Tactical Innovation and the Provisional Irish Republican Army

Abstract
This paper provides an overview of Provisional Irish Republican Army (PIRA) innovations with regards to improvised explosive devices (IEDs). It situates PIRA's tactical innovations within the broad organizational psychology literature focused on the nature and drivers of creativity and innovation. This discussion helps frame the two empirical analyses that follow. The first analysis provides a graphical timeline of PIRA's radical innovations (and their drivers) in relation to IED technology. This helps provide a sense of the specific occasions in which PIRA innovations were numerous and when they were sparse. The second analysis looks at the locations in which PIRA radical innovations debuted. This provides us with an understanding of the specific PIRA units responsible for these innovations. The results demonstrate that whilst PIRA operations spanned the six counties of Northern Ireland for 29 years, radical IED innovations were conceived, developed and initially implemented within only two areas of operations for only seven of those years.

Introduction

In November 1971, the London-based Institute for the Study of Strategic Conflict published a booklet entitled 'The Spreading Irish Conflict'. The authors refer to Provisional Irish Republican Army (PIRA) members as "clumsy", "disorganized" and unimaginative terrorists". PIRA deployed "amateurish" tactics. "Their bomb attacks up till mid-1971 often amounted to nothing more than a man nervously lobbing a petrol bomb so badly made that the wick falls out before it reaches its target".[1] Fast forward to the past decade and synopses of PIRA's capabilities look very different. Jackson's in-depth study of terrorist learning outlines, "PIRA developed a reputation for its capabilities with explosives ad the application of advanced technologies in the construction and use of bombs, mines, and other devices. These capabilities developed over time as a results of an intense learning process within the group."[2] Oppenheimer refers to PIRA's "unparalleled ingenuity in IED making.[34] Others note "PIRA is widely recognized as overseeing the greatest innovation and deepest expertise in the construction and deployment of IEDs by any non-state violent organization".[5]

Are these two strikingly different positions purely just a by-product of the time these assertions were made? In other words, is it a case of PIRA simply improving their operations between the publication of the initial report and the later citations? Or is it a case of both approaches perhaps over attributing their position to PIRA as a whole rather than the specific sub-units tasked with innovations and tactical deployment? This paper seeks to answer these questions in a number of ways. It situates PIRA's tactical innovations within the broad organizational psychology literature focused on the nature and drivers of creativity and innovation. This discussion helps frame the two empirical analyses that follow. The first analysis provides a graphical timeline of PIRA's radical innovations (and their drivers) in relation to IED technology thus highlighting the drivers of why PIRA needed to learn. This helps provide a sense of the specific occasions in which PIRA innovations were numerous and when they were sparse. The second analysis looks at the locations in which PIRA radical innovations debuted. This provides us with an understanding of the specific PIRA units responsible for these innovations.

Theory

In the past couple of decades, the study of creativity and innovation emerged as a vibrant and empirically rich area of study within the wider industrial and organizational psychology field. Despite the clear implications this field has for the study of terrorism only a few studies applied these insights into the study of terrorist organizations.[6] Research on creativity/innovation is largely in agreement on four factors. First, different types of innovation exist. Second, creativity does not equal innovation. Third, innovation is typically a process with different drivers. Fourth, innovations can be radical or incremental. The below sections elaborate upon these statements with reference to illustrative examples from PIRA's history.

Different Types of Innovation Exist

Many early studies of terrorist innovation emphasized the distinct lack of creativity and innovation within terrorist organizations. One distinguished scholar, for example,

argued that compared to conventional war, terrorism "has not changed much in the course of a century, and virtually not at all during the last 25 years."[7] Hoffman agrees, noting the terrorist attacks' remarkable consistency and conservative nature over time.[8] Dolnik refers to terrorist attacks as "relatively limited and remarkably unchanging".[9] Many recent studies, however, take a more fine-grained approach to what encompasses innovation and came to very different conclusions. Crenshaw highlights three different types of innovation.[10] First, tactical innovation involves the adoption of new technologies to achieve long-lasting strategic objectives. One example of a PIRA tactical innovation is the systematic use of car bombings against Northern Ireland's economic heart. The empirical analysis, below, focuses upon tactical innovation and elaborates upon many of these endeavors in greater depth. Second, strategic innovation involves adopting new objectives. For example, PIRA's increasing politicization through the 1980s and 1990s, reflected in the growing power and status of its political wing Sinn Fein, largely reflects a strategic innovation at the elite level of the movement.

