively limited with UK-based jihadists seemingly "not to have wanted to use, or not been able to obtain, professional explosives" and instead being steered towards home-made "peroxide-based substances" and even then frequently struggling with the necessary tacit knowledge to effectively execute attacks.[72] There have, of course, been exceptions: Dhiren Barot was described by British police as a "determined and experienced terrorist",[73] and alleged by the US Department of Justice to have been "a lead instructor at a jihad training camp in Afghanistan."[74] Moreover, Barot developed and detailed technical knowledge of explosives, something evidenced in his book.[75,76] Yet, despite developing a detailed plan for the "Gas Limos Project", Carlisle argues "he never appears to have gotten beyond the basic planning stages" and questions remain over the feasibility of the concept by the time of his arrest in 2004.[77] Indeed, in the context of the UK, there exists a relatively

robust UK regime against IEDs, in addition to which the operating environment and tacit knowledge can perhaps be seen as acting as a partial barrier to IED development with a relatively small number of experts with key skills learned from training camps upon which "UK terror cells therefore depend".[78]

Notes

1. Kaldor. In Defence of New Wars.
2. See, for example, the underlying influence of Wahhabism, with its emphasis on the concept of Tauheed (something encapsulated in the notion of there being no god but Allah). Burke suggests strict interpretations of this concept leave "little room… for diversity among the community of believers. Pluralism was polytheism, polytheism was apostasy" a logic that generates significant implications for the Shia. Burke. The New Threat. Pg 44.
3. UN News Centre. 2012. "Afghanistan: Following Deadly Blast, UN Mission Calls on Taliban to Halt Use of Improvised Explosive Devices." *UN News*, October 20. http://www.un.org/apps/news/story.asp?NewsID=43341#.Vr-ttMeYEZY.
4. Based on data provided by in Science: Bohannon, John, and George Michael Brower. 2011. "Civilian Casualties in Afghanistan, 2009–2010." *Science*. http://www.sciencemag.org/site/feature/data/hottopics/afghanistan/visualization/index.html.
5. Islamic Emirate of Afghanistan. 2012. "Reaction of Islamic Emirate Regarding Accusations of UNAMA about Explosive Devices." http://shahamat-english.com/english/index.php/paighamoona/28792-reaction-of-islamic-emirate-regarding-accusations-of-unama-about-explosive-devices.
6. It has been suggested that "Improvised explosive devices (IED) are one of the largest threats facing coalition forces in current military conflicts", Weiss, L, E Whitaker, E Briscoe, and E Trewhitt. 2011. "Evaluating Counter-IED Strategies." *Defense and Security Analysis* 27 (2): 135–47. doi:10.1080/14751798.2011.578717. http://www.scopus.com/inward/record.url?eid=2-s2.0-79960547372&partnerID=40&md5=f044a8cbc8be1b00e15f5dbc848d9bb0.
7. Bohannon, John. 2011. "Counting the Dead in Afghanistan." *Science* 331 (March): 1256–60.
8. Several sources point to the predominant use of CAN fertiliser from Pakistan: A 2013 report suggest that an estimated "80 percent of the IEDs used in Afghanistan have homemade explosives as the main charge, and more than 80 percent of these are derived from CAN fertilizer produced in Pakistan". Kamran Yousaf. 2013. "Deadly Fertiliser: Kayani Proposes

Forum to Counter IED Threats." *The Express Tribune*, May 20. http://tribune.com.pk/story/551923/deadly-fertiliser-kayani-proposes-forum-to-counter-ied-threats/. See also Brook, Tom Vanden. 2011. "Majority of IEDs Are Traced to Pakistan." *USA Today*, February 10. http://usatoday30.usatoday.com/news/military/story/2011-10-02/ieds-traced-to-pakistan/50638686/1#.; Carpenter, Jonathan. 2012. "Terrorist Networks in Pakistan and the Proliferation of Improvised Explosive Devices." https://www.gpo.gov/fdsys/pkg/CHRG-112shrg79800/html/CHRG-112shrg79800.htm.

9. JIEDDO. 2014. "IEDs – Reducing the Risk." 2014 Session of the Group of Experts, CCW Amended Protocol II http://www.unog.ch/__80256ee600585943.nsf/(httpPages)/39340de9a9659e5cc1257cf400344b35?OpenDocument&ExpandSection=3#_Section3.
10. Wilkinson, Bevan & Biddle. Improvised Explosive Devices (IEDs).
11. Tom Vanden Brook. 2013. "Afghan Bomb Makers Shifting to New Explosives for IEDs." *USA Today*, June 25. http://www.usatoday.com/story/news/world/2013/06/25/ammonium-nitrate-potassium-chlorate-ieds-afghanistan/2442191/.
12. Yusufzai, Mushtaq. 2009. "Wanted Taliban Leader Doesn't Fear U.S." *NBC News World Blog*, April 9. http://worldblog.msnbc.msn.com/_news/2009/04/09/4375885-wanted-taliban-leader-doesnt-fear-us.
13. A parallel has been drawn between chemistry of the opium refinement process and the development of home-made explosives in Afghanistan; certainly, Tomasi has suggested that "A chemist with the ability to refine opium would have sufficient skills to develop HME" Marco D. Tomasi. 2009. "Alternative Motivations for IED Use in Afghanistan." Vol. Product Se. http://info.publicintelligence.net/JIEDDOafghanieds.pdf.
14. See: Wilson, Clay. 2007. "Improvised Explosive Devices (IEDs) in Iraq and Afghanistan: Effects and Countermeasures." http://fas.org/sgp/crs/weapons/RS22330.pdf.; Johnson, Thomas H. 2013. "Taliban Adaptations and Innovations." *Small Wars & Insurgencies* 24 (1): 3–27. doi:10.1080/09592318.2013.740228. http://www.tandfonline.com/doi/abs/10.1080/09592318.2013.740228.
15. Dietz, A S. 2011. "Countering the Effects of IED Systems in Afghanistan: An Integral Approach." *Small Wars and Insurgencies* 22 (2): 385–401. doi:10.1080/09592318.2011.573423. http://www.scopus.com/inward/record.url?eid=2-s2.0-79959549871&partnerID=40&md5=3dc7917242c5519f5a4ecf4ffb29cac6.
16. Several individuals have been explicitly identified in the "List of individuals and entities established pursuant to Security Council Resolution 1988 (2011)", such as Abdul Rauf and Sayed Esmatullah and other such actors identified as providing training and support for IED manufacture and deployment in Afghanistan, see UN Security Council Committee estab-

lished pursuant to resolution 1988 (2011). 2015. "The List Established and Maintained by the 1988 (2011) Committee." Vol. 1988. http://www.un.org/sc/committees/1988/list.shtml.
17. Dietz. Countering the Effects of IED Systems in Afghanistan.
18. Nasiri, Omar. 2007. *Inside the Jihad: My Life with Al Qaeda*. Basic Books. Pg 221.
19. Yousafzai, Sami. 2009. "The Taliban's Oral History of the Afghanistan War." *Newsweek*.http://www.newsweek.com/talibans-oral-history-afghanistan-war-79553.; See also Johnson, Thomas H. 2013. "Taliban Adaptations and Innovations." *Small Wars & Insurgencies* 24 (1): 3–27. doi:10.1080/09592318.2013.740228. http://www.tandfonline.com/doi/abs/10.1080/09592318.2013.740228.
20. Barker, A D. 2011. "Improvised Explosive Devices in Southern Afghanistan and Western Pakistan, 2002–2009." *Studies in Conflict and Terrorism* 34 (8): 600–620. doi:10.1080/1057610X.2011.582630. http://www.scopus.com/inward/record.url?eid=2-s2.0-79960960598&partnerID=40&md5=ac36934f62ee1d91d9fc131c9f38c2c0.
21. Barker. Improvised explosive devices in Southern Afghanistan and Western Pakistan.
22. Binnie & Wright. 'Infernal Machines' Improvised Explosive Devices.
23. Barker. Improvised explosive devices in Southern Afghanistan and Western Pakistan.
24. National Research Council. 2007. "Countering the Threat of Improvised Explosive Devices: Basic Research Opportunities." doi:0-309-10916-7,. http://www.nap.edu/openbook.php?record_id=11953. Pg xi.
25. Grouille, Olivier. 2009. "Bird and Fairweather in Context Assessing the Ied Threat." *TheRUSIJournal*154(4):40–45.doi:10.1080/03071840903255252. http://www.tandfonline.com/doi/abs/10.1080/03071840903255252.
26. Barker. Improvised explosive devices in Southern Afghanistan and Western Pakistan.
27. Smith, Andrew. 2003. "Improvised Explosive Devices in Iraq, 2003–09: A Case of Operational Surprise and Institutional Response." Strategic Studies Institute U.S. Army War College, Carlisle, PA.
28. Smith. Improvised Explosive Devices in Iraq, 2003–09.
29. Atkinson, Rick. 2007. "The Single Most Effective Weapon against Our Deployed Forces." *Washington Post*, September 30. http://www.washingtonpost.com/wp-dyn/content/article/2007/09/29/AR2007092900750.html.
30. Wilkinson et al. have suggested that by January 2003, "377 tonnes of premium quality high explosive had been looted" adding that Iraq "stands as an example of how access to ammunition stockpiles in post-conflict environments can provide heavy firepower to non-state actors and, ultimately, compromise post-conflict recovery". Wilkinson, Bevan & Biddle. *Improvised*

Explosive Devices (IEDs); Klingelhoefer, Mark. 2005. "Captured Enemy Ammunition in Operation Iraqi Freedom and Its Strategic Importance in Post-Conflict Operations." http://www.strategicstudiesinstitute.army.mil/pdffiles/ksil72.pdf.

31. Atkinson, Rick. 2007. "'There Was a Two-Year Learning Curve…and a Lot of People Died in Those Two Years.'" *The Washington Post*, October 1. http://www.washingtonpost.com/wp-dyn/content/article/2007/09/30/AR2007093001675_pf.html.
32. The Iraqi Perspectives Project provides a number of examples of how regime elements smuggled IED components in diplomatic bags but also how "An IIS memorandum dated 5 August 2001 describes in detail the manufacture and testing of a powerful type of lED that could be exploded by remote control and 'vectored like rays so it will largely [destroy] the objective' ... These devices were tested in a 'residential area,' with an emphasis on wireless detonation from 100 to 200 meters, and camouflaged to match the area" see Woods, Kevin M. 2007. "Primary Source Material for Saddam and Terrorism: Emerging Insights from Captured Iraqi Documents." Vol. 1. https://www.fas.org/irp/eprint/iraqi/v1.pdf pg. 7.
33. Woods. Saddam and Terrorism.
34. Moreover, such expertise has proved innovative and been able to respond to US and coalition improvements in detection and defence by moving from simple wired devices to remote detonation via "cell-phones and garage-door openers". Hoffman, Bruce. 2007. "The 'cult of the Insurgent': Its Tactical and Strategic Implications." *Australian Journal of International Affairs* 61 (3): 312–29. doi:10.1080/10357710701531503. http://www.tandfonline.com/doi/abs/10.1080/10357710701531503.
35. Jones, S G, and P B Johnston. 2012. "The Future of Insurgency." Studies in Conflict and Terrorism 36 (1): 1–25. doi: 10.1080/1057610X.2013.739077. http://www.scopus.com/inward/record.url?eid=2-s2.0-84871452316&partnerID=40&md5=1a897f31cf9e0658903af4da7b3505ba.
36. Atkinson. The Single Most Effective Weapon against Our Deployed Forces.
37. Atkinson, Rick. 2008. "Left of the Boom: The Struggle to Defeat Roadside Bombs." *The Washington Post*. http://www.washingtonpost.com/wp-srv/world/specials/leftofboom/.
38. Cordesman, Anthony H, Charles Loi, and Vivek Kocharlakota. 2010. "IED Metrics for Iraq: June 2003 – September 2010." http://csis.org/files/publication/101110_ied_metrics_iraq.pdf.
39. There is a series of attacks attributed to the factions of the Mahdi militia in Spring 2008. See Johnson, David E., M. Wade Markel, and Brian Shannon. 2013. "*The 2008 Battle of Sadr City.*" RAND http://www.rand.org/content/dam/rand/pubs/occasional_papers/2011/RAND_OP335.pdf.
40. Wilson. Improvised Explosive Devices. Pg 5.

41. Atkinson. The single most effective weapon against our deployed forces.
42. Ackerman, Gary, and Maranda Sorrells. 2009. "Workshop Report Human and Social Forces in the Spread of the IED Threat: Innovation, Diffusion and Adaptation." Study of Terrorism and Responses to Terrorism (START) http://www.start.umd.edu/sites/default/files/files/announcements/IED_Workshop_Report.pdf.
43. Mcfate, Montgomery. 2005. "Iraq: The Social Context of IEDs." *Military Review*, June.
44. Mcfate. Iraq.
45. Garver, Christopher. 2007. "Amateur Hour." *CBRNE World*, 24–27.
46. In Baghdad, a roadside bomb containing sarin nerve agent explodes in the vicinity of a US military convoy, resulting in two persons requiring treatment for "minor exposure". Recounting the incident two days later, US military spokesman in Iraq, Mark Kimmitt, says: "The Iraqi Survey Group confirmed today that a 155-millimeter artillery round containing sarin nerve agent had been found. The round had been rigged as an IED (improvised explosive device) which was discovered by a US force convoy. A detonation occurred before the IED could be rendered inoperable. This produced a very small dispersal of agent… Two explosive ordnance team members were treated for minor exposure to nerve agent as a result of the partial detonation of the round." As Cited in: Harvard Sussex Program. 2004. News Chronology May through July 2004. *The CBW Conventions Bulletin*, (65), Pg 24.
47. Harvard Sussex Program. News Chronology May through July 2004.
48. Ali, A L I. 2011. "Displacement and Statecraft in Iraq : Recent Trends," 5 (2): 231–45. doi:10.1386/ijcis.5.2.231.
49. International Crisis Group. 2008. "Iraq after the Surge I: The New Sunni Landscape." *Middle East Report*. http://www.crisisgroup.org/~/media/Files/MiddleEastNorthAfrica/IraqSyriaLebanon/Iraq/74_iraq_after_the_surge_i_the_new_sunni_landscape.pdf. Pg 7.
50. Higgins, Eliot. 2012. "Syria's DIY Revolt." *Foreign Policy* July. http://foreignpolicy.com/2012/07/30/syrias-diy-revolt/.
51. Karouny, Mariam. 2014. "Massive Tunnel Bomb Hits Syrian Army Base: Video." *Reuters*, May 15. http://www.reuters.com/article/us-syria-crisis-airstrikes-idUSBREA4E09520140515.
52. Unknown. 2012. "Syrian Rebels Make Driverless Car Bomb." *Military.Com*. http://www.military.com/video/operations-and-strategy/improvised-weapons/syrian-rebels-make-driverless-car-bomb/1565016817001. Notably this tacit was reportedly tried by Sendero Luminos and FARC in Latin America previously see United States Office of the Secretary of State. 1991. "Patterns of Global Terrorism: 1990." http://fas.org/irp/threat/terror_90/index.html.