Third, changes organizational/structural changes exhibit organizational innovation. A large-scale re-organization of PIRA's structure to a tighter cellular based network in which cells acted independently of one another occurred between 1977 and 1980.[11] Previously, PIRA structured itself like a conventional army with various brigades, battalions and companies responsible for specific geographical combat areas. This change placed far less emphasis on the quantity of recruits and far more emphasis on secrecy and discipline than the preceding phase. Almost instantly, the effects of the structural changes became noticeable with 465 fewer charges for paramilitary offences occurring within a year.[12]

Creativity does not equal innovation

Creativity and innovation are not the same thing. Creativity involves generating ideas and novel concepts. Innovation involves implementing these ideas.[13] In the context of learning (the topic of this special issue), creative thinking is a response to learning about the need for improvement (be it through effective counter-terrorism or another source), whereas innovations are the proof that lessons learned and the solutions applied were correct. For an innovation to occur, it must first go through a creative process from idea generation through to full implementation. If a very creative act of violence is devised, but the group lacks the capability to carry it out, the creative output will fall short of being an innovation. Such issues were common in PIRA's history especially with regards to delivery methods of IEDs. For example, an early PIRA incendiary device utilized a condom as a fuse delay device. The device entailed filling a condom with sulphuric acid. The time the acid took to dissolve the rubber acted as the time delay mechanism. Upon dissolving, the acid reacted with the incendiary material and produced fire. Two reasons led to this device's demise. First, although it was highly novel, original, relevant and elegant, it was highly dangerous to the operator.[14] The main resistance to this bomb however came from individuals who refused to store caches of condoms, previously proscribed by the Catholic Church, in their homes.[15]

Other highly creative ideas were also soon consigned to the dustbin after one use. For example, on August 10th 1971, PIRA militants pushed a 50lb. gelignite bomb down a sewer pipe. The intention was for the bomb to float under an Army post that was occupied by 330 soldiers at the time. Unfortunately for PIRA, the Volunteers used the

incorrect pipe and the bomb instead exploded under an unoccupied drinking club instead.[16] Another particularly creative delivery system used in May 1992 involved a stolen Hitachi excavator and laundry van. PIRA volunteers removed the van's tires to make it capable of running along the railway track on its rims. The excavator lifted the laundry van onto the tracks. The van was loaded with 1000lb of explosives and plentiful command wire. The van was put into gear and sent along the track, driverless. Its open backdoors allowed the command wire to fall alongside the railway tracks. As it got close to an Army Barracks, it was detonated, killing one of the sentries in the process. Another example is the January 1974 airborne IED attack. After forcibly taking control of a helicopter and its pilot, PIRA volunteers attempted to drop a milk churn full of explosives upon a police station in the town of Strabane. The milk churn jammed in the helicopter's door. The second milk churn bounced harmlessly off the police station wall and landed in an adjacent garden without exploding. Finally, a March 1977 attack on the home of a husband and wife who were both RUC Reserve members, involved suspending a bomb down a chimney by a piece of string. The bomb was later successfully defused.[17]

If we look at creativity and innovation as a process, phase-specific intervention points may identifiable for counter-terrorism practitioners thus demonstrating the practical importance of understanding the nature of the creative process within terrorist organizations.[18]

Innovation is typically a process with different drivers

Contrary to common perception, innovation and creativity is not akin to a spontaneous flash of a light-bulb moment. Instead, they result from a well-aimed, intentional search for improvement.[19] Most process models of creativity follow a general pattern of problem definition, idea generation and exploration, and idea implementation.[20] Gill et al. outline a conceptual framework for understanding innovation and creativity in terrorist networks.[21] They outline how aspects such as the greater environment (distal grievances, contemporary counter-terrorism practices, inter-group competition, political opportunity structure), organizational dynamics (organizational age, member age, previous success, structure, size, reward structure, collaborative environment, trust, finances, external support), small-group dynamics (team composition, size), individual characteristics (expertise, experience, personality traits, achievement motivation, autonomy, risk-taking) and leadership characteristics (technical expertise, participatory decision-making) collectively impact upon a group's capacity for creativity. From there, a mixture of extrinsic and intrinsic motivations coupled with creativity facilitators (exposure to novel problems, goal awareness, freedom, reward for creativity, resource availability, idea exchange) help produce a creative output. To become an innovation, the output depends upon a number of additional innovation facilitators (secrecy from counter-terrorism community, supporter acceptance, inter-group competition, implementation resources, capabilities and capacities, organizational elite support, idea champions). To be considered an innovation it needs to be novel, relevant, elegant and generalizable.

Innovation can be Radical or Incremental

There are two forms of product innovation– incremental and radical innovation. These variants differ in the degree to which they are revolutionary and novel. Radical innovation consists of fundamental changes that strike a clear departure from existing processes and products. Incremental innovation describes small adjustments to the

current technology or product.[22] PIRA's development of mortar bombs is a perfect example of incremental innovation. Responding to the increased fortification of police stations and army barracks, PIRA needed to develop a stand-off weapon capable of circumventing the fortification. The original stand-off weapon, labeled by the British Army the 'spigot grenade', was propelled from a standard shotgun. It was quite primitive, made from packing a pound of gelignite into a 6-inch pipe taped to a wooden pin. It was also hazardous to the user. As mentioned previously, user safety was a high-priority in any PIRA military action and because of this the 'spigot grenade' was quickly abandoned and the systematic development of safer, more accurate and destructive mortars began.[23] Mark 1 mortars emerged in June 1972. The nose fuse, according to Explosive Ordnance Teams (EOD) was of "ingenious design". However, many propelled Mark 1 mortars failed to explode because of the angle of contact – the mortar tended to spin in flight. Trigger operated, and lacking a safety mechanism or delay circuit, the Mark 1 was highly dangerous to the operatives. It was only used twice. By December 1972, the Mark 2 was in use. It contained a kilogram of commercial explosive. No longer trigger operated, the Mark 2 instead propelled from an L-shaped base plate. It also incorporated a five-second delay to improve operator safety. The nose-cone's fuse was simplified and made more durable. It was used 25 times in its first four months. However, aiming reliability did not improve because of volatile base-plate movement. In June 1973, PIRA fired 16 Mark 3's in Derry and Omagh. Firing distance improved to 250 meters, as the explosive used was half the weight of the Mark 2. Accuracy also enhanced because of the stronger base plate and because of the introduction of "an aiming quadrant which set the line of fire by rotating the barrel and locking it into position".[24] However, despite the improvements, the explosive mixture was highly volatile and now included items such as sodium chlorate and high-grade crystalline ammonium nitrate. This volatile mix led to premature explosions and explosions in flight. It was used 105 times in 14 separate attacks in its opening six months.[25]

The Mark 4 arrived in February 1974 and increased firing distance further to 400 meters. Ball bearings and shrapnel were added to the design. However, the lack of a safety mechanism again increased the danger for the militants themselves. It was abandoned within six months of its first use. "The Mark 5 included a 'bombard', a primitive cannon of around 25 meters range".[26] Because of its early capture in May 1974 due to good intelligence, it was never used in an operation. The Mark 6 (September 1974) was the first truly reliable mortar. The range improved considerably to 1,200 meters by improving the propeller (which was now wind-driven) and fins. The base plate was military standard. Innovations in timing, and initiation components (incl. electronic components) were also included. Remote-controlled detonation increased operative safety. Weapons specialist A.R. Oppenheimer notes that: "In just over a year, the IRA mortar had developed from something relatively primitive to an advanced weapons series".[27] The Mark 6 remained the mortar of choice for a number of years.

Marks 7 and 8 included more explosive power. Accuracy was drastically reduced however. The Mark 8 was an amalgam of previous models. It incorporated the tail fins of the Mark 3 and wind-driven propeller from Mark 6. By extending the casing tube from seven to thirty inches, the explosive charge was increased six-fold. Mortars were launched electronically with a 2.5 second gap between each firing. This became standard in later models. One report on the Mark 8 by the British Army noted this

particular design was “the result of bastardising a mortar bomb from existing material by persons other than the designer. The terrorist is displaying a requirement to deliver an increased warhead for greater material damage with scant regard to accuracy, flight, ballistics, or range. All the technical advances which culminated in the Mark 6 have been rejected in favor of inaccurate delivery of large charges the propaganda effect of which outweighs that achieved by many Mark 6s on the target”.[28]

The Mark 9’s bomb design was shortened but was wider than the Mark 7 and 8. The warhead was an adapted industrial gas cylinder containing 10lb of explosives. Because of the danger of premature explosion, it was initiated via command wire. The latest model again suggested PIRA was opting for maximum carnage rather than accuracy.

The Mark 10 was frequently used in Northern Ireland following its introduction by PIRA in 1979. This may be because it produced the first mortar related fatality in April 1980.[29] It was also the Mark trusted for the Downing Street attack in 1991. It could fire 11kg of explosives up to 300 meters. The Downing Street attack involved mortars just over six inches in diameter and four feet long. This iteration was also the first design to incorporate multiple launching tubes. Typically, four large bolts secured the fuse to the mortar’s nose. The mortar also contained a heavy weight locked into place by a safety pin and was detonated by electrical timers. Upon firing, the pin ejects thus leaving the weight to move inside the mortar’s shell. On impact, the weight strikes the internal percussion cap at the front of the mortar and detonates. Initiated electronically but lacking accuracy, the device also incorporated a blast incendiary that was designed to detonate after the mortars were fired. The intention was to destroy the evidence and became a standard tactic in later models.