53. Amnesty International. 2015. "Syria's 'Circle of Hell': Barrel Bombs in Aleppo Bring Terror and Bloodshed Forcing Civilians Underground." *Amnesty International News*. https://www.amnesty.org/en/latest/news/2015/05/syrias-circle-of-hell-barrel-bombs-in-aleppo/.
54. UN Security Council. 2014. "Security Council Unanimously Adopts Resolution 2139 (2014) to Ease Aid Delivery to Syrians, Provide Relief from 'Chilling Darkness.'" United Nations. http://www.un.org/press/en/2014/sc11292.doc.htm.
55. Jones, S G, and P B Johnston. 2012. "The Future of Insurgency." *Studies in Conflict and Terrorism* 36 (1): 1–25. doi:10.1080/1057610X.2013.739077. http://www.scopus.com/inward/record.url?eid=2-s2.0-84871452316&partnerID=40&md5=1a897f31cf9c0658903af4da7b3505ba.
56. Walters, Robert. 2013. "Remarks by Brigadier General Robert Walters Deputy Director for Operations and Intelligence." In *Pakistan Counter-IED Symposium*. JIEDDO. https://www.jieddo.mil/content/docs/20130520_BG_Walters_remarks_at_Pakistan_Counter-IED_Symposium_AS_PREPARED.pdf; Sonnex, Peter, and Tim Peacock. 2012. "Counter-Improvised Explosive Devices." In *2012 Session of the Group of Experts on Amended Protocol II*. Geneva: United Nations Office at Geneva. http://www.unog.ch/80256EDD006B8954/(httpAssets)/4659EE6F59A2374DC12579F10039C3DC/$file/UK_IEDs+2012.pdf.
57. Jones & Johnston. The Future of Insurgency.
58. Gallego, Pablo Esteban Parra. 2012. "COLOMBIA Improvised Explosive Devices." In *2012 Session of the Group of Experts on Amended Protocol II*. Geneva: United Nations Office at Geneva. http://www.unog.ch/80256EDD006B8954/(httpAssets)/EFDFCCD728A2754FC12579F1003988EE/$file/Colombia_IEDs+2012.pdf.
59. BBC. 2000. "'Necklace' Bomb Halts Colombia Talks." *BBC News*. http://news.bbc.co.uk/1/hi/world/americas/751237.stm.
60. Gallego. COLOMBIA Improvised Explosive Devices.
61. BBC. 2000. "'Necklace' Bomb Halts Colombia Talks." *BBC News*. http://news.bbc.co.uk/1/hi/world/americas/751237.stm.
62. US Army Intelligence and Security Command. "Review of IED Activity in Mexico." https://wikileaks.org/gifiles/attach/9/9625_US%20Army%20NGIC%20Review%20of%20IED%20Activity%20in%20Mexico-1.pdf.
63. Campbell, Lisa J. 2010. "Los Zetas: Operational Assessment." *Small Wars & Insurgencies* 21 (1): 55–80. doi:10.1080/09592310903561429. http://www.tandfonline.com/doi/abs/10.1080/09592310903561429.
64. US Army Intelligence and Security Command. "Review of IED Activity in Mexico". https://wikileaks.org/gifiles/attach/9/9625_US%20Army%20NGIC%20Review%20of%20IED%20Activity%20in%20Mexico-1.pdf

65. Jones, Calvert. 2006. "Al-Qaeda's Innovative Improvisers: Learning in a Diffuse Transnational Network." *Cambridge Review of International Affairs* 19 (4): 555–69. doi:10.1080/09557570601003205. http://www.tandfonline.com/doi/abs/10.1080/09557570601003205.
66. Clarke, Michael, and Valentina Soria. 2009. "Terrorism in the United Kingdom." *The RUSI Journal* 154 (3): 44–53. doi:10.1080/03071840903097647. http://www.tandfonline.com/doi/abs/10.1080/03071840903097647.
67. According to Jones and Johnston Boko Haram: "dramatically increased its rate of IED attacks, from only one documented attack in 2009 to nine in 2010 and 88 in 2011… Boko Haram has improved its ability to build hollow charges—or directional blast devices—that are capable of causing substantial damage to structures and lightly armoured vehicles". Jones & Johnston. The Future of Insurgency. Pg 16.
68. Bale. Jihadist Cells and "IED" Capabilities in Europe. Pg 11.
69. Stenersen. Bomb-Making for Beginners.
70. Bale. Jihadist Cells and "IED" Capabilities in Europe. Pg 62.
71. Micha Michael Corderre, and Michael Register. 2009. "Fighting Back Against IEDs." *Police – The Law Enforcement Magazine* September (September). http://www.policemag.com/channel/swat/articles/2009/09/fighting-back-against-ieds.aspx.
72. Clarke & Soria. Terrorism in the United Kingdom.
73. Metropolitan Police. 2006. "Metropolitan Police Terrorist Jailed for Life for Conspiracy to Murder in the UK and US." *News*. http://content.met.police.uk/News/Terrorist-jailed-for-life-for-conspiracy-to-murder-in-the-UK-and-US/1260267887712/1257246745756.
74. Unknown. 2006. "United States of America V Dhiren Barot." *Washington Post*. http://www.washingtonpost.com/wp-srv/articles/hindi.pdf.
75. Carlisle, David. 2007. "Dhiren Barot: Was He an Al Qaeda Mastermind or Merely a Hapless Plotter?" *Studies in Conflict & Terrorism* 30 (March 2015): 1057–71. doi:10.1080/10576100701670979.
76. Carlisle. Dhiren Barot.
77. Carlisle. Dhiren Barot.
78. Clarke & Soria. Terrorism in the United Kingdom. Pg 50.

CHAPTER 5

The Diffusion and Adoption of IED Technology

Abstract This chapter draws on the work of Everett Rogers on the diffusion of innovations to outline factors that influence whether and how actors innovate with technology in the context of IEDs. In doing so, the text brings together insights from the previous sections.

Keywords Technology • Diffusion • Rogers • Innovation • Relative advantage • Compatibility • Ethics • Tacit knowledge • Complexity • Trialability • Observability

The short history of IEDs outlined above illustrates the diversity of utilities of IEDs, which have variously been employed as a psychological tool of terror and intimidation; a tool of sabotage and subversion; a means of demoralising enemy forces; a means of inspiring likeminded actors through propaganda by the deed; an equaliser in asymmetrical conflict; a deterrent; an area denial mechanism[1]; a defensive alarm; and a means of undermining enemy mobility. Indeed, IEDs not only serve tactical objectives, with some IED attacks or campaigns, particularly those that receive high-profile media coverage, serving strategic functions.[2] However, the utility calculus of IEDs is likely to be determined by factors less congruent with traditional military operational metrics, such as casualties per ton of ordnance and more vis-à-vis factors such as the terrorisation potential, scope for eliciting media attention, or the "suitability for covert use"

J. Revill, *Improvised Explosive Devices*,
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in conditions when it may be reckless to employ standardized military explosives.

Yet the fact that IEDs can be employed to meet multiple tactical as well as strategic objectives and serve utilities that are perhaps more suited to New Wars does not, however, dictate that IEDs will be assimilated by all future groups. Nor is it necessarily the case that IED technology will proliferate in a manner that is inevitable, linear, irreversible, and rapid, with scholars of science and technology studies (STS) suggesting that "the process of technology acquisition by any organization is often a very complex process that is both promoted and inhibited by many different pressures and variables".[3]

Of course, the organisations most frequently studied by STS scholars are not insurgent groups, and there are clear differences between the commercial organisations that form the focus of the majority of STS scholarship and those violent extremist organisations that are seeking to use IEDs. As Dolnik remarked, "the business approach to innovation arguing that terrorists always seek new technologies in order to boost the ever-increasing lethality of their attacks is fundamentally flawed."[4] Nevertheless, there are also similarities between commercial entities and insurgent organisations, in that both "face analogous pressures" such as challenges with knowledge transfer and "preserving a level of 'trade secrecy' necessary for their operations".[5]

As such, there are lessons and frameworks from scholarship in other fields, which can prove valuable in understanding the diffusion of IED technology. Indeed, an exploration of the literature on the diffusion of innovations suggests several factors will feed into any utility calculus of IEDs and there are insights from the work of communications scholars, which can be usefully employed as a framework for thinking about the assimilation of IED technology and the integration of incremental innovations. Specifically, an adaptation of the work of Everett Rogers on the implications of factors, such as the "relative advantage", "compatibility", "complexity", "trialability", and "observability" in technological diffusion and adoption, is useful in this regard.[6] The following sections lay out these concepts vis-à-vis the adoption of IED technology, drawing on the historical case study material identified and developed above.

Relative Advantage

IED innovation is rarely undertaken for the sake of it; rather innovations are pursued for a specific purpose, as Jackson has remarked: "a company or terrorist group will choose to pursue a new piece of technology because of the belief that there is something to be gained by doing so."[7] As such, IED innovations—regardless of whether they are radical decisions to innovate with entirely new technology or incremental innovations with existing technologies—can be seen as driven by the quest for some form of "relative advantage". The "relative advantage" factor has been defined by Rogers as "the degree to which an innovation is perceived as better than the idea it supersedes. It does not matter so much if an innovation has a great deal of objective advantage. What does matter is whether an individual perceives the innovation as advantageous."[8]

The series of IED micro case studies outlined above illustrates the perceived relative advantage factor in rejecting or adopting/innovating with IEDs is important. In terms of the rejection of IEDs in favour of other means or methods of violence, Ayman al-Zawahiri reportedly encouraged followers to undertake "individual acts of jihad" further instructing those jihadists "based in the United States … [to] … attack with firearms, as these are assumed to be easily accessible"[9]; whereas Anders Breivik's manifesto bluntly titles one section: "Manufacturing explosives – worth it or not?", and indeed Breivik's infamy was the result of a massacre using small arms (rather than the bomb he detonated).

Yet there are also many cases where IEDs have been adopted or innovated to gain a relative advantage in some form or other. Johann Ostromecki's booby-trapped jewelled casket, Giambelli's fireships and IRA use of precision time delay switches, as in the case of the Brighton bomb, all had the "relative advantage" of destroying difficult to reach targets at distance; sea torpedoes offered the relative advantage of being cheap compared with naval fleets for the newly independent American government; Nobel's chemical fuse was a cheaper and more reliable alternative to the fougasses which removed the problem of timing remote detonation; electrically detonated mines were seen as limiting enemies scope for deactivating mechanical mines and providing detonation that was closer to instantaneous; dynamite appeared to offer nineteenth-century Anarchists "extraordinary power to execute their grandiose objectives";[10] Orsini's bombs were reportedly designed to mitigate the immobility of previous available design; the PFLP-GC's altimeter bomb enabled the

group to detonate bombs remotely and at a particular point in an aircraft's flight plan, but also bypass airport security measures imposed as a result of hijackings; and the LTTE used suicide truck bombs as a form of artillery to augment commando raids or assassinate hard targets. Notably too, for the Special Forces of states, IEDs offer a relative advantage in that they provide an alternative in circumstances where it would be rash to use conventional military munitions.

Over the last decade, there appears to be a trend towards incremental innovations in IED development and deployment through the integration of aspects of ICT in pursuit of a perceived relative advantage. As the above section illustrates, different aspects of ICT offer different relative advantages: Camera phones enable actors to capture IED events and disseminate propaganda and information sharing; cells phones assist in the remote detonation of IEDs.

As such, the perception of some form of relative advantage can be seen as a key driver in IED innovation. However, exploiting a relative advantage does not necessarily need to be technological in nature, tactical changes also offer 'relative advantages': The Galleanist's horse-and-cart bomb offered one of very few cost effective and inconspicuous means of delivering explosives to their target; the Taliban moved the field of operation from Kandahar to the Helmand River Valley "apparently as a result of the increased deployment there of NATO forces"[11]; and several groups have undertaken tactical innovations such as the grooming of less conspicuous mules in the case of the PFLP-GC, the LTTE, and the Chechen-based Riyadus-Salikhin Suicide (RAS) Battalion. This is consistent with the suggestion by Hoffman: "When confronted by new security measures, terrorists will seek to identify and exploit new vulnerabilities, adjusting their means of attack accordingly and often carrying on despite the obstacles in their path."[12]

The importance of the notion of a relative advantage does not equate to the suggestion that groups will always reach decisions that are timely and well informed; drawing on analogies with commercial entities, Jackson suggests, "In the absence of any solid analytical method to guide technology adoption, most of these decisions are made using a sort of organizational intuition that the noted economist John Maynard Keynes called 'animal spirits'."[13] Indeed, decisions based on organisational intuition or "gut feelings" are not always good or "rational" decisions; arguably the fixation on explosives of *Narodnaya Volya* and the Anarchist groups of the late nineteenth century led to a number of decisions which offered little

tactical (or strategic) advantage over other means of causing harm, with dynamite proving "less lethal and more cumbersome than expected".[14] Similarly, many of the early ideas for the American Civil War torpedoes and the Irish Republican Brotherhood IEDs exploiting balloon and submarines, respectively, perhaps offered a seductive illusion of relative advantage which was in fact detached from the technological reality of the time. Yet irrational and/or ill-advised as it may be, the perception of a relative advantage factor nevertheless remains important in looking at the diffusion of innovation and the adoption of IED technology by extremist groups of differing persuasions.

Complexity

In contrast to what Kaldor has labelled the "Baroque" arsenals of some states during the Cold War,[15] IEDs are typically "vernacular", functional weapons, with the development and deployment of IEDs overwhelmingly drawing on technologies that are relatively "easily obtained and simple to use".[16] In this regard, complexity, that is, "the degree to which an innovation is perceived as difficult to understand and use"[17] remains an important factor in determining whether a group will adopt innovations, not least because of the risks of failing with IEDs. As Jackson has remarked, "In the legitimate business world, these risks are financial—the costs of purchasing and adopting a new technique may not be recouped and the company may go out of business … The risks to a terrorist group, because of the lethality and illegitimacy of its "business," can be significantly higher."[18]

The high risks to insurgent groups seeking to innovate with complex IEDs can take different forms. First and foremost, a high risk is posed by the physical dangers of failing to master the complexity of IED technology. As noted above, several members of *Narodnaya Volya* were killed or impaired in the handling of explosives; in the early stages of the IRA, campaigns resulted in more than 100 accidental deaths or "own goals", caused by premature bomb explosions between 1971 and 1975[19]; whereas several Middle Eastern organisations have lost members due to mishaps in the preparations of IEDs.[20] Indeed, it has been "estimated that approximately thirty percent of the deaths caused by homemade explosives are the bomb-makers themselves".[21]

Yet beyond the physical risks to mastering new techniques and technology, there are also secondary risks posed to the organisation that can be gen-

erated by mishaps. This can include the decimation of technical capabilities or leadership groups through the injury or death resulting from mistakes, and also the increased risk of being detected. As Dolnik has remarked:

> An accidental explosion of a new and untested device during assembly at a secluded Revolutionary Armed Forces of Colombia (FARC) or Abu Sayyaf training camp will hardly endanger the existence of these organizations, for groups such as the Red Army Faction (RAF) or the Red Brigades which assembled their devices in city apartments, such a mistake could prove fatal.[22]

Such a scenario is not purely academic. Ramzi Yousef was caught following an accidental fire,[23] whereas in 1970, three Weathermen were killed in an accidental explosion incurred whilst putting IEDs together, the subsequent blast levelled "their Greenwich Village townhouse, drawing attention to the group and accelerating its move underground."[24] In cases where terrorist groups are in competition, such mishaps and failures pose further potential implications for the credibility of the groups.

For those groups that were able to master complex IED technologies, individuals appear to have played a significant role through acting as pivots or conduits for information and sources of expertise and innovative creativity. Indeed, key actors in the early evolution of IEDs included individuals, such as Giambelli, Fulton, Nobel, Maury, Rains, Colt, Orsini, and Kibalchich, who developed tacit knowledge, the "knowhow" and "knack", necessary to launch effective attacks and, in some cases, augmented the specialist expertise of others.[25] Yet, perhaps more importantly, many of these individuals demonstrated a remarkable talent for creativity and innovation, not just in the field of explosives but in other areas. Giambelli reportedly designed the fortification for Carisbrooke Castle; David Bushnell is accredited with the first submarine, the Turtle; Immanuel Nobel invented the rotary lathe; Robert Fulton is credited with developing the first commercially successful steamboat; Samuel Colt invented a number of firearms; Matthew Maury has been titled the "Father of Oceanography" for his bathymetric endeavours[26]; and during his time on death row, Ivanovich Kibalchich designed a rocket-powered human-carrying flying device which has now become mythologised as a seminal Soviet contribution to the field of rocket science.

Making IEDs is relatively easy compared to the production of nuclear, chemical, or biological weapons. Yet whilst there are many individuals that could no doubt be trained in bomb making and provided with the req-

uisite explicit knowledge and instruction to produce a workable device, bomb making is difficult, and the ability to reproduce designs is not the same as the capacity to adapt and innovate around challenges or obstacles that may emerge in an IED campaign. Such a capacity is perhaps what makes the individuals above, along with certain contemporary bomb makers, particularly unique. Indeed, history perhaps underlines the point made by McFate that there are currently "relatively few expert bombmakers".[27] Or, at least there are relatively few experts able to both imagine and realise a way around security measures and design and redesign improvised explosive devices in response to changing obstacles and requirements.

Compatibility

Rogers defines Compatibility as "the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters".[28] Adapting this for the purpose of understanding IEDs, several sub-strands to the notion of compatibility can be identified, and the following section looks at compatibility in terms of skill sets, available materials, group and wider community values, and organisational mind-set.

Firstly, at a practical level, obtaining and practising the necessary skills for IED development, as well as acquiring the necessary component parts for IED manufacture, will be determined to some extent by the social context, with neither materials to hand nor capabilities necessarily readily compatible between one environment and another, or indeed between one period of time and another. Certainly, the explosive ingredients used in certain IEDs, such as fertilisers, vary from region to region, and although such differences may be small, it nevertheless suggests that IED tradecraft perfected in Iraq or Afghanistan may not *necessarily* be compatible in London or Washington where the process of acquiring materials and deploying IEDs without being caught will present different, if not insurmountable, challenges. As Kenney has stated:

> While many insurgents in Iraq have learned how to plant roadside bombs in that conflict, drawing on locally available materials and their own practical experience, these skills and knowledge do not transfer seamlessly to Western countries outside the Middle East. To detonate an improvised explosive device (IED) on the Washington Beltway, for example, an Iraqi insurgent

> would need to operate in clandestine fashion within the United States for days or weeks, during which time he would have to acquire the materials necessary for the attack, without attracting the attention of law enforcers.[29]

Moreover, it is notable that the vast majority of IED development draws on locally available materials. Thus, as noted above in the text, nineteenth-century Anarchists groups concocted IEDs "from such objects as tin pans, coffee-grinders, metal boxes, and banister knobs"; the Mujahedeen fashioned IEDs out of truck tyre inner tubes, cooking oil containers, and water vessels and disguised them with manure,[30] and notably the Taliban appear to have continued the trend with "cooking oil cans most common for making homemade IED[s]"[31]; early IRA IEDs employed clothes pegs, mousetraps, and condoms; and some of Hezbollah's IEDs have been assembled in "fake plastic rocks, which could be bought in Beirut garden stores".[32] There are of course several exceptions where bespoke or specialist materials were employed, however for the large part, IEDs appear to be developed "using local materials, building upon local skills and knowledge".[33] Put otherwise, they are *improvised* in the sense that they are frequently made or fabricated using locally available materials rather than traditional commercial forms of innovation, and remain limited by "context-specificity and 'geographical rootedness'".[34]

A second strand of compatibility can be seen regarding the consistency of IEDs "with the existing values" of the group or individual. As the above section illustrates, history is replete with examples of IEDs being met with obloquy and rejected because they are variously perceived as "satanic", "inhuman", "barbarous", "unmanly", diabolical, cowardly, or, in the words of Taliban leader Mullah Omar, "un-Islamic" and "anti-human".[35] Yet values, as socially constructed concepts, are liable to change particularly with the all too frequent sliding of moral baselines in warfare[36] and/or conditions of frustration, desperation, and pragmatism.

Such factors have historically served to undermine any sense of contempt surrounding the development and deployment of IEDs, and by implication, increase their perceived compatibility. Thus, during the American Civil War, the frequency of use of IEDs and their utility meant that any initial objections became eroded, particularly amongst Confederate fighting forces waging an asymmetrical conflict. The perceived need for more "urgent, brutal and pragmatic tactics" amongst the Irish Republican Brotherhood[37] served to justify the use of explosives by extreme Irish nationalists; for Anarchists, the increasing severity of repressive measures

and the failure of past programmes of action, such as Bakunin's collectivism, paved the way for the Anarchists dynamite campaigns; whereas for the LTTE, the failure of *satyagraha*, led to growing violence in the 1970s, something fuelled further by increased government repression.

The concept of compatibility with values might also be extended in many cases beyond the immediate group to the wider community. Most technological systems require social commitments in order to function—specifically such systems require contracts, funders, brokers, and political backers. IEDs or at least IED campaigns of non-state actors may operate through informal or black market networks, yet there nevertheless needs to be some degree of social interaction and agreement in place to function. This often entails a degree of active support and/or passive acceptance from the wider community and, in some cases, the tacit support of particular experts.There is, however, a fine line between exploiting the utilities of IEDs to meet the specific needs of potential adopters, whether they be demoralising an enemy, sabotage or subversion et cetera, and alienating significant sectors of the population and invoking widespread condemnation. In several cases, IED events which have become excessively lethal have failed to meet the needs of adopters and instead resulted in groups shedding support and sympathy, as was the case with the attacks on the Clerkenwell House of detention by the Irish Republican Brotherhood; the OAS campaign; the bombings of Bloody Friday by the IRA; and the wave of bombings in Iraq over the course of 2006 which alienated many locals regardless of religious or political persuasion.

A third element of the compatibility factor is the organisation or individual's openness to new ideas. Despite extremist political views, terrorist groups are, more often than not, technologically conservative—perhaps for good reasons given the potential opportunity costs of exploring alternative approaches—and exhibit a marked reluctance to deviate too much from tried and tested technologies. However, in cases where insurgent leaders have technical backgrounds, there may be more scope for innovation. As Jackson has stated:

> Groups whose leaders have technical backgrounds—like Yasser Arafat of the PLO, who has an engineering degree; George Habash of the PFLF, who was a medical doctor; and Ramzi Yousef, who had a diploma in computer-aided electrical engineering —would be expected to have a greater organizational "desire" to innovate than a group led by a conservative Islamic cleric who has spoken publicly against modern science.[38]

Yet even amongst those groups open to new ideas and high-tech weapons, this does not necessarily entail advanced IEDs will be pursued. Aum Shinrikyo largely eschewed IEDs in favour of biological and then chemical weapons. The disinclination towards bombing perhaps lies in their pre-1995 modus operandi, which appears to have avoided the shedding of blood, alternatively it could have been informed by a "fascination with modern technology".[39] Either way, bombs do not appear to have figured widely in Aum's activities perhaps because of their incompatibility with the "values, past experiences, and needs" of Aum.

Trialability

The Trialability of an innovation, that is the "degree to which an innovation may be experimented with on a limited basis" is a further factor influencing whether or not a technology will be adopted; as Cragin et al. have stated: "'[t]est driving' a technology before committing to adopt can provide significant information and reduces adoption risks."[40] Although there are several cases where IEDs appear to have been successfully employed without evidence of a process of experimentation and testing, several of the micro case studies of IED use outlined above illustrate how actors trialled and tested innovations in the build up to an attack. For example, prior to the detonation of the Hope, Giambelli reportedly tried floating barrels of gunpowder and rafts with explosives; during the American Civil War, both Maury and Rains enjoyed a period of experimentation and testing in England and the US, respectively. Orsini reportedly tested his bomb on two occasions in Sheffield and Devon prior to his attempted assassination of Napoleon III[41]; Kibalchich tested his explosive devices in the forest along the Russian/Finnish border; the PIRA developed bombs in secluded locations away from the border, presumably in part to be able to test devices; and Marwan Kreeshat trialled his altimeter bomb in the mountains in Germany.[42]

Linked to the trialability factor is the importance of organisational support or some form of provision of resources, time, and space in which to innovate and test new devices. Giambelli was granted resources from the Senate of Antwerp; in the case of the American Civil War, there was both an organisational body for IED development (the torpedo bureau) and an interlinked financial incentive structure, which led to a step change in IED technology[43]; the Skirmishers established an early form of crowd sourced funding for the skirmishing campaign; whereas the PIRA centralised IED

development and provided institutional support and resources; and the LTTE had the advantage of a "long period to develop such capability; a well-financed organisation; [and] relatively secure territory".[44] Trialability also requires a suitable environment, and whilst there is perhaps scope for trialability in the context of the jungles of Colombia or a training camp on the Af–Pak border, aspiring IED makers operating in urban areas are likely to face environmental obstacles to testing devices in their immediate locality without being caught or at least arousing suspicion.

Observability

As Jackson has stated, "no terrorist group can adopt a technology of which it is unaware."[45] As such, the "observability"—the "degree to which the results of an innovation are visible to others"[46]—of an innovation is an important factor influencing whether it will be adopted. One can see such a trend in the historical micro case study accounts of IED development and deployment, which illustrates a pattern of recycling IED delivery mechanisms and learning from others. Confederate forces observed the benefits of the mines generally and the Nobel chemical fuse specifically; Irish volunteers during the American Civil War would have doubtlessly observed the use of torpedoes in the conflict and brought ideas back to aid the Irish Republican Brotherhood, which was, in turn, observed by a number of other radical groups operating in an environment where "scientific warfare was more obvious than anomic", or as more crudely stated a context where "dynamite was 'cheap as soap and common as sugar'".[47] Whilst it remains difficult to demonstrate, it would be remarkable if *Narodnaya Volya* were not aware of the early Fenian bombings and, regardless of whether it did or did not know of the Clerkenwell attack, the Narodnaya model served as a model for other groups, including Armenian revolutionaries[48] and transnational Anarchists.[49] Palestinian groups observed the Stern Gang's IED campaign of violence before retaliating in kind; the LTTE's first use of a suicide truck bomb bore such similarities with the earlier bombing of the US marine barracks by Hezbollah that it would be remarkable if LTTE did not have this in mind in planning its operation; and Al Qaeda drew from LTTE marine born-IED attacks from the early 1990s in their bombing of the USS Cole in 2000. And as Klingelhoefer has remarked "With the amount of media coverage of the effectiveness of IEDs in the Israeli–Palestinian conflict, any future Iraqi insurgency would surely have looked at IEDs, and especially suicide car bombs as a viable tactic in their fight."[50]

ICT, specifically, improvements in camera phone technology and the spread of social media, has the potential to play an important role in increasing the observability of innovations in IED development and deployment and promulgating successes quicker and more graphically than ever before. As noted above, IED cells now appear to frequently employ cameramen to record the IED events as well as the response both to feed into lessons learned, but also for the purposes of generating twenty-first century propaganda by the deed that can be narrowcast to likeminded individuals through social media networks. Indeed, advances in digital technology have allowed extremists to control the production and dissemination of footage of IED attacks in a manner that was not previously possible, a step that represents a significant advance in modern terrorism. As Weismann has stated:

> Social networking websites allow terrorists to disseminate propaganda to an impressionable age bracket that might empathize with their cause and possibly agree to join… Terrorists apply the narrowcasting strategy to social networking sites as well. The name, accompanying default image, and information on a group message board are all tailored to fit the profile of a particular social group[51]

As such, ICT generally and social media specifically facilitate the observability of IEDs and can be seen as eroding "barriers raised between the group and the larger world—including physical isolation, intellectual distance, or lack of contact out of a desire to avoid scrutiny or law enforcement attention—[that] might serve as might serve as an impediment to technology adoption".[52]

Notes

1. Youngblood. The Development of Mine Warfare.
2. Litowitz, Jason A. 2011. "The Infernal Machine: The Use of Improvised Explosive Devices, IED, Against U.S. Forces." Marine Corps University.
3. Jackson. Technology Acquisition by Terrorist Groups.
4. Dolnik. *Understanding Terrorist Innovation*. Pg 57.
5. Jackson. Technology Acquisition by Terrorist Groups.
6. Rogers, Everett M. 2002. "Diffusion of Preventive Innovations." *Addictive Behaviors*27(6):989–93.http://www.ncbi.nlm.nih.gov/pubmed/12369480.
7. Jackson. Technology Acquisition by Terrorist Groups.
8. Rogers. Diffusion of Preventive Innovations.
9. Stenersen. Bomb-Making for Beginners.
10. Gill, Horgan & Lovelace, J. Improvised Explosive Device.

11. Gill, Horgan & Lovelace, J. Improvised Explosive Device.
12. Hoffman. *Inside Terrorism*. Pgs 182 & 183.
13. Jackson. Technology Acquisition by Terrorist Groups.
14. Jensen. Daggers, Rifles and Dynamite.
15. Kaldor, Mary. 1982. *The Baroque Arsenal*. Andre Deutsch.
16. Clutterbuck. Trends in terrorist weaponry.
17. Rogers. Diffusion of Preventive Innovations.
18. Jackson. Technology Acquisition by Terrorist Groups.
19. This is based on the data provided through the Sutton Index of Deaths, which provides data from the conflict in Ireland between 14 July 1969 and 31 December 2001.
20. Jackson. Technology Acquisition by Terrorist Groups.
21. Jackson. Technology Acquisition by Terrorist Groups.
22. Dolnik. *Understanding Terrorist Innovation*. Pg 14.
23. Jackson. Technology Acquisition by Terrorist Groups.
24. Tsintsadze-Maass, Eteri, and Richard W. Maass. 2014. "Groupthink and Terrorist Radicalization." *Terrorism and Political Violence*, no. March: 1–24. doi:10.1080/09546553.2013.805094. http://www.tandfonline.com/doi/abs/10.1080/09546553.2013.805094.
25. For example, as noted above, Maury sought the assistance of the electrical expert William Norris and the English scientist Sir Charles Wheatstone; Giambelli employed Bory and Timmerman; Orsini sought the skills of the English gunsmith Joseph Taylor.
26. Cohen, Howard J. 2006. "Happy Birthday, Matthew Maury." *The Washington Times*. http://www.washingtontimes.com/news/2006/jun/16/20060616-094756-3971r/?page=all.
27. McFate. Iraq.
28. Rogers. Diffusion of Preventive Innovations.
29. Kenney. Organizational Learning and Islamic Militancy. Pg 117.
30. Mining Attacks Near Mehtar Lam by Commander Sher Padshah and Sheragha IN: Jalali & Grau. The Other Side of the Mountain.
31. Mustafa Bahaduri. 2015. "IEDs and Countering IEDs in Afghanistan." In *2015 Session of the Group of Experts on Amended Protocol II*. UN Office in Geneva. http://www.unog.ch/80256EDD006B8954/(httpAssets)/9078020AC5479B8AC1257E230073117F/$file/02+Afghanistan-Mustafa+Bahaduri.pdf.
32. Kifner. In Long Fight With Israel, Hezbollah Tactics Evolved.
33. Smith, Adrian, Mariano Fressoli, and Hernán Thomas. 2014. "Grassroots Innovation Movements: Challenges and Contributions." *Journal of Cleaner Production* 63 (January). Elsevier Ltd: 114–24. doi:10.1016/j.jclepro.2012.12.025. http://linkinghub.elsevier.com/retrieve/pii/S0959652612006786. Pg 2.

34. Hargreaves et al. Grassroots Innovations in Community Energy. Pg 869.
35. UN News Centre. Afghanistan.
36. This is not unique to IEDs, as Jonathan Glover has noted in the book Humanity: "Moral identity is about being a 'good enough' person, in terms of a baseline set by others […] In the decision to use the [Atomic] bomb the baseline had shifted down during the moral slide from the blockade to the area bombing of Germany and the fire-bombing of Japan". Glover, Jonathan. 2001. *Humanity*: *The Moral History of the Twentieth Century*. Pimlico, London. Pg 99.
37. McConville. Irish Political Prisoners, 1848–1922. Pg 338.
38. Jackson. Technology Acquisition by Terrorist Groups.
39. Dolnik. *Understanding Terrorist Innovation*. Pg 82.
40. Cragin et al. Sharing the Dragon's Teeth. Pg 15.
41. Cropley & Cropley. Creativity and Crime. Pgs 82 & 83.
42. Dolnik. Understanding Terrorist Innovation. Pg 82.
43. Davies, Roger. 2012. "Confederate IED Organization." *Standing Well Back*. http://www.standingwellback.com/home/2012/12/24/confederate-ied-organization.html.
44. Kennedy-Pipe. *The Historical Use of Maritime Improvised Explosive Devices.*
45. Jackson. Technology Acquisition by Terrorist Groups. Pg 191.
46. Rogers. Diffusion of preventive innovations. Pg 990.
47. Whelehan. *The Dynamiters*. Pg 145.
48. Laqueur. *A History of Terrorism*. Pg 43.
49. Jensen. Daggers, Rifles and Dynamite.
50. Klingelhoefer. *Captured Enemy Ammunition in Operation Iraqi Freedom and its Strategic Importance in Post-Conflict Operations.*
51. Weimann, Gabriel. 2011. "Al Qaeda Has Sent You A Friend Request: Terrorists Using Online Social Networking." *Israeli Communication ssociation*. https://sm.asisonline.org/ASISSMDocuments/AlQaedaHasSentYouaFriendRequestTerroristsUsingOnlineSocialNetworking.pdf. Pg 6.
52. Jackson. Technology Acquisition by Terrorist Groups. Pg 191.

CHAPTER 6

Strategic Governance of IEDs

Abstract This chapter brings together a number of tools and activities that collectively form a toolkit of mutually reinforcing measures with which to mitigate the threat posed by IEDs. These are framed through the notion of a web of prevention, drawing on a concept employed in looking at chemical and biological weapons.

Keywords Prevention • Politics • Legislation • Material control • Stigmatisation • Information management • Export controls • Engagement

Discourse instils social and physical phenomenon with meaning, which is necessary to make sense of a particular problem.[1] Unfortunately, the discourse on IEDs is somewhat fragmented at the international level, with differing parties problematising IEDs in different ways. For example, the humanitarian discourse surrounding explosive weapons generally focuses on the human implications of explosive weapons, including IEDs. This narrative has been developed by groups, such as the United Nations Institute for Disarmament Research (UNIDIR), and focuses on the "risk of humanitarian harm associated with the use of explosive weapons in populated areas",[2] with policy responses intended to address how actors can better protect civilians from IEDs. From a humanitarian perspective, there is little distinction between state and non-state actor's use of explosives—if

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indeed such a distinction can in practice be made in the first place—but rather the focus is on the humanitarian consequences of explosive events.

In contrast, national security orientated discourse often tends towards framing IEDs in terms of their use by terrorist or insurgent groups,[3] or around a "threat spectrum" which ranges from the disenfranchised to pirates to terrorists. Through this narrative, IEDs are problematised vis-à-vis the perpetrator.[4] As illustrated in the introduction, this narrowing of applicable perpetrators for IED use is evident in the definition of IED employed in several national security narratives.[5] Whilst understandable from the perspective of national security thinking, the logic can perhaps undermine efforts to deal with the broader problem of IEDs as it focuses primarily on the use of IEDs by terrorists whilst implicitly maintaining the legitimacy of the use of explosives (improvised or otherwise) "by combatants in armed conflict". Or as more bluntly stated by Borrie:

> States often use a discourse of 'terrorism', which focuses on the harm and illegitimacy of use of explosive and other weapons by non-state actors. This can detract critical attention from states' own use of explosive weapons in populated areas, which is also a source of harm.[6]

There is also evidence of international legal discourses dealing with IEDs. However, in part because of the different framings and definitions of IEDs, the legal discourse at the international level becomes slippery, with international legal measures proving a somewhat difficult component of the web of preventative measures developed to deal with IEDs, something discussed further below. The differing framings of IEDs is more than an academic issue, rather it has a bearing on the strategic governance of IEDs with different points of reference, objectives, and interests providing shaky ground for the constructions of a more robust governance architecture to deal with IEDs. As a "Food-For-Thought" paper developed by the Geneva Academy of International Law and Human Rights concluded:

> States need to establish what their agenda is with respect to IEDs—to better protect civilians or to reduce the impact on their armed forces (or both)—for this agenda will determine what measures are likely to have a positive impact on the behaviour of parties to a conflict[7]

With this in mind, the following section lays out a patchwork of measures that are, to some extent, mutually reinforcing and can be seen as feeding into a "Web of IED Prevention", drawing on the concept of a "Web of Deterrence" and later "prevention" developed by Pearson, Rappert & McLeish and others in relation to chemical and biological weapons.[8] There are several components to an IED web of prevention, including political interest, legal measures, export controls, material controls and modification, information management, CIED efforts, engagement, and stigmatisation. The suggestion is not that any measure or series of measures alone can prevent IEDs, but through undertaking a number of different complementary measures and drawing in a range of different actors including from government, law enforcement, and industry, the challenge of IEDs could be reduced.