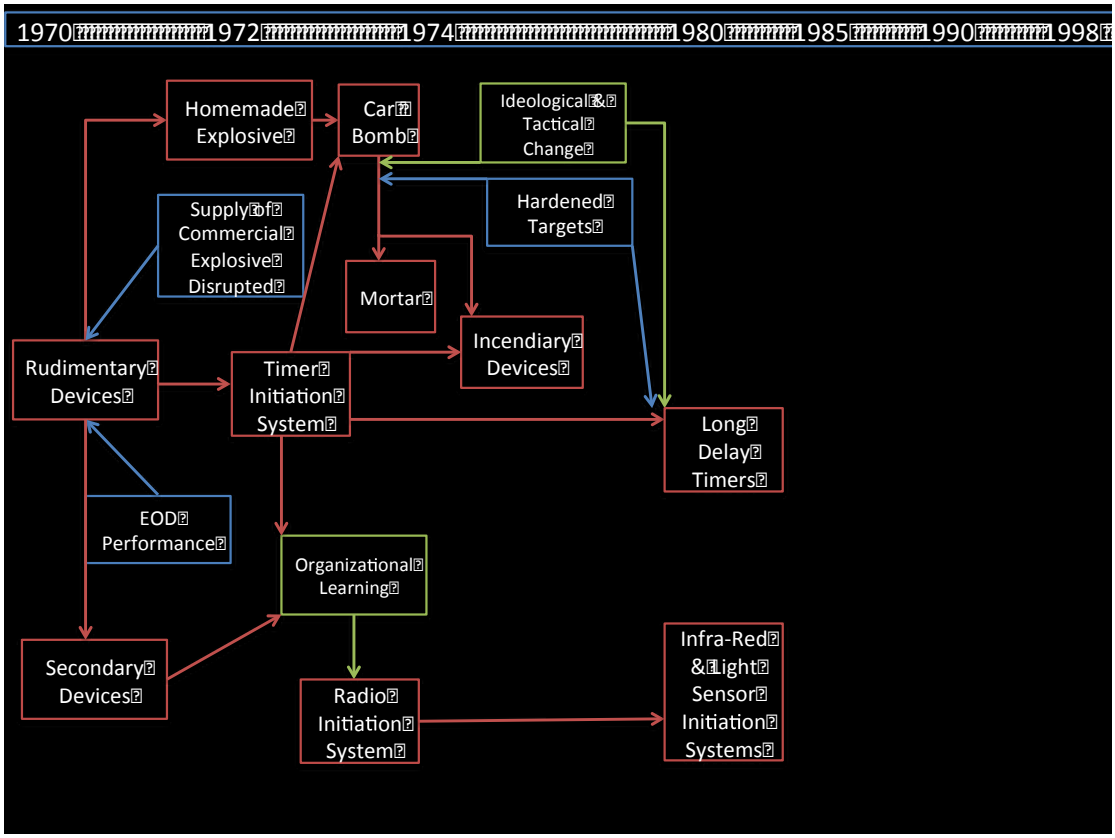
The Mark 11’s range was 500 meters and could carry 50kg explosives. The Mark 12 was a smaller model but held 2.5kg of Semtex and was first deployed in 1989. It differed from previous models, as it was a direct fire weapon. In effect, its design was a hybrid of a mortar and an armor-piercing rocket-propelled grenade. The effects of which successfully rendered the protection of armored vehicles regularly used by the British Army obsolete. The Mark 13 debuted in 1990 and sacrificed distance for more explosive power. It was made from a 45-gallon oil drum. Able to carry 36kg of explosives or 350lb of HME, its firing range was 25 meters. The Mark 14 (1992) could carry 20kg of HME. Mark 15 (1992) contained 75kg of explosives and coins as shrapnel. Referred to as the “barracks buster”, this iteration’s firing and launching mechanisms were perfected. Distance improved to 100-150 meters. It was 3 meters long. The tube consisted of a gas cylinder and scaffolding. The explosives were contained in a 45-gallon drum and fired from a JCB bucket. The use of everyday items would not arouse suspicion during the acquisition phase of development. A photoflash bulb acted as a trigger. This particular model was not reusable. From 1994 onwards, the Mark 16 was used with greater frequency. It returned to the design of earlier shoulder-held models and was a horizontal mortar in the same vein as the Mark 11. The mortar fired from a disposable two and a half foot long tube and was accurate from a range of 50 meters. Typically, this version contained one and a half pounds of Semtex. The explosive effects of which also made this version capable of penetrating armored vehicles.

We now turn our attention towards some original analyses centered on the radical innovations developed and adopted by PIRA.

PIRA'S Radical Innovation Timeline

The below figure illustrates a graphical timeline of PIRA's radical innovations in relation to IED technology. The innovations (in red) consistently led to further innovations either through organizational mechanisms (in green) or through counter-terrorist activities (in blue).

Figure 1: PIRA's Radical Innovation Timeline



PIRA's original IEDs were quite rudimentary in their design and utilized commercial explosives such as gelignite. The rudimentary nature of the IEDs made them easier for EOD operatives to dismantle/disrupt/prevent. By the tail-end of 1970, PIRA began to incorporate secondary devices into their IED design. This radical innovation was described in one EOD report as a "savage twist". For example, the secondary devices within the 'Castlerobin' encompassed both anti-opening and anti-lifting micro-switches. If the device was moved, tilted, or the top opened, it would detonate. It proved fatal to the first EOD operative to attempt to defuse it. A second EOD death through this particular type of IED illustrated more malevolent creativity. By burning the fuse on the IED, PIRA made the bomb look inoperable. However, anti-handling mechanisms detonated the bomb as the bomb disposal squad moved the device by wire. After five unexploded 'Castlerobins' were captured at a bomb making factory and its separate components were investigated, bomb disposal operatives quickly

learned how to successfully disarm this IED, the effects of which lead to incremental innovations and adaptations in terms of secondary devices throughout the course of the Northern Ireland conflict.[30] The organizational learning experienced through the incorporation of electronics in their IEDs later led to the radical innovation of electronic timer units, radio initiation systems, and much later infra-red and light-sensored initiation systems.