Political Interest

In 2015, the UN Secretary General, Ban Ki-moon, stated thus: "The increasing use of improvised explosive devices in today's conflicts is another worrisome trend" and correspondingly called "on parties to conflict to desist from the use of such weapons and methods". Ki-moon's call was timely, as despite the evidently destructive nature of IEDs in New Wars of the twenty-first century, "there is a gap at the international level, where strong leadership and a clear political response are currently required".[9] A paper from the Graduate Institute of International and Development Studies and UNIDIR identifies a number of means through which this political gap could be rectified including measures such as a United Nations General Assembly (UNGA) First Committee resolution or the appointment of a UN Special Representative. There is perhaps much to be gained from such a mechanism as a means to "increase awareness of the urgency of the IED issue … [or]… Demonstrate unity… At the very least, the presentation of a First Committee resolution would serve as a … litmus test amongst Member States as to their willingness to take forward the issue of IEDs".[10] However, the continued use of IEDs by state actors in politically sensitive conflicts and the lack of apparent prioritisation of this issue suggest the prospects for such an approach may not be optimistic, although several measures identified in the report could be useful in building political interest in this area.

Legal Measures

At the international level, there are several legal agreements of relevance to IEDs.[11] Under Article 2 of the *1997 International Convention for the Suppression of Terrorist Bombings*, it is stated thus:

> Any person commits an offence within the meaning of this Convention if that person unlawfully and intentionally delivers, places, discharges or detonates an explosive or other lethal device in, into or against a place of public use, a State or government facility, a public transportation system or an infrastructure facility:
>
> a) With the intent to cause death or serious bodily injury; or
> b) With the intent to cause extensive destruction of such a place, facility or system, where such destruction results in or is likely to result in major economic loss.

However, there are several problems with the implementation of the 1997 Convention in relation to its applicability to IEDs. Firstly, the convention binds states and largely serves to obligate its States Parties to transpose the crimes in the treaty into national criminal laws. Secondly, there is no clear definition of "terrorism" in international law, and despite the not insignificant efforts of states, a clear and cohesively agreed appreciation of terrorism is lacking in international law.[12] This is not a problem with the Convention per se but raises difficulties with some contemporary IED events sitting uncomfortably under the ambiguous label of "terrorist bombing" in international law, even if some would see certain IED events as precisely that. Thirdly, the convention does little to deal with the fact that armed forces in certain countries continue to use IEDs on a not insignificant scale. As such, rather than unequivocally proscribed under international law as is the case with most forms of chemical or biological weapons, IEDs are perhaps best understood as a conventional weapon as any other from an international legal perspective. Indeed, rather than just the device, it is the device, its design, the context and outcomes of use which determine the legality or illegality of the IED.

Accordingly, one could turn to international humanitarian law (IHL). Since 2009, a Group of Experts has been convened under the Amended Protocol II to the Convention on Certain Conventional Weapons (CCW) to look at IEDs. Amended Protocol II of the CCW is the only existing

text of international humanitarian law which explicitly mentions IEDs, with Article 2 stating:

> "Other devices" means manually-emplaced munitions and devices including improvised explosive devices designed to kill, injure or damage and which are actuated manually, by remote control or automatically after a lapse of time.

Yet, whilst in principle, such legislative measures limit the means and method of warfare legally available to combatants (rather than prohibit such weapons outright) again it is the weapon, its design and the context of use that determines legality or illegality. Under Article 3, the Amended Protocol states:

> It is prohibited in all circumstances to use any mine, booby-trap or other device which is designed or of a nature to cause superfluous injury or unnecessary suffering. … It is prohibited in all circumstances to direct weapons to which this Article applies, either in offence, defence or by way of reprisals, against the civilian population as such or against individual civilians or civilian objects. … The indiscriminate use of weapons to which this Article applies is prohibited… All feasible precautions shall be taken to protect civilians from the effects of weapons to which this Article applies.

Thus, the CCW prohibits weapons that may have indiscriminate effects or weapons that may cause "superfluous injury or unnecessary suffering" i.e. injury and suffering which serves no military purpose or aggravates the wounds and suffering of combatants.[13] However, IEDs, like most weapons, are not inherently indiscriminate *per se*. Whilst many have been used indiscriminately, there are also cases where they have been designed to discriminate,[14] or deployed in such a manner as to avoid civilian casualties, as was the case in certain phases of IRA bombings. Nor are IEDs inherently a cause of "superfluous injury or unnecessary suffering"; there may be many cases where attacks appear to be unnecessarily destructive, for example, where IEDs appear to employ unnecessary amounts of explosives. However, as has been pointed out:

> The rebuttal to this assertion could be that these weapons are actually intended to penetrate soft-skinned or even armour-plated vehicles, and it is— in Afghanistan at least—the choice of certain forces to conduct more

> foot patrols as a way of connecting with the local population that is resulting in such extensive physical harm.

As such, legal measures at the international level largely fail to make IEDs unlawful per se, and as a presentation by the UK representative to the 2012 Expert Group stated:

> IEDs are capable of being used lawfully… By combatants in armed conflict - Including 'insurgents' in a non-international armed conflict - Against military objects in accordance with IHL principles"… IEDs are unlawful when used indiscriminately or deliberately in attacks on civilians … By insurgents in ignorance, terrorists and criminals - For intimidation and coercion - In publicity for a cause[15]

At the national level, many countries have a long history of legislative measures to control explosives,[16] and there are ongoing efforts to build national penal laws pertaining to terrorism and explosives. However, as sovereign states with different historical experiences, systems of criminal law, and priorities, there is a predictable degree of difference in the nature and efficacy of national legal measures, with some states reportedly not having updated national laws pertaining to explosives since 1918.[17] This is exacerbated by limitations in the extent to which some national legislative measures are promulgated, implemented, and enforced particularly in countries such as Iraq, Afghanistan, and Syria where law enforcement and systems of justice have become eroded through years of conflict.

Yet, further compounding this difficulty is the fact that many of the materials employed in IEDs are dual use and have legitimate purposes, for example, in farming or mining. In some cases, this entails that the prosecution of acquisition of certain materials requires determining intent. The Breivik case is particularly instructive in this regard, illustrating how the Norwegian went to some length to generate "Mining prospectus" and business cards for his front company along with conducting the necessary due diligence on the peaceful uses of fertilisers in farming. Such efforts, Breivik wrote in his manifesto, would make it difficult for authorities to demonstrate his *intention* to cause terror.

Despite these limitations in the existing legal regime at both the national and international levels, a solid legal foundation remains a keystone in efforts to prevent IEDs, and, as such, it raises the question over whether more could be done at both the national and international levels.

For example, there could be scope for fostering interagency cooperation between key stakeholders in order to be able to more effectively prosecute IED acts at the national level, or some form of gap analysis and/or sharing best practices and lessons learned in the prohibition and prosecution of IED cases across borders. Alternatively, could there be scope for a more ambitious peer review process in relation to IED? This could draw on the notion of peer review as defined by the Organisation for Economic Co-operation and Development (OECD) as "the systematic examination and assessment of the performance of a State by other States, with the ultimate goal of helping the reviewed State improve its policy making, adopt best-practices, and comply with established standards and principles".[18] The concept has been employed in a number of other different contexts—including recently by some States Parties to the Biological Weapons Convention—wherein national experts have reviewed each other's legislative or regulatory measures and identified better (if not best) practices and shared lessons learned. [19]

Export Controls

As the above section demonstrates, there is a long history of state and non-state actors sharing IED materials, equipment, and information with other actors across borders for various purposes at various times.[20] In order to counter such activities, several export control mechanisms have been developed. This includes a recent partnership between the World Customs Organization (WCO), INTERPOL, and the United Nations Office on Drugs and Crime (UNODC) designed to "protect the global supply chain and the safety of citizens", through efforts to "thwart the smuggling of precursor chemicals that could be used to build improvised explosive devices (IEDs)".[21] Labelled Project "Global Shield", the latest initiative, is billed as an "unprecedented international effort to counter the illicit diversion and trafficking of precursor chemicals used by terrorists and other criminal organizations to manufacture explosive devices".[22] This has been coupled with awareness raising programmes for companies involved in the manufacture, distribution, and sale of explosives, and the development of "tripwires" that alert authorities to online attempts to purchase IED components, all of which combine to make shopping for IED components (including online shopping) a more risky activity. There have also been efforts to deal with more intangible elements of IED export controls.

However, as with national legislation, export controls also require enforcement and vigilance, and a study by the Government Accountability Office (GAO) in the US demonstrated the ease at which they were able to export several items "obtained by our fictitious individuals includ [ing] ... electronic components used in IEDs".[23] Export control-focused measures are always going to be faced with challenges, particularly with the wide range of possible IED components. However, through increasing the difficulty with which bomb makers can acquire key materials and pushing them towards less powerful explosives and less effective detonators, export controls along with material control measures form a key part of the web of prevention.

Material Control and Modification

Export control measures have been complemented by a number of other material control or modification initiatives. With regards to the former, there exist several material control guidelines and regulations focused on safety and (to a lesser extent) security of stocks of explosives and explosive precursors as well as other IED components.[24] This includes supporting tools such as the International Ammunition Technical Guidelines (IATG) Risk reduction checklist.

There have also been a number of regulatory measures pertaining to the distribution of materials used in home-made IEDs, such as fertiliser. Such measures are not new; in the 1970s, new regulations were brought in the UK to introduce licensing and vetting arrangements for the distribution of ammonium nitrate fertilisers.[25] However, with growing concerns over the IED threat, this is an area of renewed interest and, indeed, some success stories. For example, upon realisation that the bulk of home-made Calcium Ammonium Nitrate (CAN)-based explosives employed in Afghanistan had origins in one key supplier in Pakistan, a partnership was established between the Pakistani Government and the Fatima group of fertiliser producers. The partnership curbed the distribution of CAN, at one point even suspending sales of the fertiliser in certain parts of Pakistan, and led to the investigation and closure of distribution networks involving "ghost" traders.[26]

Material control measures are important. As noted above, some "342 tonnes of HMX, RDX, and PETN high explosives disappeared from the Al-Qaqaa weapons facility south of Baghdad",[27] an amount sufficient to sustain IED attacks for years. Accordingly, one of the lessons learned has to

be the importance of the security of stockpiles of high explosives and arms caches to prevent materials being purloined for the purposes of IED development, something that is frequently difficult within the context of New Wars.[28] Whilst this would not eliminate IEDs, by denying actors easy access to military explosives, it could force aspiring bomb makers to adopt pathways that utilise materials that are more difficult to produce, less destructive weight for weight, and take time to develop and optimise. As Binnie and Wright have stated, the objective would not be to eliminate IEDs, but:

> increase the logistical burden on bomb makers by forcing them to shift to materials that are harder, riskier, and more expensive to acquire, or that have to be transported over longer distances and in smaller batches, that require more complex processing, or that are less powerful when they are turned into explosives.[29]

Similarly, limiting the availability of commercial low-voltage blasting caps—technology that is comparatively more difficult to improvise—could push aspiring weaponeers towards mechanical or chemical detonators that provide less scope for instantaneous detonation. This has been a topic of several discussions in the CCW Article II Expert Group and something that could be taken further forward. As the JIEDDO representative to the Article II Expert Group remarked: "The intent is to focus the community and industry efforts on the commercially produced products that are most difficult to improvise, most easily controlled, and most commonly used in IEDs if not controlled."[30]

As such, there is a clear role for material controls in the web of prevention, yet it is a role which needs to be delicately developed through building long-term relations with those in the fertiliser and explosive industries and making sure industry is both duly informed of the potential risks but also brought in as part of the solution rather than being seen as part of the problem.

As part of what can be seen as a web of preventative measures, there have also been a number of technical responses in which precursors employed for IEDs have been modified to mitigate their efficacy as an explosive ingredient or tagged to enable better detection and forensics. With regard to modification, an engineer with Sandia National Laboratories (US) "has developed a fertilizer that helps plants grow but can't detonate a bomb. It's an alternative to ammonium nitrate, an agricultural staple that is also the raw ingredient in most of the IEDs in Afghanistan".[31]

The idea of marking or tagging explosives has long been attractive[32] and influential in the genesis of the 1991 Convention on the Marking of Plastic Explosives for the Purpose of Detection, which stipulates "each State Party shall take the necessary and effective measure to prohibit and prevent the manufacture in its territory of unmarked explosives".[33] Notably, this also applies pressure to states to ensure that "plastic explosives made in signatory states must include detection taggants—volatile chemicals that slowly evaporate from the explosive and can be detected by either trained sniffer dogs or specialized air-sampling machines".[34] The role of marking has undergone somewhat of a resurgence of late through discussions in the Experts Group to the Amended Protocol II of the CCW. In 2012, for example, it was reasoned that "If producers of industrial or military explosives can be convinced - or legally forced - to mark their products, then detecting hidden explosives or tracing the origin of explosives in post-explosion scenarios will be greatly facilitated".[35] To this end, the Institute of Makers of Explosives (IME) has developed a "globally harmonized format for explosives security markings" drawing from the "marking format required by European Commission Directive 2009/43/EC".[36] Speaking at the Expert Meeting, Lt Col Bradley Preston of the United States Air Force suggested that such a step could help "improving the ability of law enforcement to identify the last legal owner of recovered explosives and reducing the likelihood of theft of explosives during transport, storage, and use".[37] Whilst this approach could usefully assist in material control and accountability of commercial and military grade explosives, it is less suitable for home-made explosives.[38]

Information Management

The prevention of IEDs requires not only the control of materials, but also the control of IED knowledge in both tacit and explicit forms. This is, however, a particularly weak strand of the web of prevention, not least as the history of IEDs illustrates how IED "information non-proliferation" became increasingly outmoded in the early twentieth century in the face of a slew of articles in the mainstream literature, such as the *Scientific American* as well as materials produced by radical groups.[39] Such materials were designed to suit the context of the time and, as such, perhaps remain less readily applicable to aspiring bomb makers operating in the twenty-first century. However, early twentieth-century materials have been augmented by other more contemporary sources of IED information ranging

from Special Forces manuals, to terrorist manuals, to mainstream publications, such as editions of Readers Digest. There is thus a plethora of publicly available materials on IEDs already available in hard copy, suggesting that information management is likely to be difficult.

The difficulties posed by the availability of hard copy literature have been compounded over the last two decades by the emergence of radical websites and online forums that serve as potential sources of IED instruction and guidance. This is an issue which has received much attention of late, for good reason: the Boston Marathon bomber, Dzhokhar Tsarnaev, reportedly "told interrogators that he and his brother used a bomb-making recipe from al Qaeda's online Inspire magazine"[40]; the right-wing extremist Anders Breivik claimed he spent 200 hours searching online for information on IED construction in preparation for his bombing of government buildings in 2011[41]; *Spiegel Online* reported that the Madrid train bombers used manuals downloaded from the Internet[42]; and most recently Erol Incedal was jailed for three and a half years for possession of a bomb-making manual in electronic format.[43] Although concern over the proliferation of bomb-making manuals is therefore not new, there are differences in terms of the speed at which information can circulate across the globe through the Internet, with a magazine electronically produced in and disseminated from Yemen seemingly informing and encouraging—along with other influences—the activities of disillusioned young men in Boston.

Advances in ICT present further problems in relation to the provision of online training. Outside the sphere of bomb making, e-learning is generating significant interest as a tool for learning at distance and is often argued as supporting knowledge transfer.[44] As with other aspects of ICT, e-learning systems have also been exploited for purposes of training bomb makers.[45] However, there is a need for caution in overstating the value of such materials to aspiring bomb makers. Such courses only reveal as much as the lecturer deems necessary, and "success" with IEDs may still require filling in the blanks. Indeed, information is not knowledge and converting IED instruction—regardless of whether it takes the form of audio-visual instruction or written form—into a viable weapon will in many cases require a degree of determination as well as tacit knowledge or know-how to variously make sense of technical jargon or get the knack of certain techniques. It also requires not getting caught in the process of searching for sources of information and, as such ICT perhaps offers opportunities (as well as threats) for those seeking to prevent and prosecute aspiring bomb makers.