After forensic investigation of PIRA's early IEDs, measures were put in place to trace PIRA's supply route of commercial explosives. British legislation responded by requiring producers to place markings on the explosives. This unmasked PIRA's supply route. Explosives were traced to factories in Counties Cavan, Dublin, and Louth. A Joint Security Committee report to the Northern Irish parliament acknowledged that this forced PIRA's hand to build homemade explosives.[31] This in turn, led to PIRA pioneering the systematic use of car bombs. Coogan credits PIRA member Daithi O'Connell as the chief architect behind PIRA's development of the car bomb, whereas Sean O'Callaghan pinpoints Seamus Twomey.[32] For Ryder, the car bomb inherently possessed a number of advantages.[33] They could carry far more explosives. A car's space provided ample room to easily organize the firing mechanism. Both the car and the device can be booby-trapped. Planting a car bomb and keeping it undetected proved easier than a bomb encased in a box or a bag. Despite these clear tactical advantages of the car bomb, the decision to innovate with these devices reflects more practical concerns than proactive strategizing. PIRA's dwindling stock of commercial explosive (because of effective British counter-terrorism policy) forced their hand into experimenting with homemade explosives and in particular fertilizer-based explosives. These forms of explosives were typically heavier and bigger than commercial explosives and therefore needed a new more suitable delivery system. The effect of the homemade explosive was also exacerbated by the fuel within the exploding vehicle and helps account for the car bomb's proliferation in the early 1970's.[34] Later, PIRA turned to using van bombs in order to lessen the line-of-sight of EOD teams (Ryder, 2006:152).

The impact of the car bomb led to target hardening efforts by the security forces. Responding to the increased fortification of police stations and army barracks, PIRA needed to develop a stand-off weapon capable of circumventing the fortification. This led to the previously mentioned 'spigot grenade' which was subsequently quickly abandoned and the systematic development of safer mortars began.[35]

This target hardening coupled with the wealth of road-checks and security cordons limited opportunities for car-bombing attacks. In order to continue causing economic damage (a goal that had moved to the forefront of PIRA's new long war campaign), PIRA strategists instead turned to smaller, easily concealed, incendiary devices in the car bombs' stead. The move toward using incendiaries was further stimulated by advances in electronic circuitry that had incrementally been added to PIRA's original rudimentary devices. One report noted that a typical incendiary device could cause "as much as the largest car bomb".[36] While 1972 was the year of the car bomb, 1977 was the year of the firebomb. This was largely because of a new 'blast incendiary' device. A larger device than previous incendiary IEDs, its various components included metal piping filled with commercial explosive attached to a one or five gallon container of petrol and a timer-power unit. Once detonated, the petrol further exacerbated the incendiary effect. Bomb intelligence experts originally believed that

petrol was adopted in these devices so that PIRA could save their diminishing stock of commercial explosive. Upon realizing the destructive effect of this IED, its use increased.[37]

PIRA's strategic move toward 'spectaculars' also necessitated a longer timer to be developed. The basic principal was that the longer the timer, the greater distance the bomber could be from the site when detonation occurred. The longest time-delay device known was used in the assassination attempt on Margaret Thatcher. Here PIRA operatives modified a video player to set the IED twenty-four days, six hours and thirty-six minutes in advance of its eventual detonation

In essence, the graphical timeline above illustrates that the vast majority of PIRA's radical innovations occurred within six years of the group's inception. From 1977 onwards, there is relatively little progress in terms of new products. Of those products that did arise in the 1977+ era, they were barely used and did not become routine. So what changed in the immediate operating environment or within the group itself that impacted upon PIRA's lack of innovation?

First, PIRA's structure changed in 1977. The urge for this change was borne out of a mixture of improved British intelligence, war weariness, and attrition. Facing these problems, PIRA decided a structural change was required that involved moving from an "outmoded pattern which was proving susceptible to penetration".[38] The blueprint – entitled 'Staff Report' – for this structural change was seized from leading PIRA member Seamus Twomey in December 1977. The Staff Report's authors noted the PIRA ranks "are burdened with an inefficient infrastructure of commands, brigades, battalions and companies... We recommend reorganization and remotivation, the building of a new Irish Republican Army".[39] Emphasizing a return to secrecy and stricter discipline, the report created new departments within the organization (including Education Officers whose job entailed providing anti-interrogation lectures in conjunction with indoctrination lectures), outlined the new cell structure for urban based operations and the command and functional structures of these new cells, specified the new role for PIRA's female and youth wings, instituted a new auxiliary unit to take over policing duties in Catholic strongholds, and a promoted the political wing *Sinn Fein* to the forefront.[40] Together, these changes placed far less emphasis on the quantity of Volunteers and far more emphasis on secrecy and discipline.[41] Gill et al.'s social network analysis of 1300+ PIRA members shows that the cluster of bomb-makers became more centralized from 1980 onwards.[42] This pooling of resources fostered an easier mechanism for intra-group communication, the effect of which seemingly normalized the return to the routine rather than fostering new innovations.

Second, many of the situational crime prevention strategies employed by British forces had also become routine by the mid-1970s. Instead, security forces improved their intelligence and use of informants to prevent and disrupt plots at earlier stages. This new crime prevention strategy incentivized PIRA to innovate in areas other than tactics, namely organizational structure and training practices.

Third, Gill and Horgan's descriptive analysis of the PIRA cadre illustrates that the average age of new recruits became older as the conflict ensued and this may have impacted upon new innovations.[43] Once PIRA's training regime became enshrined in the 'Green Book' (rather than being carried out on an ad hoc basis), it prioritized

routine over innovation because each individual recruit was given the same training and induction rather than having to make their own standards of practice due to organizational amnesia.

Finally, the story of bomb-making innovation needs to be set within the wider context of where PIRA sourced weapons. The fall in innovation in the 1980s corresponds in time with Libya's shipment of weapons and explosives to PIRA. This may have, in part, negated the need for new innovations.[44]

Diffusion of Tactics

During PIRA's early innovative years, bomb-making was not undertaken centrally within the organization. Instead, it was up to individual brigades (each of which had a defined territory to operate within) to develop their own technology. The below table illustrates the innovator across a wide range of IED types and initiation systems. A striking feature of this table is that of the 18 radical innovations outlined, all but one of them debuted in either Belfast or Armagh, which suggests that these particular brigades were key to PIRA's image as an innovative terrorist organization.

Different factors may explain how these two groups learned. The units comprised of the Antrim Brigade largely conducted urban based bombing attacks in the city of Belfast. The vast majority of PIRA bombings were conducted there. This was a central hub of the Northern Ireland conflict. These operatives may have simply "learned from doing", a case of trial and error. They were also the largest in terms of manpower, thus making the likelihood of innovations to occur here statistically higher. Interestingly, Gill and Horgan's analysis shows that from 1980 onwards, the Antrim brigade's size reduced considerably compared to others whose size grew through the 1980's such as Tyrone and Derry.[45] Perhaps another reason for PIRA's lack of innovation post-restructuring may have come from the Belfast-brigades capacity being reduced.

The Armagh Brigade, on the other hand, were largely a rural based unit with a largely supportive community of nationalists surrounding them and vast expanses of land available to conduct testing. The South Armagh Brigade were responsible for PIRA's incremental mortar innovations, innovated in the use of radio-controlled bombs, pioneered the use of PIRA snipers, carried out the Warrenpoint attack that killed 18 British soldiers, engaged in many of the 'spectacular' bombing attacks carried out on the British mainland through the 1990's, became PIRA's most proficient unit in attempting to shoot down British military helicopters, and were closely connected to weapons smuggling networks in the United States and Libya.[46] What also set them apart from the rest of the group was their level of independence. Indeed, O'Brien portrays the South Armagh Brigade as an 'independent Republic' within the wider Provisional Irish Republican movement.[47] For Moloney, the South Armagh Brigade was really "under the control of local chieftains…rather than part of a structured centrally directed organization".[48] As one former activist noted, "the leadership would never try to give them orders. There was virtually no control from the center. They mounted operations against the British, and the job of leadership was to provide resources, training guns, explosives, etc. You just could not guarantee that they would vote at a Convention for the leadership's political strategy".[49] Like every other PIRA Brigade, the South Armagh Brigade was made up of an indeterminate number of

active service units (ASUs), each in theory were supposed to contain four or five individuals. South Armagh ASUs displayed far more independence in target selection and operations in general than any other ASUs within PIRA's broader structure.[50] Upon the march towards the Good Friday Agreement, which many saw as the end of the Northern Ireland conflict, a number of South Armagh based Volunteers left PIRA and formed the Real Irish Republican Army.

The other striking feature of Table 1 is that although Belfast and Armagh were, by far and away, the main innovators, they were rarely the first adopter of the other brigade's innovation. In fact, this only occurred once. This may suggest that there was no intra-group coordination between the two brigades or perhaps they were in competition with one another in relation to innovations and did not share pertinent information with one another.

Table 1: PIRA IED Innovations and their Spatio-Temporal Diffusion

Innovation	Innovator	Adopter 1	Adopter 2	Adopter 3	Adopter 4	Adopter 5	Innovation - Adoption Time	Total Adoption	Total Adoption Time
IED Letter	Belfast – August 71	Derry – April 72	Armagh – Nov 73	Down – April 1975	Tyrone – August 86	N/A	6 Months	No	N/A
IED Pipe	Armagh – Jan 80	Derry – Dec 81	Tyrone – Oct 83	Down – Aug 93	Belfast – Sept 93	N/A	1 Year 11 Months	No	N/A
IED Grenade	Down – Sept 71	Belfast – Sept 72	Armagh – Dec 78	Derry – Aug 81	Fermanagh - Dec 87	Tyrone – June 88	1 Year	Yes	16 Years 3 Months
IED Munition	Armagh – 8th Sept 72	Tyrone – 11th Sept72	Fermanagh – 13th Sept72	Belfast – June 77	Down – June 80	Derry – Feb 89	0 Months	Yes	7 Years 9 Months
IED Bury	Armagh – Jan 72	Fermanagh – June 72	Tyrone – Jan 73	Derry – Feb 73	Belfast – July 84	N/A	5 Months	Yes	12 Years 5 Months
IED Shape Charged	Belfast & Derry – May 82	Armagh – Aug 91	N/A	N/A	N/A	N/A	9 Years 3 Months	No	N/A
IED Undercar	Belfast – Jan 72	Fermanagh – Aug 72	Tyrone – Dec 72	Derry – Jan 73	Down – May 73	Armagh – October 80	7 Months	Yes	8 Years 9 Months
IED – Car	Belfast – Dec 71	Derry – April 72	Armagh – Jan 73	Tyrone – May 73	Fermanagh – Aug 73	Down – May 74	4 Months	Yes	2 Years 5 Months
IED – Rocket	Belfast – December 72	Armagh – December 72	Derry – December 72	Tyrone – February 73	Fermanagh – March 73	Down – May 77	0 Year (1 week to Derry)	Yes	4 Years 5 Months
Timer Initiated	Belfast – Aug 70	Tyrone – April 71	Fermanagh – Feb 72	Derry - 72	Armagh – April 75	Down – April 1977	7 Months	Yes	6 Years 8 Months