CIED Efforts and Forensics

As part of a shift to the "left of the boom"—that is developing an appreciation of factors prior to the explosion and in contrast to post explosion analysis—the JIEDDO has increasingly addressed "non-technological ways to combat IEDs, such as improved training and deeper understanding of the local socio-political landscape where IED planters are created". More recently, this has led to an emphasis on the notion of "defeating", "disrupting", or "destroying" the network.[46] Such an approach is difficult to evaluate based on the open source literature, but perhaps offers greater scope for minimising IED damage. As the above indicates, the impact of IEDs has historically been more damaging when organised and centralised around specialists, suggesting that it might be possible to identify nodes of bomb-making expertise, on which attention could then be focussed.[47]

This further highlights the important role of forensic investigations of explosive devices in building an understanding of the manufacture, manufacturers, and handlers of IEDs. The biometric and forensic data collection processes developed in part in Afghanistan are argued to be amongst the most advanced explosive forensic programmes anywhere, and are a crucial aspect to developing and mapping the social networks involved in the IED process.[48] As such, the knowledge acquired through these programmes will be important to both maintain (in order to ensure a sustainable capacity to prevent IEDs) *and* share between different actors working in different countries on the prevention of IEDs.

Such data could also be usefully employed in methods for IED technology forecasting. Whilst it would be naïve to assume that IED adoption and innovation could ever be accurately calculated based on aggregate data because of the wide range of human variables, building a database of IED events and combining context-specific local knowledge with an appreciation of historical data on IEDs could be useful in informing future possible trends in a more meaningful way, potentially exploiting advances in understandings of the concept of technology forecasting (and its limits). At the very least, such methods might help "provide warning that further … [IED] … developments may follow".[49]

Engagement

The realisation of several elements of the web of prevention requires engagement between key stakeholders working towards the prevention of IEDs. Such stakeholders include the security services, the explosive

industry, fertiliser producers, law enforcement communities, customs officials, and bodies of government who need to work together in the implementation of legal measures, the sharing of data on networks and actors, and the prosecution of perpetrators. Given the initiatives of the Institute of Makers of Explosives (IME) and the apparent success with, for example, the Fatima Group in Pakistan, further industrial engagement and working with distributor companies around the world could be a particularly useful area to explore further to determine who is being sold key materials and what methods could be employed to maintain a degree of vigilance in the circulation of dual use precursors. Indeed, there are perhaps a number of procedural steps, such as the establishment of rigid stock inventories, accurate accounting, and secure storage conditions that could be achieved with minimal financial costs[50] once industry actors are better informed and know where to find information, but also know whom to contact with questions and/or in the event of an anomaly.

There is perhaps another dimension to engagement outlined by UNIDIR in their 2015 report on *The International Community and IEDs: building coordinated processes and responses*. This report acknowledges the difficulties of engaging IED users, before pointing to the experience of Geneva Call in relation to the mine ban treaty and suggesting the introduction of "a parallel process with [non-state armed groups] NSAGs to that of the ongoing broader initiative that is seeking political commitment to introduce new standards for the use of explosive weapons in populated areas by states".[51] Whilst unlikely to prevent IEDs in their entirety, the approach could facilitate the process of stigmatising the indiscriminate use of IEDs in populated areas and potentially undermine the compatibility of IEDs with group norms.

Stigmatisation

As the history above illustrates, IEDs have frequently been greeted with censure, something evident in the language used to describe IEDs which have variously been labelled as: "satanic", "inhuman", "barbarous", "unmanly", "diabolical", "cowardly", or, in the words of Taliban leader Mullah Omar, "un-Islamic" and "anti-human". Moreover, it remains clear that several IED incidents, but particularly those that have killed or injured a significant number of civilians, have led to widespread alienation amongst those that may have been otherwise sympathetic towards the cause of the perpetrators. Examples here include the OAS bombing in Algeria, the Bloody Friday IRA bombings, and events in Iraq in and around 2006. As

such, the notion of stigmatising of IEDs or at least stigmatising the indiscriminate use of IEDs against civilian targets could be "a powerful deterrent for … [non state actors]… who are either seeking credibility as a political state alternative or seeking support within its local constituencies".[52]

However, it is also clear that stigmatisation is a product of group norms and moral baselines and, as such a social construct that could rapidly erode in the face of prolonged violence. Indeed, there remain several examples of how time, pressure, and brutality in conflicts can undermine any sense of opprobrium or stigma associated with IEDs or even serve as a trigger for IED campaigns. For instance, the perceived need for more "urgent, brutal and pragmatic tactics" amongst the Irish Republican Brotherhood served to justify the use of explosives by extreme Irish nationalists; for Anarchists, the increasing severity of repressive measures and the failure of past programmes of action, such as Bakunin's collectivism, paved the way for the Anarchist dynamite campaigns, whereas for the LTTE, the failure of *satyagraha* led to growing violence in the 1970s. It is also telling that the Islamic Emirate of Afghanistan has justified their use of IEDs on the grounds that "our defenseless nation has very limited tools to counter the advanced and indiscriminate weapons deployed by the enemy".[53]

This raises questions over the extent to which stigmatisation of IEDs could usefully deter in the absence of commensurate stigmatisation or redress of those perceived grievances and injustices which lead actors to the development and use of such weapons in the first place. More specifically, it is hard to stigmatise certain uses of IEDs by non-state actors when systematically produced explosive devices are used indiscriminately by states and "specific references to the use of explosive weapons in populated areas are generally absent from existing military policy".[54] However, it is telling that organisations such as the Islamic Emirate of Afghanistan bother to respond to criticism over indiscriminate bombings in the first place, suggesting as it does that stigmatisation and norms do matter to such groups, if only as tools of propaganda. As such, the proposal to stigmatise IEDs, or at least the indiscriminate use of such devices, as proposed by UNIDIR, could be a valuable strand of the web of prevention to explore further. The value of efforts to stigmatise IEDs will, however, be dependent not only on the ability of actors to meaningfully engage with groups using IEDs, potentially drawing from materials resonating with the target audience (e.g. those that originate from salient individuals or religious texts), but also on a commensurate expression of concern and condemnation directed towards the indiscriminate use of explosives by such a groups' enemies.

Notes

1. Hajer, Maarten A. 2005. "'Chapter 12 Coalitions, Practices, and Meaning in Environmental Politics: From Acid Rain to BSE.'" In *Discourse Theory in European Politics*, edited by David Howarth and Jacob Torfing. Palgrave Macmillan.
2. Maya Brehm. 2012. *Protecting Civilians from the Effects of Explosive Weapons An Analysis of International Legal and Policy Standards.* UNIDIR.
3. For example, JIEDDO stated the "The future IED threat consists of an overlapping consortium of networks spanning the entire threat continuum — from criminal gangs to insurgencies to terrorists with global reach — for which the IED is the common weapon of choice. These threat networks operate in an environment characterized by the easy flow of dual-use components through legitimate businesses and one with access to local, readily available explosive materials." JIEDDO. 2012. "Counter-IED Strategic Plan 2012–2016." www.jieddo.dod.mil.
4. As UNIDIR have has noted, "State actors tend to frame explosive weapon use by non-state actors in terms of terrorism" Brehm. Protecting Civilians from the Effects of Explosive Weapons.
5. Something evident in the definition of IEDs provided by certain organisations.
6. Borrie, John, and Maya Brehm. 2012. "Enhancing Civilian Protection from Use of Explosive Weapons in Populated Areas: Building a Policy and Research Agenda." *International Review of the Red Cross* 93 (883): 809–36. doi:10.1017/S1816383112000124. http://www.journals.cambridge.org/abstract_S1816383112000124.
7. Casey-Maslen, Stuart. 2012. "A Need for Greater Restrictions on the Use of Improvised Explosive Devices." ADH Geneva A "Food-for-Thought" Paper. Geneva. http://www.unog.ch/80256EDD006B8954/(httpAssets)/B1048E1B45685499C12579EA00380448/$file/IEDS_ADH+Food+for+Thought+Paper.pdf.
8. Rappert, Brian, and Caitríona McLeish. 2007. "A Web of Prevention: Biological Weapons, Life Sciences and the Governance of Research." London: Earthscan.
9. Graduate Institute of International and Development Studies & the United Nations Institute for Disarmament Research. 2015. "The International Community and IEDs: Building Coordinated Processes and Responses." http://www.unidir.org/files/publications/pdfs/the-international-community-and-ieds-en-644.pdf. Pg 6.
10. Graduate Institute of International and Development Studies & the United Nations Institute for Disarmament Research. The International Community and IEDs.

11. UNIDIR. *Addressing Improvised Explosive Devices.*
12. In this case, the Jury asked for confirmation on whether "within Iraq/Afghanistan now there are governments in place there cannot now be said to be a 'conflict' and therefore no combatant exemption from what would otherwise be a terrorist attack, ie IED on Coalition Forces. To simplify, would an IED attack (ignoring self-defence) on Coalition Forces be a terrorist attack if carried out in 2008/9?" The Supreme Court [UK]. 2013. *JUDGMENT R v Gul (Appellant)*. https://www.supremecourt.uk/cases/docs/uksc-2012-0124-judgment.pdf
13. See, for example, the 1868 St. Petersburg Declaration; Article 35(2) of the 1977 Additional Protocol I; Convention on Certain Conventional Weapons; Article 6(2) of the 1980 Protocol II to the Convention on Certain Conventional Weapons; Article 8(2)(b)(xx) of the 1998 ICC Statute; and the Amended Article 1 of the 1980 Convention on Certain Conventional Weapons. See the International Committee of the Red Cross. 1995. "Rule 70. Weapons of a Nature to Cause Superfluous Injury or Unnecessary Suffering." *Customary International Law*. https://www.icrc.org/customary-ihl/eng/docs/v1_rul_rule70.
14. For example, the Mujahedeen designed triggers using wires which discriminated between the rubber tyres of civilian and military vehicles and the metal tracks of tanks. See Jalali & Grau. The Other Side of the Mountain.
15. Sonnex & Peacock. Counter-Improvised Explosive Devices.
16. In the UK, for example, the 1860 Gunpowder Act set out "regulations about the making and storage of gunpowder". See: Pellew, Jill H. 2013. "The Home Office and the Explosives Act of 1875." *Victorian Studies* 18 (2): 175–94.
17. JIEDDO. 2014. IEDs – Reducing the Risk.
18. Pagani, Fabricio. 2002. "Peer Review as a Tool for Co-Operation and Change: An Analysis of an OECD Working Method." *African Security Review* 11 (4). para. 3.
19. Revill, James. 2013. *A Peer-Review Mechanism for the Biological and Toxin Weapons Convention*. Edited by Kerstin Vignard. UNIDIR Books. New York and Geneva: United Nations Institute for Disarmament Research (UNIDIR).
20. There are several examples of technology transfer outlined in the text above.
21. Project "global shield" concentrates on the following chemical precursors: Ammonium Nitrate (HS Code 3102 30); Nitromethane (HS Code 2904 20); Sodium Nitrate (HS Code 3102 50); Potassium Nitrate (HS Code 2834 21); Sodium Chlorate (HS Code 2829 11); Potassium Chlorate (HS Code 2829 19); Potassium Perchlorate (HS Code 2829 19); Acetone (HS Code 2914 11); Hydrogen Peroxide (HS Code 2847 00); Nitric Acid (HS Code 2808 00); Urea (HS Code 3102 10); Aluminium Powder (HS

Code 7603); CAN (HS Code 3102 60); and Acetic Anhydride (HS Code 2915 24). See further details on World Customs Organization. 2013. "Programme GLOBAL SHIELD." http://www.wcoomd.org/en/topics/key-issues/~/media/WCO/Public/Global/PDF/Topics/EnforcementandCompliance/ActivitiesandProgrammes/SecurityProgramme/PGS/ProgrammeGlobalShieldEN.ashx.
22. World Customs Organization. 2013. "Programme GLOBAL SHIELD." http://www.wcoomd.org/en/topics/key-issues/~/media/WCO/Public/Global/PDF/Topics/EnforcementandCompliance/ActivitiesandProgrammes/SecurityProgramme/PGS/ProgrammeGlobalShieldEN.ashx.
23. Kutz, Gregory D. 2009. "MILITARY AND DUAL-USE TECHNOLOGY – Covert Testing Shows Continuing Vulnerabilities of Domestic Sales for Illegal Export." http://www.gao.gov/assets/130/122654.pdf.
24. Examples include OSCE Handbook on Best Practices on Conventional Ammunition; NATO "Manual of NATO Safety Principles for the Hazard Classification of Military Ammunition and Explosives"; the UN IATG; and the US DoD "Manual on Ammunition and Explosives Safety Standards: General Explosives Safety Information and Requirements".
25. Binnie, & Wright. 'Infernal Machines' Improvised Explosive Devices.
26. JIEDDO. Presentation on IEDs – Reducing the risk.
27. Binnie, & Wright. 'Infernal Machines' Improvised Explosive Devices.
28. Farrior, Stephanie. 2007. "Introductory Note To Behrami And Behrami V. France And Saramati V. France, Germany & Norway European Court Of Human Rights Grand Chamber." *International Legal Materials* 46 (4): 743–45.
29. Binnie & Wright. 'Infernal Machines' Improvised Explosive Devices.
30. JIEDDO (2014) Briefing to the UN Convention on Certain Conventional Weapons: Diversion of Civilian Explosives and Commercial Products for use in IEDs. April 2014. http://www.unog.ch/80256EDD006B8954/(httpAssets)/D4830D557AE1C3A0C1257CAE0045D4E0/$file/09+USA-JIEDDO+(Maj+O'Connell)_APII+GX+2014.pdf.
31. Sandia National Laboratories. 2013. "Fertilizer That Fizzles in a Homemade Bomb Could Save Lives around the World." https://share.sandia.gov/news/resources/news_releases/ied_fertilizer/#.VsETDceYEZY.
32. Charters. The Deadly Sin of Terrorism. Pg 33.
33. UN. 1991. "Convention on the Marking of Plastic Explosives for the Purpose of Detection." http://www.un.org/en/sc/ctc/docs/conventions/Conv10.pdf.
34. UN. 1991. "Convention on the Marking of Plastic Explosives for the Purpose of Detection." http://www.un.org/en/sc/ctc/docs/conven-

tions/Conv10.pdf.; Binnie & Wright. 'Infernal Machines' Improvised Explosive Devices.
35. Zitrin, Shmuel. 2012. "Improvised Explosive Devices (IEDs) in Israel." In *CCW Meeting of Experts on IEDs*. UN Office in Geneva. http://www.unog.ch/80256EDD006B8954/(httpAssets)/7536E2CDABA210D6C12579F10039F404/$file/Israel_IEDs+2012.pdf.
36. Institute of Makers of Explosives. "Security Marking of Explosives." *UN Office in Geneva*.
37. Bradley Preston. "UN Convention on Conventional Weapons." In.https://www.unog.ch/80256EDD006B8954/(httpAssets)/3B5E9F47263DAEB3C1257E23007555C4/$file/07+USA+JIEDDO+LtCol.B.Preston.pdf.
38. Johnson, Charles Michael. 2012. "COUNTERTERRORISM U.S. Agencies Face Challenges Countering the Use of Improvised Explosive Devices in the Afghanistan/Pakistan Region." http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA564137.
39. Dolnik. Understanding Terrorist Innovation. Pg 156.
40. http://www.wsj.com/articles/SB10001424127887324235304578440843633991044.
41. Wright, Craig S. 2011. "Why Didn't Google Catch the Norway Killer?" *The Conversation*. http://theconversation.com/why-didnt-google-catch-the-norway-killer-2514.
42. Musharbash, Yassin. 2006. "Al-Qaida's Online University: Jihad 101 for Would-Be Terrorists." *Spiegel Online*. http://www.spiegel.de/international/al-qaida-s-online-university-jihad-101-for-would-be-terrorists-a-432133-druck.html.
43. BBC. 2015. "Erol Incedal: Jailed for 42 Months over Bomb-Making Manual." *BBC News*. http://www.bbc.co.uk/news/uk-32142038.
44. See, for example, Foray, Dominique, and W Edward Steinmueller. 2003. "The Economics of Knowledge Reproduction by Inscription" 12 (2): 299–319.
45. Stenersen, writing in Perspective on Terrorism, describes at some length Al-Shumukh's "Special Explosives Course for Beginners", and how Al Qaeda have sought to improve the efficacy of online training, in the process exploiting audio-visual means of instruction. Stenersen. Bomb-Making for Beginners.
46. Ellis, Richard F., Richard D. Rogers, and Bryan M. Cochran. 2007. "Joint Improvised Explosive Device Defeat Organization (JIEDDO): Tactical Successes Mired in Organizational Chaos; Roadblock in the Counter-IED Fight." http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA473109.; Zorpette, Glenn. 2008. "Countering IEDs." *IEEE SPECTRUM* September.
47. Reportedly, the biometric and forensic data collection processes developed in part in Afghanistan are among the most advanced forensic programmes

anywhere and are a crucial aspect to developing and mapping the social networks involved in the IED process. See Dietz. Countering the effects of IED systems in Afghanistan.
48. Dietz. Countering the effects of IED systems in Afghanistan.
49. Martino, Joseph P. 2002. "A Review of Selected Recent Advances in Technological Forecasting." *Technological Forecasting & Social Change* 70: 719–33. doi:10.1016/S0040-1625(02)00375-X.
50. Geneva International Centre for Humanitarian Demining. 2014. "IEDs – Reducing the Risk." In *2014 Session of the Group of Experts on Amended Protocol II*. UN Office in Geneva. http://www.unog.ch/80256EE600585943/(httpPages)/95522D21FFBCDBABC1257EEB004CB9B8?OpenDocument.
51. Graduate Institute of International and Development Studies & the United Nations Institute for Disarmament Research. The International Community and IEDs. Pg 5.
52. Graduate Institute of International and Development Studies & the United Nations Institute for Disarmament Research. 2015. "The International Community and IEDs: Building Coordinated Processes and Responses." http://www.unidir.org/files/publications/pdfs/the-international-community-and-ieds-en-644.pdf. Pg 5.
53. Islamic Emirate of Afghanistan. 2012. "Reaction of Islamic Emirate Regarding Accusations of UNAMA about Explosive Devices." http://shahamat-english.com/english/index.php/paighamoona/28792-reaction-of-islamic-emirate-regarding-accusations-of-unama-about-explosive-devices.
54. International Committee of the Red Cross. 2015. "Explosive Weapons in Populated Areas: Humanitarian, Legal, Technical and Military Aspects." In *Explosive Weapons in Populated Areas: Humanitarian, Legal, Technical and Military Aspects. Expert Meeting.*, 24–25. ICRC. https://www.icrc.org/en/download/file/8995/icrc_ewpa_report_12.06.20151.pdf.