Wire Initiated	Armagh & Fermanagh – June 72	Tyrone – July 78	Derry – May 82	Belfast – November 83	Down – June 1990	N/A	6 Years 1 Month	Yes	18 Years
Remote Initiated	Armagh – December 73	Derry – March 74	Fermanagh – June 78	Tyrone – July 78	Down – August 79	Belfast – April 82	3 Months	Yes	8 Years 4 Months
Infrared Initiated	Armagh – Jan 80	Fermanagh – June 92	N/A	N/A	N/A	N/A	12 Years 5 Months	No	N/A
Booby Trap Initiated	Armagh – October 71	Derry – January 73	Belfast – March 73	Tyrone – Nov 74	Down – June 78	N/A	1 Year 3 Months	Yes	6 Years 8 Months
Impact Initiated	Belfast – Feb 70	Derry – June 70	Tyrone – Jan 74	Down – May 77	Armagh – Mar 79	Fermanagh – Sept 88	4 Months	Yes	18 Years 7 Months
Victim Initiated	Belfast – Jan 72	Fermanagh –August 72	Tyrone – December 72	Derry – May 73	Armagh – November 73	Down – April 75	7 Months	Yes	3 Years 3 Months

Conclusion

PIRA engaged in one of the longest paramilitary campaigns in modern times. One of the hallmarks of PIRA's ability to survive and adapt was its substantial technical and innovative acumen in IED development. Although PIRA utilized a wide repertoire of violent tactics including, but not necessarily limited to, armed assaults, hostage takings, punishment shootings, assassinations and kidnappings, it is perhaps PIRA's expertise in IED technology that has had the longest impact upon terrorist activity globally. Arguably PIRA was responsible for the greatest innovations and the deepest expertise in the construction and deployment of IEDs by any non-state militant group. PIRA IED technology emerged in conflicts within Colombia, Spain (especially with mortar technology), Israel, Lebanon, Iraq, and Afghanistan. The analyses throughout this paper however illustrate the importance of looking at terrorist organizations in a disaggregated manner and across time. While PIRA operations spanned the six counties of Northern Ireland for 29 years, innovations were conceived, developed and implemented within only two areas of operations for only seven of those years. The South Armagh Brigade, in particular. While the factors outlined in the Gill et al.'s model of malevolent creativity may not be readily apparent at the aggregate level, they may be apparent within a small cluster on the periphery of the whole network (for example the South Armagh Brigade).[51] This small cluster can, in turn, have a disproportionate impact upon the organization's image of being innovative. Looking at the scale of innovations across time also illustrates that a terrorist organization's prolific output of tactical innovations can be interrupted once some of the factors that drove the process are absent or once a routine set of behaviors and tactics become institutionalized.

---

[1] Brady, Conor. (1971) I.R.A. are clumsy and lacking in imagination, says booklet. *Irish Times*, November 20th 1971.

[2] Jackson, Brian Anthony, and John C. Baker. *Aptitude for Destruction: Case studies of organizational learning in five terrorist groups*. Vol. 2. Rand Corporation, 2005. P98.

[3] Oppenheimer, A. The Evolution of IEDs. http://www.andyoppenheimer.com/wp-content/uploads/2010/07/PUBLIC-SERVICE-HA19-A-Oppenheimer-ATL.pdf (last accessed Feb 2nd, 2016).

[4] For a discussion on defining improvised explosive devices see: Gill, Paul, John Horgan, and Jeffrey Lovelace. "Improvised explosive device: The problem of definition." *Studies in Conflict & Terrorism* 34, no. 9 (2011): 732-748.

[5] Gill, Paul, John Horgan, Samuel T. Hunter, and Lily D Cushenbery. "Malevolent creativity in terrorist organizations." *The Journal of Creative Behavior* 47, no. 2 (2013): 125-151. P136.

[6] Gill et al. (2014), see note 5; Cropley, David H., Arthur J. Cropley, James C. Kaufman, and Mark A. Runco, eds. *The dark side of creativity*. Cambridge University Press, 2010; Cropley, David H., James C. Kaufman, and Arthur J. Cropley. "Malevolent creativity: A functional model of creativity in terrorism and crime." *Creativity Research Journal* 20, no. 2 (2008): 105-115; Ranstorp, Magnus, and Magnus Normark, eds. *Understanding Terrorism Innovation and Learning: Al-Qaeda and Beyond*. Routledge, 2015; Knight, Sarah E., Carys Keane, and Amy Murphy.

"Adversary Group Decision-Making Regarding Choice of Attack Methods: Expecting the Unexpected." *Terrorism and Political Violence* (2015): 1-22.

[7] Merari, A. (1999) Terrorism as a strategy of struggle: Past and future. *Terrorism and Political Violence* 11(4):52-65. P54

[8] Hoffman, B. (1993) Terrorist targeting: Tactics, trends, and potentialities. *Terrorism and Political Violence* 5(2):12-29

[9] Dolnik, A. (2007) *Understanding terrorist innovation: Technology, tactics and global trends*. London: Routledge

[10] Crenshaw, M. (2010) Innovation: Decision points in the trajectory of terrorism in *Terrorist innovations in weapons of mass effect: Preconditions, causes and predictive indicators* (pp35-50), M. Rasmussen and M. Hafez (eds.), *Terrorist innovations in weapons of mass effect: Preconditions, causes and predictive indicators*. Washington: The Defense Threat Reduction Agency

[11] Coogan, T.P. (2000) *The IRA*. New York: Palgrave

[12] Smith, M.L.R. (1997) *Fighting for Ireland: The military strategy of the Irish Republican movement*. London: Routledge p145.

[13] Amabile, T. M. (1996). Creativity in context: Update to "The social psychology of creativity." Boulder, CO: Westview Press

[14] Oppenheimer, A.R. (2009) *IRA: The bombs and the bullets, a history of deadly ingenuity*. Dublin: Irish Academic Press. P202

[15] O'Doherty, S.P. (2008) *The Volunteer*. New York: Strategic Books Publishing. P59.

[16] Ryder, C. (2005) *A special kind of courage: Bomb disposal and the inside story of 321 EOD squadron*. London: Methuen Publishing Ltd. P38

[17] Some of these case studies were sourced during our data collection of the Irish Times archive. Other similar cases can be found in Oppenheimer, 2009. See note 3.

[18] Cropley, 2010. See note 6

[19] Anderson, N. & Gasteiger, R.M. (2007). Helping Creativity and Innovation Thrive in Organizations: Functional and Dysfunctional Perspectives. In J. Langan-Fox, C.L. Cooper, & R.J. Klimoski (Eds.) *Research Companion to the Dysfunctional Workplace: Management Challenges and Symptoms* (422-440). Cheltenham: Edward Elgar Publishing.

[20] Amabile, 1996. See note 13.

[21] Gill et al. (2014), see note 5

[22] Dewar, R. D., & Dutton, J.E. (1986). The adoption of radical and incremental innovations: An empirical analysis. *Management Science, 32*(11), 1422-1433.

[23] Ryder, 2005. See note 16, p214

[24] Ryder, 2005. See note 16, p216

[25] Ryder, 2005. See note 16, p215

[26] Oppenheimer, 2009. See note 14, p231

[27] IBID

[28] Ryder, 2005. See note 16, p230

[29] For more on mortar development and Britain's response, see Ryder, 2005, note 16.

[30] Ryder, 2005. See note 16, p40

[31] Ryder, 2005. See note 16, p118

[32] O'Callaghan, S. (1999) *The informer*. London: Corgi Books. P66.

[33] Ryder, 2005. See note 16, p65

[34] IBID

[35] Ryder, 2005. See note 16, p214

[36] Ryder, 2005. See note 16, p156
[37] Ryder, 2005. See note 16, p190
[38] Coogan, T.P. (2000) *The IRA*. New York, NY Palgrave. P465
[39] IBID
[40] IBID
[41] Horgan, John, and Max Taylor. "The provisional Irish Republican army: Command and functional structure." *Terrorism and Political Violence* 9, no. 3 (1997): 1-32.
[42] Gill, Paul, Jeongyoon Lee, Karl R. Rethemeyer, John Horgan, and Victor Asal. "Lethal Connections: The Determinants of Network Connections in the Provisional Irish Republican Army, 1970–1998." *International Interactions* 40, no. 1 (2014): 52-78.
[43] Gill, Paul, and John Horgan. "Who Were the Volunteers? 1 The Shifting Sociological and Operational Profile of 1240 Provisional Irish Republican Army Members." *Terrorism and Political Violence* 25, no. 3 (2013): 435-456.
[44] I would like to thank one of the anonymous reviewers for this point
[45] IBID
[46] Harnden, Toby. *Bandit country: the IRA and South Armagh*. Hodder & Stoughton, 2000.
[47] O'Brien, Brendan. *The long war: the IRA and Sinn Féin*. Syracuse University Press, 1999.
[48] Moloney, Ed. *A Secret History of the IRA*. WW Norton & Company, 2003, p160
[49] IBID p160
[50] IBID p433
[51] Gill et al. (2014), see note 5