Conclusions: IED Futures from Past

IEDs have a long history of use by state and non-state actors alike for a number of different reasons. Although the use of incendiaries and later explosives was primarily the preserve of state actors, by the nineteenth century fin de siècle, it was apparent that dynamite had captured the imagination of several insurgent or terrorist groups (as well as Special Forces and other actors), and the expanding array of IED techniques has continued to fulfil a number of possible strategic, tactical, and psychological objectives ever since.

It is however in the twenty-first century that IEDs have come of age. In part, because of the advance and availability of the technological components required for IEDs; and, in part, because of changes in the nature of war fighting and the shifting of the social, political, and ideological landscape. Such factors have cumulatively fed into the emergence of IEDs as the paradigmatic weapon of New Wars, with their use in some cases "constitute[ing] a direct challenge to some states' monopoly over explosive force".[1] Indeed, such is the challenge posed by improvised explosive devices that they have fed into a debate over the focus and future of Western military strategy,[2] with the increasing volume and deadly efficacy of IEDs bolstering arguments to shift from more population-centric security measures (embodied in COIN) to more robust forms of counterterrorism and remote warfare.

Moreover, the challenge posed by IEDs looks set to continue with IEDs causing significant harm to combatants and civilians alike. Action on Armed Violence has reported "22,735 civilians were killed and injured

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by IEDs in 2013, a figure which represents a 70% increase in civilian casualties since 2011"[3]; and more recently that over 2015, "9,109 civilians were reported killed or injured by suicide attacks".[4] Indeed, the statistic of IED casualties has led many to conclude that the problem of IEDs will not go away, as JIEDDO has remarked:

> IEDs will continue to be a threat throughout the world – they will never go away. They will grow in sophistication and frequency as more enemies of peace realize the potential psychological, social and political impact a weapon like this provides. There is no other widely available terror weapon that provides the mass media focus, sheer panic and strategic influence than the IED[5]

Such sentiments are reflected in a number of other bleak technologically deterministic prophecies of an IED-laced future in which such weapons become ever more prevalent, progressively more destructive, and increasingly sophisticated,[6] with future IED developments limited only by the "imagination" or "ingenuity" of their creators.

Such claims are not entirely misplaced; however, they are problematic for several reasons. Firstly, as this volume has demonstrated, technological innovation is evident in many of the micro case studies but particularly in cases of high-profile attacks; however, for the large part, technology has not driven IED campaigns on its own and the majority of devices used are more vernacular than baroque. Moreover, contemporary IED tactics are rarely "new" or "novel", with most acts being knowingly or unwittingly the recycling of age-old techniques. From the perspective of strategic governance, this recycling of technology provides a cautionary reminder of the importance of guarding against technological surprise, not least technological surprise caused by the "shock of the old". In doing so, it perhaps points to the importance of history as a useful basis for risk assessment and scenario-building activities designed to inform the future of IED technology.

Secondly, it is also questionable whether imagination or ingenuity is the only limit to IED development and deployment. Certainly, imagination and ingenuity matter, but so too does the relative advantage of IEDs (and incremental IED innovations) over other means of causing harm; the compatibility of IEDs with the context, organisational thinking, objectives and norms of any group or individual, and the relative complexity of IED construction and use (and the availability of coercible or co-optable

specialist expertise), as well as the trialability and the observability of the weapons.

Thirdly, but perhaps most importantly, whether "IEDs will continue to be a threat throughout the world" rather depends on the action taken at the international, national, and local level to prevent IEDs and address the underlying causes of such weapons. As the section on a web of prevention indicates, there are things that can be done by several different actors which could contribute to reducing the prevalence of IEDs in the future, if not eliminating them completely. However, it remains unclear whether there is currently the collective will to address the complex web of factors that have fed into the emergence of IEDs as the paradigmatic weapons of New Wars.

Notes

1. Brehm. Protecting Civilians from the Effects of Explosive Weapons.
2. Barker, A. D. 2011. "Improvised Explosive Devices in Southern Afghanistan and Western Pakistan, 2002–2009." *Studies in Conflict and Terrorism* 34 (8): 600–620. doi:10.1080/1057610X.2011.582630. http://www.scopus.com/inward/record.url?eid=2-s2.0-79960960598&partnerID=40&md5=ac36934f62ee1d91d9fc131c9f38c2c0.
3. AOAV. 2014. "The Impact of IEDs: Three Years of Data, 2011–2013." *Action on Armed Violence*. https://aoav.org.uk/2014/three-years-ieds/.
4. Overton, Iain. 2016. "What Can Be Done to Stop the Rising Cult of the Suicide Bomber?" *Action on Armed Violence*. https://aoav.org.uk/2016/what-can-be-done-to-stop-the-rising-cult-of-the-suicide-bomber/.
5. JIEDDO as cited in: Casey-Maslen, Stuart. 2012. "A Need for Greater Restrictions on the Use of Improvised Explosive Devices." ADH Geneva A "Food-for-Thought" Paper. Geneva. http://www.unog.ch/80256EDD006B8954/(httpAssets)/B1048E1B45685499C12579EA00380448/$file/IEDS_ADH+Food+for+Thought+Paper.pdf.
6. CNA Analysis and Solutions. 2013. "The Post-Afghanistan IED Threat Assessment: Executive Summary." https://www.cna.org/CNA_files/PDF/DSI-2013-U-004754-1Rev.pdf. Pg 2.

Bibliography

Ackerman, Gary, and Maranda Sorrells. 2009. Workshop report human and social forces in the spread of the IED threat: Innovation, diffusion and adaptation. Study of Terrorism and Responses to Terrorism (START). http://www.start.umd.edu/sites/default/files/files/announcements/IED_Workshop_Report.pdf.

Addis, Casey L., and Christopher M. Blanchard. 2011. Hezbollah: Background and issues for congress. *Congressional Research Service (CRS) Report for Congress*, 1–33.

Ali, A. L. I. 2011. Displacement and statecraft in Iraq : Recent trends. *International Journal of Contemporary Iraqi Studies*, 5(2): 231–245. doi:10.1386/ijcis.5.2.231.

Alleyne, Richard. 2010. Garland of Arabia: The forgotten story of TE Lawrence's brother-in-arms. *The Telegraph*, July 30. http://www.telegraph.co.uk/news/uknews/7918929/Garland-of-Arabia-the-forgotten-story-of-TE-Lawrences-brother-in-arms.html.n

Allison, John. 2008. Terrorist weapons and technology. In *Combating terrorism in Northern Ireland*, ed. James Dingley, Routledge, London.

Amnesty International. 2015. Syria's 'Circle of hell': Barrel bombs in Aleppo bring terror and bloodshed forcing civilians underground. *Amnesty International News*. https://www.amnesty.org/en/latest/news/2015/05/syrias-circle-of-hell-barrel-bombs-in-aleppo/.

AOAV. 2014. The impact of IEDs: Three years of data, 2011–2013. *Action on Armed Violence*. https://aoav.org.uk/2014/three-years-ieds/.

Asal, Victor, Paul Gill, Karl Rethemeyer, and John Horgan. 2013. Killing range: Explaining lethality variance within a terrorist organization. *Journal of Conflict Resolution* 1–27. doi:10.1177/0022002713508927. http://jcr.sagepub.com/cgi/doi/10.1177/0022002713508927.

J. Revill, *Improvised Explosive Devices*,
DOI 10.1007/978-3-319-33834-7

Atkinson, Rick. 2007a. There was a two-year learning curve…and a lot of people died in those two years. *The Washington Post*, October 1. http://www.washingtonpost.com/wp-dyn/content/article/2007/09/30/AR2007093001675_pf.html.

Atkinson, Rick. 2007b. The single most effective weapon against our deployed forces. *Washington Post*, September 30. http://www.washingtonpost.com/wp-dyn/content/article/2007/09/29/AR2007092900750.html.

Atkinson, Rick. 2008. Left of the boom: The struggle to defeat roadside bombs. *The Washington Post*. http://www.washingtonpost.com/wp-srv/world/specials/leftofboom/.

Bale, Jeffrey M. 2012. *Jihadist cells and 'IED' capabilities in Europe: Assessing the present and future threat to the west*. Strategic Studies Institute Monograph.

Barker, A.D. 2011. Improvised explosive devices in Southern Afghanistan and Western Pakistan, 2002–2009. *Studies in Conflict and Terrorism* 34(8): 600–620. doi:10.1080/1057610X.2011.582630. http://www.scopus.com/inward/record.url?eid=2-s2.0-79960960598&partnerID=40&md5=ac36934f62ee1d91d9fc131c9f38c2c0.

BBC. 1999. Prince of Wales 'Bomb Plot' revealed. *BBC News*. http://news.bbc.co.uk/1/hi/wales/446072.stm.

BBC. 2000. 'Necklace' bomb halts Colombia talks. *BBC News*. http://news.bbc.co.uk/1/hi/world/americas/751237.stm.

BBC. 2009. Was this man the first terrorist of the Modern Age? *BBC Magazine*. http://news.bbc.co.uk/1/hi/8263858.stm.

BBC. 2015a. Erol Incedal: Jailed for 42 months over bomb-making manual. *BBC News*. http://www.bbc.co.uk/news/uk-32142038.

BBC. 2015b. Gunpowder 5/11: The greatest terror plot. UK: BBC 2. http://www.bbc.co.uk/programmes/b04mhwfn

Beckett, Ian. 2001. *Modern insurgencies and counter-insurgencies: Guerrillas and their opponents since 1750*. Routledge, London.

Beretta, Antonio Ballesteros. 1963. *Alfonso X El Sabio*. 1st ed. Salvat Ed.

Blair, William. 2000. The seven days and the radical persuasion. In *The Richmond Campaign of 1862: The Peninsula and the seven days*, ed. Gary W. Gallagher. University of North Carolina Press.

Bohannon, John. 2011. Counting the dead in Afghanistan. *Science* 331(March): 1256–1260.

Bohannon, John, and George Michael Brower. 2011. Civilian casualties in Afghanistan, 2009–2010. *Science*. http://www.sciencemag.org/site/feature/data/hottopics/afghanistan/visualization/index.html

Borrie, John, and Maya Brehm. 2012. Enhancing civilian protection from use of explosive weapons in populated areas: Building a policy and research agenda. *International Review of the Red Cross* 93(883): 809–836. doi:10.1017/

S1816383112000124. http://www.journals.cambridge.org/abstract_S1816383112000124.

Boyce, Frederic, and Douglas Everett. 2014. *SOE: The scientific secrets*. Ebook edit, vol. 8. History Press Limited.

Boyd, Robert S. 1986. SPETSNAZ Soviet innovation in special forces. *Air University Review*, November. http://www.airpower.maxwell.af.mil/airchronicles/aureview/1986/nov-dec/boyd.html.

Bradley Preston. UN convention on conventional weapons. https://www.unog.ch/80256EDD006B8954/(httpAssets)/3B5E9F47263DAEB3C1257E23007555C4/$file/07+USA+JIEDDO+LtCol.B.Preston.pdf.

Braithwaite, Rodric. 2011. *Afgantsy: The Russians in Afghanistan, 1979–89*. Profile Books.

Brehm, Maya. 2012. *Protecting civilians from the effects of explosive weapons an analysis of international legal and policy standards*. UNIDIR.

Brodie, Bernard, and Fawn McKay Brodie. 1973. *From crossbow to H-bomb*. Indiana University Press.

Brown, G.I. 1998. *The big bang – A history of explosives*. Stroud: Sutton Publishing Limited.

Buchanan, Brenda J. 2006. *Gunpowder, explosives and the state: A technological history*. Ashgate Publishing.

Burke, Jason. 1999. Frankenstein the CIA created. *The Guardian*, January 17. http://www.theguardian.com/world/1999/jan/17/yemen.islam.

Burke, Jason. 2015. *The new threat: From Islamic militancy*. Random House.

Butalia, Romesh C. 1998. *The evolution of the artillery in India: From the battle of Plassey (1757) to the revolt of 1857*, 17. Allied Publishers.

Campbell, Lisa J. 2010. Los Zetas: Operational assessment. *Small Wars & Insurgencies* 21(1): 55–80. doi:10.1080/09592310903561429. http://www.tandfonline.com/doi/abs/10.1080/09592310903561429.

Carlisle, David. 2007. Dhiren Barot: Was he an Al Qaeda mastermind or merely a hapless plotter? *Studies in Conflict & Terrorism* 30(March 2015): 1057–1071. doi:10.1080/10576100701670979.

Carpenter, Jonathan. 2012. Terrorist networks in Pakistan and the proliferation of improvised explosive devices. https://www.gpo.gov/fdsys/pkg/CHRG-112shrg79800/html/CHRG-112shrg79800.htm.

Carrington, Damian. 2003. Gunpowder plot would have devastated London. *New Scientist*, November.

Casey-Maslen, Stuart. 2012. A need for greater restrictions on the use of improvised explosive devices. ADH Geneva A "Food-for-Thought" Paper. Geneva. http://www.unog.ch/80256EDD006B8954/(httpAssets)/B1048E1B45685499C12579EA00380448/$file/IEDS_ADH+Food+for+Thought+Paper.pdf.

Chaliand, Gérard, and Arnaud Blin, ed. 2007. *The history of terrorism: From antiquity to Al Qaeda*. University of California Press.

Charters, David. 1994. *The deadly sin of terrorism: Its effect on democracy and civil liberty in six countries*. Greenwood Publishing Group.

Charters, David A. 2007. Jewish terrorism and the modern Middle East by. *The Journal of Conflict Studies* Winter: 80–89.

Childs, David. 2009. *Tudor sea power: The foundation of greatness*. Seaforth Publishing.

CIA. 1981. Soviet support for international terrorism and revolutionary violence, special national intelligence estimate. http://www.foia.cia.gov/sites/default/files/document_conversions/89801/DOC_0000272980.pdf.

Clarke, Michael, and Valentina Soria. 2009. Terrorism in the United Kingdom. *The RUSI Journal* 154(3): 44–53. doi:10.1080/03071840903097647. http://www.tandfonline.com/doi/abs/10.1080/03071840903097647.

Clutterbuck, Lindsay. 2004. The progenitors of terrorism: Russian revolutionaries or extreme Irish republicans? *Terrorism and Political Violence* 16(1): 154–181.

Clutterbuck, Richard. 2007. Trends in terrorist weaponry. *Terrorism and Political Violence* 5(2): 37–41.

CNA Analysis and Solutions. 2013. The post-Afghanistan IED threat assessment: Executive summary. https://www.cna.org/CNA_files/PDF/DSI-2013-U-004754-1Rev.pdf.

Confederate States of America. 1862. *Public laws of the Confederate States of America*, ed. James Matthews. Gale Cengage Learning.

Cooley, John K. 2002. *Unholy wars: Afghanistan, America and international terrorism*. Pluto Press.

Cordesman, Anthony H, Charles Loi, and Vivek Kocharlakota. 2010. IED metrics for Iraq: June 2003–September 2010. http://csis.org/files/publication/101110_ied_metrics_iraq.pdf.

Cragin, Kim, Peter Chalk, Sara A. Daly, and Brian A. Jackson. 2007. Sharing the Dragon's Teeth Terrorist Groups and the exchange of new technologies. RAND Corporation.

Creveld, Martin L. Van. 1989. *Technology and war: From 2000 B.C. to the present*. Collier Macmillan.

Croft, Lee B. 2006. *Nikolai Ivanovich Kibalchich: Terrorist Rocket Pioneer*. Lulu.com.

Cropley, David H., and Arthur J. Cropley. 2013. *Creativity and crime: A psychological analysis*. Cambridge University Press.

Davies, Mike. 2008. *Buda's Wagon a brief history of the car bomb*. Verso Books.

Davies, Roger. 2011. Complex IED attack circa 1584. *Standing Well Back*. http://www.standingwellback.com/home/2011/10/4/complex-ied-attack-circa-1584.html.

Davies, Roger. 2011a. Hellburner hoop. *Standing Well Back*. http://www.standingwellback.com/home/2012/10/2/big-ieds-in-ships.html.

Davies, Roger. 2011b. The tsar and the suicide bomber. *Standing Well Back*. http://www.standingwellback.com/home/2011/11/7/the-tsar-and-the-suicide-bomber.html.

Davies, Roger. 2012a. Confederate IED organization. *Standing Well Back*. http://www.standingwellback.com/home/2012/12/24/confederate-ied-organization.html.

Davies, Roger. 2012b. The Felix Orsini bomb. *Standing Well Back*. http://www.standingwellback.com/home/2012/12/30/the-felix-orsini-bomb.html.

Davies, Roger. 2013. A booby trap IED from 1630. *Standing Well Back*. http://www.standingwellback.com/home/2013/1/5/a-booby-trap-ied-from-1630.html.

Davies, Roger. 2014a. 1948 Truck bombs by British Army deserters. *Standing Well Back*. http://www.standingwellback.com/home/2014/8/10/1948-truck-bombs-by-british-army-deserters.html.

Davies, Roger. 2014b. Things that have happened before. *Standing Well Back*. http://www.standingwellback.com/home/2014/6/18/things-that-have-happened-before.html.

Davies, Roger. 2014c. USS intrepid – Another ship-borne massive IED. *Standing Well Back*. http://www.standingwellback.com/home/2014/5/26/uss-intrepid-another-ship-borne-massive-ied.html.

Davis, John Paul. 2013. *Pity for the guy: A biography of Guy Fawkes*. Peter Owen Limited, London.

Davis, Paul K. 2003. *Besieged: 100 Great sieges from Jericho to Sarajevo*. Oxford University Press.

Delafield, Richard. 1860. *Report on the art of war in Europe in 1854, 1855, and 1856*. Washington, DC.

Dietz, A.S. 2011. Countering the effects of IED systems in Afghanistan: An integral approach. *Small Wars and Insurgencies* 22(2): 385–401. doi:10.1080/09592318.2011.573423. http://www.scopus.com/inward/record.url?eid=2-s2.0-79959549871&partnerID=40&md5=3dc7917242c5519f5a4ecf4ffb29cac6.

Dingley, James. 2012. *The IRA: The Irish Republican Army*. ABC-CLIO.

Dissanayaka, T.D.S.A. 2005. *War or peace in Sri Lanka*. Popular Prakashan.

Dodd, Scott, and Peter Smolowitz. 2003. 1983 Beirut bomb began era of terror. *Knight Ridder Newspapers*. http://www.deseretnews.com/article/515039782/1983-Beirut-bomb-began-era-of-terror.html?pg=all.

Dolnik, Adam. 2009. *Understanding terrorist innovation: Technology, tactics and global trends*. Routledge.

Donghaile, Deaglán Ó. 2011. 'The doctrine of dynamite': Anarchist literature and terrorist violence. In *Blasted literature*, 136–178. Edinburgh University Press.

Dudley, William S., and Michael J. Crawford. 1985. *The Naval War of 1812: A documentary history*. Government Printing Office.

Duffy, Christopher. 2013. *Siege warfare: The fortress in the early Modern World 1494–1660*. Routledge.

Ehud Sprinzak. 2009. Rational fanatics. *Foreign Policy* November(120): 66–73. http://foreignpolicy.com/2009/11/20/rational-fanatics/.

Ellis, Richard F., Richard D. Rogers, and Bryan M. Cochran. 2007. Joint Improvised Explosive Device Defeat Organization (JIEDDO): Tactical successes mired in organizational chaos; Roadblock in the Counter-IED Fight. http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA473109.

English, Richard. 2013. Terrorist innovation and international politics: Lessons from an IRA case study? *International Politics* 50(4). Nature Publishing Group, 496–511. doi:10.1057/ip.2013.18. http://www.palgrave-journals.com/doifinder/10.1057/ip.2013.18.

Erlanger, Steven, and Richard Oppel. 2006. A disciplined Hezbollah surprises Israel with its training, tactics and weapons. *The New York Times*, August 7. http://www.nytimes.com/2006/08/07/world/middleeast/07hezbollah.html?pagewanted=all&_r=0.

Erwan Roche, and Anne Morel. 2015. IEDs: What further action for the international community? *Counter-IED Report* Spring.

Evans, Martin. 2011. 17 October 1961: Fifty years on. *OUP Blog*. http://blog.oup.com/2011/10/17october1961/.

Fair, Christine. 2004. *Urban battle fields of South Asia: Lessons learned from Sri Lanka, India, and Pakistan*. RAND Corporation. http://www.rand.org/content/dam/rand/pubs/monographs/2004/RAND_MG210.pdf.

Farrior, Stephanie. 2007. Introductory note to Behrami and Behrami V. France and Saramati V. France, Germany & Norway European Court Of Human Rights Grand Chamber. *International Legal Materials* 46(4): 743–745.

FBI. 2008. Taming the Tamil Tigers – From here in the U.S. http://www.fbi.gov/news/stories/2008/january/tamil_tigers011008.

Feldhaus, Franz Maria. 1910. *Ruhmesblätter Der Technik von Den Urerfindungen Bis Zur Gegenwart*. F. Brandstetter.

Fleming, Marie. 2008. Propaganda by the deed: Terrorism and anarchist theory in late nineteenth-century Europe. *Terrorism* 4(1–4): 1–23.

Foley, Vernard, Steven Rowley, David F. Cassidy, and F. Charles Logan. 1983. Leonardo, the wheel lock, and the milling process. *Technology and Culture* 24(3): 399–427.

Foray, Dominique, and W. Edward Steinmueller. 2003. The economics of knowledge reproduction by inscription. 12(2): 299–319.

Gage, Beverly. 2009. *The day Wall Street exploded: A story of America in its first age of terror*. Oxford University Press.

Gallego, Pablo Esteban Parra. 2012. COLOMBIA improvised explosive devices. In *2012 session of the Group of Experts on Amended Protocol II*. Geneva: United Nations Office at Geneva. http://www.unog.ch/80256EDD006B8954/(httpAssets)/EFDFCCD728A2754FC12579F1003988EE/$file/Colombia_IEDs+2012.pdf.

Garrison, Arthur H. 2004. Defining terrorism: Philosophy of the bomb, propaganda by deed and change through fear and violence. *Criminal Justice Studies* 17(3): 259–279.

Garver, Christopher. 2007. Amateur hour. *CBRNE World*, 24–27.

Geels, Frank W. 2006. Major system change through stepwise reconfiguration: A multi-level analysis of the transformation of American factory production (1850–1930). *Technology in Society* 28(4): 445–476.

Gelvin, James L. 2008. Al-Qaeda and Anarchism: A historian's reply to terrorology: Response to commentaries. *Terrorism and Political Violence* 20(4): 606–611. doi:10.1080/09546550802257390.

Geneva International Centre for Humanitarian Demining. 2014. IEDs – Reducing the risk. In *2014 Session of the Group of Experts on Amended Protocol II*. UN Office in Geneva. http://www.unog.ch/80256EE600585943/(httpPages)/95522D21FFBCDBABC1257EEB004CB9B8?OpenDocument.

Gerringer, Arthur E. 2002. *Terrorism: From one millennium to the next*. iUniverse.

Gill, P., J. Horgan, and J. Lovelace. 2011. Improvised explosive device: The problem of definition. *Studies in Conflict and Terrorism* 34(9): 732–748.

Gleis, Joshua L., and Benedetta Berti. 2012. *Hezbollah and Hamas: A comparative study*. JHU Press.

Glover, Jonathan. 2001. *Humanity: The moral history of the twentieth century*. London: Pimlico.

Goldman, Adam, and Ellen Nakashima. 2008. CIA and Mossad killed senior Hezbollah figure in car bombing. *The Washington Post*, January 30.

Gordon, Lawrence L. 1968. British orders and awards. Kaye & Ward.

Graduate Institute of International and Development Studies & the United Nations Institute for Disarmament Research. 2015. The International Community and IEDs: Building coordinated processes and responses. http://www.unidir.org/files/publications/pdfs/the-international-community-and-ieds-en-644.pdf.

Gregory, Shaun. 2003. France and the war on terrorism. *Terrorism and Political Violence* 15(1): 124–147. doi:10.1080/09546550312331292987. http://www.tandfonline.com/doi/abs/10.1080/09546550312331292987.

Griffiths, Hugh, and Alastair McAslan. 2009. Low frequency radar for buried target detection. *NATO Science for Peace and Security Series B: Physics and Biophysics*: 125–140. doi:10.1007/978-1-4020-9253-4-6.

Grouille, Olivier. 2009. Bird and Fairweather in context assessing the IED threat. *The RUSI Journal* 154(4): 40–45. doi:10.1080/03071840903255252. http://www.tandfonline.com/doi/abs/10.1080/03071840903255252.

Hajer, Maarten A. 2005. Chapter 12 Coalitions, practices, and meaning in environmental politics: From acid rain to BSE. In *Discourse theory in European politics*, ed. David Howarth and Jacob Torfing. Palgrave Macmillan.

Hargreaves, Tom, Sabine Hielscher, Gill Seyfang, and Adrian Smith. 2013. Grassroots innovations in community energy: The role of intermediaries in niche development. *Global Environmental Change* 23(5): 868–880. doi:10.1016/j.gloenvcha.2013.02.008.

Harvard Sussex Program. 2004. News chronology May through July 2004. *The CBW Conventions Bulletin*, 65: 24.

Hashim, Ahmed. 2013. *When counterinsurgency wins: Sri Lanka's defeat of the Tamil Tigers*. University of Pennsylvania Press.

Hassan, Riaz. 2014. *Life as a weapon: The global rise of suicide bombings*. Routledge.

Higgins, Eliot. 2012. Syria's DIY revolt. *Foreign Policy*, July. http://foreignpolicy.com/2012/07/30/syrias-diy-revolt/.

Higham. N. 2015. Drawings reveal Germans' World War Two boobytrap bombs. *BBC News*, 30 September 2015.

Hiro, Dilip. 2013. *Inside the Middle East (Routledge revivals)*. Taylor & Francis.

Hoffman, Bruce. 2007. The 'cult of the insurgent': Its tactical and strategic implications. *Australian Journal of International Affairs* 61(3): 312–329. doi:10.1080/10357710701531503. http://www.tandfonline.com/doi/abs/10.1080/10357710701531503.

Hopgood, Stephen. 2005. Tamil Tigers, 1987–2002. In *Making sense of suicide missions*, ed. Diego Gambetta, vol. 16, 301–315. Oxford University Press. doi:9780199276998.

Horgan, John, Paul Gill, Sam Hunter, and James Piazza. 2013. *From bomb to bomb-maker*. International Center for the Study of Terrorism.

Iacopo, Mariano Di. 1430. Underground mine causing a fortress to collapse. In *De Machinis*. Institute and Museum of the History of Science. http://brunelleschi.imss.fi.it/genscheda.asp?appl=LIR&xsl=manoscritto&lingua=ENG&chiave=100557.

Imperial War Museum. 1980. *Norman, Compton Patrick (IWM interview)*. UK. http://www.iwm.org.uk/collections/item/object/80004589.

Institute of Makers of Explosives. 2016. Security marking of explosives. *UN Office in Geneva*.

International Campaign to Ban Landmines. 1999. Sri Lanka. *Landmine Monitor Report 1999*. http://www.the-monitor.org/index.php/publications/display?url=lm/1999/sri_lanka.html.

International Committee of the Red Cross. 1995. Rule 70. Weapons of a nature to cause superfluous injury or unnecessary suffering. *Customary International Law*. https://www.icrc.org/customary-ihl/eng/docs/v1_rul_rule70.

International Crisis Group. 2008. Iraq after the surge I: The new Sunni landscape. *Middle East Report*. http://www.crisisgroup.org/~/media/Files/MiddleEastNorthAfrica/IraqSyriaLebanon/Iraq/74_iraq_after_the_surge_i_the_new_sunni_landscape.pdf.

Irwin, Will. 2005. *The Jedburghs: The secret history of the allied special forces, France 1944*. Public Affairs.

Islamic Emirate of Afghanistan. 2012. Reaction of Islamic Emirate regarding accusations of UNAMA about explosive devices. https://blogs.mediapart.fr/lynx/blog/241012/reaction-islamic-emirate-regardingaccusations-unama-about-explosive-devices

Jalali, Ali Ahmad, and Lester W. Grau. 2012. *The other side of the mountain: Mujahideen tactics in the Soviet-Afghan war*. Tales End Press.

Jensen, Richard. 2004. Daggers, rifles and dynamite: Anarchist terrorism in nineteenth century Europe. *Terrorism and Political Violence* 16(1): 116–153.

Jensen, Richard. 2008. Nineteenth century anarchist terrorism: How comparable to the terrorism of Al-Qaeda? *Terrorism and Political Violence* 20(4): 589–596.

JIEDDO. 2012. *Counter-IED strategic plan 2012–2016*. www.jieddo.dod.mil.

JIEDDO. 2014. IEDs – Reducing the risk. 2014 session of the group of experts, CCW Amended Protocol II http://www.unog.ch/__80256ee600585943.nsf/(httpPages)/39340de9a9659e5cc1257cf400344b35?OpenDocument&ExpandSection=3#_Section3.

Johnson, Thomas H. 2013. Taliban adaptations and innovations. *Small Wars & Insurgencies* 24(1): 3–27. doi:10.1080/09592318.2013.740228. http://www.tandfonline.com/doi/abs/10.1080/09592318.2013.740228.

Johnson, Charles Michael. 2012. COUNTERTERRORISM U.S. Agencies Face Challenges Countering the use of improvised explosive devices in the Afghanistan/Pakistan region. http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADA564137

Johnson, David E., M. Wade Markel, and Brian Shannon. 2013. The 2008 battle of Sadr City. http://www.rand.org/content/dam/rand/pubs/occasional_papers/2011/RAND_OP335.pdf.

Jones, Calvert. 2006. Al-Qaeda's innovative improvisers: Learning in a diffuse transnational network. *Cambridge Review of International Affairs* 19(4): 555–569. doi:10.1080/09557570601003205. http://www.tandfonline.com/doi/abs/10.1080/09557570601003205.

Jones, Ian. 2004. *Malice Aforethought: The history of booby traps from World War One to Vietnam*. Greenhill.

Jones, S.G., and P.B. Johnston. 2012. The future of insurgency. *Studies in Conflict and Terrorism* 36(1): 1–25. doi:10.1080/1057610X.2013.739077. http://www.scopus.com/inward/record.url?eid=2-s2.0-84871452316&partnerID=40&md5=1a897f31cf9e0658903af4da7b3505ba.

Jorpes, J Erik. 1959. Alfred Nobel. *British Medical Journal*, January.

Kagan, Kimberly. 2013. *The surge: A military history*. Encounter Books.

Kaldor, Mary. 2013. In defence of new wars. *Stability* 2(1): 1–16.
Kaldor, Mary. 1982. *The Baroque Arsenal*. Andre Deutsch.
Kamran, Yousaf. 2013. Deadly Fertiliser: Kayani proposes forum to counter IED threats. *The Express Tribune*, May 20. http://tribune.com.pk/story/551923/deadly-fertiliser-kayani-proposes-forum-to-counter-ied-threats/.
Karouny, Mariam. 2014. Massive tunnel bomb hits Syrian Army base: Video. *Reuters*, May 15. http://www.reuters.com/article/us-syria-crisis-airstrikes-idUSBREA4E09520140515.
Katz, Samuel M. 2004. *Jerusalem or death: Palestinian terrorism*. Twenty-First Century Books.
Kennedy-Pipe, Caroline. 2010. The historical use of maritime improvised explosive devices. *Hull University Centre for Security Studies IED Project Occasional Paper No. 1*. Hull University Centre for Security Studies IED Project Occasional Paper No. 1 THE. http://www2.hull.ac.uk/fass/pdf/CSS Occasional Paper 1.pdf.
Kenney, Michael. 2008. Organizational learning and Islamic militancy. https://www.ncjrs.gov/pdffiles1/nij/grants/226808.pdf.
Kifner, John. 2000. In long fight with Israel, Hezbollah tactics evolved. *The New York Times*, July 14. http://www.nytimes.com/2000/07/19/world/in-long-fight-with-israel-hezbollah-tactics-evolved.html.
Klingelhoefer, Mark. 2005. Captured enemy ammunition in operation Iraqi freedom and its strategic importance in post-conflict operations. http://www.strategicstudiesinstitute.army.mil/pdffiles/ksil72.pdf.
Kopp, Carlo. 2007. Technology of improvised explosive devices. *Defence Today* 6(3).
Kuperman, Alan J. 1999. The Stinger missile and U.S. intervention in Afghanistan. *Political Science Quarterly* 114(2): 219–263. doi:10.2307/2657738. http://doi.wiley.com/10.2307/2657738.
Kutz, Gregory D. 2009. Military and dual-use technology – Covert testing shows continuing vulnerabilities of domestic sales for illegal export. http://www.gao.gov/assets/130/122654.pdf.
Landau, Henry. 1937. *The enemy within*. New York: Van Rees Press.
Laqueur, Walter. 1987. *The age of terrorism*. Little, Brown and Company.
Laqueur, Walter. 2002. *A history of terrorism*. Third Prin. Transaction Publishers.
Larabee, Ann. 2004. A brief history of terrorism in the United States. In *Technology and terrorism*, ed. David Clarke, 244. Transaction Publishers.
Larabee, Ann. 2005. *The dynamite fiend: The chilling tale of a confederate spy, con artist, and mass murderer*. Palgrave Macmillan.
Lawrence, T.E. 1926. *Seven pillars of wisdom*. Reproduced by Project Gutenberg.
LeBor, Adam. 2014. Zion and the Arabs: Jaffa as a Metaphor. *World Policy Journal* 24(4): 61–75.
Likar, Lawrence E. 2011. *Eco-warriors, nihilistic terrorists, and the environment*. ABC-CLIO.

Litowitz, Jason A. 2011. *The infernal machine: The use of improvised explosive devices, IED, against U.S. Forces*. Marine Corps University.

Lundeberg, Philip K. 1974. *Samuel Colt's submarine battery – The secret and the Enigma*. Washington: Smithsonian Institution Press.

Marco D. Tomasi. 2009. Alternative motivations for IED use in Afghanistan. Vol. Product Se. http://info.publicintelligence.net/JIEDDOafghanieds.pdf.

Martin, Colin, and Geoffrey Parker. 1999. *The Spanish Armada: Revised edition*. Manchester University Press.

Martino, Joseph P. 2002. A review of selected recent advances in technological forecasting. *Technological Forecasting & Social Change* 70: 719–733. doi:10.1016/S0040-1625(02)00375-X.

Mattingly, Garrett. 1987. *The Armada*. Houghton Mifflin Harcourt.

Mayor, Adrienne. 2003. *Greek fire, poison arrows and scorpion bombs: Biological and chemical warfare in the ancient world*. Woodstock, New York, and London: Overlook Duckworth.

McClintock, Matthew. 1992. *Instruments of statecraft: U.S. Guerilla warfare, counter-insurgency, counter-terrorism, 1940–1990*. Pantheon Books.

McConville, Seán. 2003. *Irish political prisoners, 1848–1922: Theatres of war*. Psychology Press.

Mcfate, Montgomery. 2005. Iraq: The social context of IEDs. *Military Review*, June.

Merriman, John. 2009. *The dynamite club: How a bombing in Fin-de-Siecle Paris ignited the Age of Modern Terror*. Houghton Mifflin Harcourt Company.

Metropolitan Police. 2006. Metropolitan police terrorist jailed for life for conspiracy to murder in the UK and US. *News*. http://content.met.police.uk/News/Terrorist-jailed-for-life-for-conspiracy-to-murder-in-the-UK-and-US/1260267887712/1257246745756.

Meyers, Sydney, and Edward S. Shanley. 1990. Industrial explosives – A brief history of their development and use. *Journal of Hazardous Materials* 23: 183–201.

Michael Corderre, and Michael Register. 2009. Fighting back against IEDs. *Police – The Law Enforcement Magazine* September (September). http://www.policemag.com/channel/swat/articles/2009/09/fighting-back-against-ieds.aspx.

Motley, John Lothrop. 1863. *The rise of the Dutch Republic: Complete in one volume*. Strahan.

Motley, John Lothrop. 1888. *History of the United Netherlands from the death of William the silent to the twelve years' truce--1609*. New York: Harper & Brothers.

Murphy, John F. 2005. The IRA and the FARC in Colombia. *International Journal of Intelligence and CounterIntelligence* 18(1): 76–88.

doi:10.1080/08850600590905753. http://www.tandfonline.com/doi/abs/10.1080/08850600590905753.

Mustafa Bahaduri. 2015. IEDs and countering IEDs in Afghanistan. In *2015 Session of the Group of Experts on Amended Protocol II*. UN Office in Geneva. http://www.unog.ch/80256EDD006B8954/(httpAssets)/9078020AC5479B8AC1257E230073117F/$file/02+Afghanistan-Mustafa+Bahaduri.pdf.

Nasiri, Omar. 2007. *Inside the Jihad: My life with Al Qaeda*. Basic Books.

National Commission on Terrorist Attacks Upon the United States. 2004. The 9/11 Commission report. Washington, DC.

National Research Council. 2007. Countering the threat of improvised explosive devices: Basic research opportunities. doi:0-309-10916-7. http://www.nap.edu/openbook.php?record_id=11953.

Neary, Lynn. 2009. Tamil Tigers: Suicide bombing innovators – An interview with Robert Pape. *NPR*. http://www.npr.org/templates/story/story.php?storyId=104391493.

Needham, Joseph. 1986. *Science and civilisation in China: Volume 5, chemistry and chemical technology, Part 7, military technology; the gunpowder epic*. Cambridge University Press.

O'Brien, Brendan. 1999. *The long war: The IRA and Sinn Féin*. Syracuse University Press.

O'Connell, Robert L. 1989. *Of Arms and Men : A History of War, Weapons, and Aggression: A History of War, Weapons, and Aggression*. Oxford University Press, USA.

Overton, Iain. 2016. What can be done to stop the rising cult of the suicide bomber? *Action on Armed Violence*. https://aoav.org.uk/2016/what-can-be-done-to-stop-the-rising-cult-of-the-suicide-bomber/.

Pagani, Fabricio. 2002. Peer review as a tool for co-operation and change: An analysis of an OECD working method. *African Security Review* 11(4).

Palgrave, Reginald Francis Douce. 1890. *Oliver Cromwell, the protector: An appreciation based on contemporary evidence*. London: Sampson Low, Marston, Searle & Rivington.

Partington, J. R. 1960. *A history of Greek fire and gunpowder*. JHU Press.

Pellew, Jill H. 2013. The Home Office and the Explosives Act of 1875. *Victorian Studies* 18(2): 175–194.

Perry, Milton F. 1965. *Infernal machines*. Louisiana State University Press.

Porter, Bernard. 1987. *The origins of the vigilant state: The London metropolitan police special branch before the First World War Bernard Porter*. Boydell & Brewer Ltd.

Porter, Cathy. 1976. *Fathers and daughters: Russian women in revolution*. Virago.

Rains, Gabriel J., and Peter S. Michie. 2011. *Confederate torpedoes: Two illustrated 19th century works with new appendices and photographs*. ed. Herbert M. Schiller. McFarland.

Ranstorp, Magnus. 2005. The H Hizballah training camps of Lebanon. In *The making of a terrorist: Volume II recruitment*. Praeger Security International.

Rappert, Brian, and Caitríona McLeish. 2007. A web of prevention: Biological weapons, life sciences and the governance of research. London: Earthscan.

Rashid, Ahmed. 2008. *Descent into chaos*. Allen Lane.

Reuters. 1981. P.L.O. Says 'hundreds' were trained by Soviet. *The New York Times*. http://www.nytimes.com/1981/02/18/world/plo-says-hundreds-were-trained-by-soviet.html.

Revill, James. 2013. *A peer-review mechanism for the biological and toxin weapons convention*, ed. Kerstin Vignard. UNIDIR Books. New York/Geneva: United Nations Institute for Disarmament Research (UNIDIR).

Rogers, Everett M. 2002. Diffusion of preventive innovations. *Addictive Behaviors* 27(6): 989–993. http://www.ncbi.nlm.nih.gov/pubmed/12369480.

Roland, Alex. 1995. Science, technology, and war. *Technology and Culture* 36(2).

Ronfeldt, David, and William Sater. 1981. The mindsets of high-technology terrorists: Future implications from an historical analog. *RAND Notes*.

Rubinstein, Alvin Z. 1990. *Moscow's third world strategy*. Princeton University Press.

Rutt, John Towill, ed. 1828. A brief relation of the late dangerous plot for the destruction of his highness's person. In *Diary of Thomas Burton Esq: Volume 2, April 1657 – February 1658*. London: H Colburn.

Sale, R.E. 1886. On land mines. *Journal of the Royal United Services Institution* 30(133): 95–106.

Samuel Zimmermann. 1587. *Dialogus*. Augsburg.

Sandia National Laboratories. 2013. Fertilizer That Fizzles in a Homemade Bomb Could Save Lives around the World. https://share.sandia.gov/news/resources/news_releases/ied_fertilizer/#.VsETDceYEZY.

Schaack, Michael J. 1889. *Anarchy and anarchists: A history of the red terror and the social revolution in America and Europe. Communism, socialism, and nihilism in doctrine and in deed. The Chicago Haymarket conspiracy, and the detection and trial of the conspirators*. F.J. Schulte.

Scientific American. 1876. Infernal machines. *Scientific American* 34(5): 65.

Shultz, Richard. 2007. The role of external forces in third world conflicts. *Comparative Strategy* (October 2013): 37–41.

Simon, Jeffrey D. 2008. The forgotten terrorists: Lessons from the history of terrorism. *Terrorism and Political Violence* 20(2): 195–214. doi:10.1080/09546550801907599. http://www.tandfonline.com/doi/abs/10.1080/09546550801907599.

Singer, Jane. 2005. *The confederate dirty war: Arson, bombings, assassination and plots for chemical and germ attacks on the union*. McFarland.

Smith, Andrew. 2003. Improvised explosive devices in Iraq, 2003–09: A case of operational surprise and institutional response. Carlisle: Strategic Studies Institute U.S. Army War College.

Smith, Adrian, Mariano Fressoli, and Hernán Thomas. 2014. Grassroots innovation movements: Challenges and contributions. *Journal of Cleaner Production* 63. Elsevier, 114–124. doi:10.1016/j.jclepro.2012.12.025. http://linkinghub.elsevier.com/retrieve/pii/S0959652612006786.

Sonnex, Peter, and Tim Peacock. 2012. Counter-improvised explosive devices. In *2012 session of the Group of Experts on Amended Protocol II*. Geneva: United Nations Office at Geneva. http://www.unog.ch/80256EDD006B8954/(httpAssets)/4659EE6F59A2374DC12579F10039C3DC/$file/UK_IEDs+2012.pdf.

Stenersen, Anne. 2013. 'Bomb-making for beginners': Inside Al Al-Qaeda e-learning course. *Perspectives on Terrorism* 7(1): 25–37. http://www.terrorismanalysts.com/pt/index.php/pot/article/view/241/pdf.

Steward, Patrick, and Bryan P. McGovern. 2013. *The Fenians: Irish Rebellion in the North Atlantic World, 1858–1876*. University of Tennessee.

The Church Committee. 1975. Interim report: Alleged assassination plots involving foreign leader. http://www.aarclibrary.org/publib/church/reports/ir/html/ChurchIR_0105b.htm.

The National Academies [US] and Department of Homeland Security [US]. 2012. IED attack – Improvised explosive devices, fact sheet. https://www.dhs.gov/xlibrary/assets/prep_ied_fact_sheet.pdf.

The New York Times. 1985. Soviet toys of death. *The New York Times*, December 10. http://www.nytimes.com/1985/12/10/opinion/soviet-toys-of-death.html.

The Supreme Court [UK]. 2013. *JUDGMENT R v Gul (Appellant)*. https://www.supremecourt.uk/cases/docs/uksc-2012-0124-judgment.pdf

The White House. 1985. U.S. Policy, Programs and Strategy in Afghanistan, National Security Directive Number 166. http://fas.org/irp/offdocs/nsdd/nsdd-166.pdf.

Tom Vanden Brook. 2013. Afghan bomb makers shifting to new explosives for IEDs. *USA Today*, June 25. http://www.usatoday.com/story/news/world/2013/06/25/ammonium-nitrate-potassium-chlorate-ieds-afghanistan/2442191/.

Townshend, Charles. 2011. *Terrorism: A very short introduction*. Oxford University Press.

Tsintsadze-Maass, Eteri, and Richard W. Maass. 2014. Groupthink and terrorist radicalization. *Terrorism and Political Violence*, no. March: 1–24. doi:10.1080/09546553.2013.805094. http://www.tandfonline.com/doi/abs/10.1080/09546553.2013.805094.

Turnbull, Stephen. 2012. *Siege weapons of the Far East: AD 960–1644*. Osprey Publishing.

UN. 1991. Convention on the marking of plastic explosives for the purpose of detection. http://www.un.org/en/sc/ctc/docs/conventions/Conv10.pdf.

UN News Centre. 2012. Afghanistan: Following deadly blast, UN mission calls on Taliban to halt use of improvised explosive devices. *UN News*, October 20. http://www.un.org/apps/news/story.asp?NewsID=43341#.Vr-ttMeYEZY.

UN Security Council. 2014. Security Council unanimously adopts resolution 2139 (2014) to ease aid delivery to Syrians, provide relief from 'Chilling Darkness.' United Nations. http://www.un.org/press/en/2014/sc11292.doc.htm.

UN Security Council Committee established pursuant to resolution 1988 (2011). 2015. The list established and maintained by the 1988 (2011) Committee, vol. 1988. http://www.un.org/sc/committees/1988/list.shtml.

UNIDIR. 2015. *Addressing improvised explosive devices – Options and opportunities to better utilize UN processes and actors.* UNIDIR Resources

United Nations Economic and Social Council. 1988. Report on the situation of human rights in Afghanistan prepared by the special Rapporteur, Mr. Felix Ermacora, in accordance with Commission on Human Rights resolution 1985/38. http://www.refworld.org/pdfid/482996d02.pdf.

United States Office of the Secretary of State. 1991. Patterns of global terrorism: 1990. http://fas.org/irp/threat/terror_90/index.html.

United States. Naval War Records Office. 1914. *Official records of the union and confederate navies in the War of the Rebellion; Series I – Volume 26: Naval forces on western water.*

Unknown. 2006. United States of America V Dhiren Barot. *Washington Post.* http://www.washingtonpost.com/wp-srv/articles/hindi.pdf.

Unknown. 2012. Syrian rebels make driverless car bomb. *Military.Com.* http://www.military.com/video/operations-and-strategy/improvised-weapons/syrian-rebels-make-driverless-car-bomb/1565016817001.

US Army Intelligence and Security Command. Review of IED activity in Mexico. https://wikileaks.org/gifiles/attach/9/9625_US%20Army%20NGIC%20Review%20of%20IED%20Activity%20in%20Mexico-1.pdf

Van Creveld, Martin. 1994. The rise and fall of military technology. *Science in Context* 7(02) (September 26): 327–351.

Viktor von Scheliha. 1868. *A treatise on coast defence: Based on the experience gained by officers of the Corps of Engineers of the Army of the Confederate States.* London: E & F.N Spon.

Weimann, Gabriel. 2011. Al Qaeda has sent you a friend request: Terrorists using online social networking. *Israeli Communication Association.*

Weiss, L., E. Whitaker, E. Briscoe, and E. Trewhitt. 2011. Evaluating counter-IED strategies. *Defense and Security Analysis* 27(2): 135–147. doi:10.1080/14751798.2011.578717. http://www.scopus.com/inward/record.url?eid=2-s2.0-79960547372&partnerID=40&md5=f044a8cbc8be1b00e15f5dbc848d9bb0.

Whelehan, Niall. 2012. *The dynamiters: Irish nationalism and political violence in the wider world, 1867–1900.* Cambridge University Press.

Wilkinson, Adrian, James Bevan, and Ian Biddle. 2007. Improvised explosive devices (IEDs): An introduction. In *Conventional ammunition in surplus*, ed. James Bevan, 136–144. Geneva: Small Arms Survey, Graduate Institute of International Studies.

Wilson, Clay. 2007. Improvised explosive devices (IEDs) in Iraq and Afghanistan: Effects and countermeasures. http://fas.org/sgp/crs/weapons/RS22330.pdf.

Wogan, Chris. 2004. *AmIraqa and the New American Century*. Lulu.com.

Woods, Kevin M. 2007. Primary source material for Saddam and terrorism: Emerging insights from captured Iraqi documents, vol. 5.

World Customs Organization. 2013. Programme GLOBAL SHIELD. http://www.wcoomd.org/en/topics/key-issues/~/media/WCO/Public/Global/PDF/Topics/EnforcementandCompliance/ActivitiesandProgrammes/SecurityProgramme/PGS/ProgrammeGlobalShieldEN.ashx.

Wright, Craig S. 2011. Why didn't Google catch the Norway killer? *The Conversation*.http://theconversation.com/why-didnt-google-catch-the-norway-killer-2514.

Youngblood, Norman. 2006. *The development of mine warfare: A most murderous and barbarous conduct*. Westport CT: Praeger Security International.

Yousafzai, Sami. 2009. The Taliban's oral history of the Afghanistan War. *Newsweek*. http://www.newsweek.com/talibans-oral-history-afghanistan-war-79553.

Yusufzai, Mushtaq. 2009. Wanted Taliban leader doesn't fear U.S. *NBC News World Blog*, April 9. http://worldblog.msnbc.msn.com/_news/2009/04/09/4375885-wanted-taliban-leader-doesnt-fear-us.

Zitrin, Shmuel. 2012. Improvised explosive devices (IEDs) in Israel. In *CCW meeting of experts on IEDs*. Geneva: UN Office. http://www.unog.ch/80256EDD006B8954/(httpAssets)/7536E2CDABA210D6C12579F10039F404/$file/Israel_IEDs+2012.pdf.

Zorpette, Glenn. 2008. Countering IEDs. *IEEE SPECTRUM* September.

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