Delocalization of the Kill Zone *

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In 1692, the distinguished classicist and theologian Richard Bentley (1662–1742) delivered a series of sermons at St. Martin-in-the-Field. The topic was what we might now describe as the interface between science and religion, or more specifically, Newtonian physics and Christian theology. In preparing his notes for publication, Bentley corresponded with Newton (1642–1727) to clarify his understanding on several important points. In a letter dated February 25, 1692/3, Newton explained:

> *Tis unconceivable that inanimate brute matter should (without the mediation of something else which is not material) operate upon and affect other matter without mutual contact; as it must if gravitation in the sense of Epicurus be essential and inherent in it. And this is one reason why I desired you would not ascribe [innate] gravity to me. That gravity should be innate inherent and [essential] to matter so that one body may act upon another at a distance through a vacuum without the mediation of any thing else by and through which their action or force [may] be conveyed from one to another is to me so great an absurdity that I believe no man who has in philosophical matters any competent faculty of thinking can ever fall into it.*

Newton was drawing attention to a profound mystery at the heart of his theory of universal gravitation, that is, how can one object apparently affect the motion of another in the absence of physical contact? Newton's description of gravitational force – in the absence of any mechanism or further explanation – left open the problem of such apparent "*action at a distance*." He continued:

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> *"Gravity must be caused by an agent [acting] constantly according to certain laws, but whether this agent be material or immaterial is a question I have left to the consideration of my readers."*

In referring to an immaterial agent, Newton was leaving open the possibility of mediation through divine action, a prospect compatible with the world view of his time, but not so readily embraced in today's empirically based scientific discourse. Rather, modern theoretical physics is guided by the "*principle of locality/local action*." It states that an object can only be influenced by its immediate surroundings – there is no such thing as action at a distance. If two objects are not in direct contact, the principle of locality dictates that the state of one may only affect the state of another through some mediating particle or wave. A physical theory is called "*local*" if it satisfies the principle of locality. Einstein's great achievement was to find a local theory of gravity that could supersede Newton's theory. Indeed, Einstein held the principle of locality sacrosanct and sought to reformulate the entire edifice of physical theory in such a way that all interactions are manifestly local.

For example, all forms of communication are local in this sense. If I have a thought I wish to share, I must encode it in a mutually intelligible form that can be sent to a receiver – be that speech, text, or some other medium. The transmission of thought is never "*telepathic*," it does not instantaneously appear in the mind of a receiver. On the contrary, all communication is necessarily *mediated* through some physical channel, for example, a letter, sound or radio waves.

In this essay we will explore how the principle of locality can be used figuratively to describe the evolution of lethal force. In particular, I shall call an event "*localized*" if it results from the local action of an individual at a particular moment of time. In a war zone a combatant may identify a target – someone he or she perceives as an enemy – and choose to fire upon that individual at a given moment. The resulting death is then "*localized*" in my sense. That is to say, a chain of local interactions inextricably links the death of that combatant to the conscious decision of our soldier to engage. Of course, not all casualties of war occur in this way. In a theatre of war fatalities abound, often by chance or misadventure. But what concerns us here is intention, i.e., when human cognition is employed in lethal conflict – even when that intention is mistaken. For example, the moment after our hypothetical soldier engages a target we may discover that he or she is mistaken – the target was not the enemy combatant initially perceived. Nevertheless, the death of that individual is still "localized" in my sense because it's rooted in a conscious - albeit misguided - decision to discharge a weapon at a particular moment of time.

War – at least in the tenor of coalitionary killing – may be deeply rooted in our protohuman lineage. In 1974 the well known primatologist Jane Goodall

first became aware of incidents of lethal violence among the Chimpanzee populations of Gombe Stream Research Centre. Goodall's descriptions of coalitionary killing and canabalistic infanticide are hard to read. In trying to explain such behaviour, Richard Wrangham suggested an "*imbalance-of-power hypothesis*" which posits that "coalitionary killing is an expression of a drive for dominance over neighbours". He argues:

> *Two conditions are proposed to be both necessary and sufficient to account for coalitional killing of neighbors:*
>
> 1. *a state of intergroup hostility;*
> 2. *sufficient imbalances of power between parties that one party can attack the other with impunity.*
>
> *Under these conditions, it is suggested, selection favors the tendency to hunt and kill rivals when the costs are sufficiently low.*

We note that in a *state of nature* lethal violence is *ultra-local* in character. By this we mean not just close range, but combat takes place within easy reach and often through direct physical contact. They may use rocks and sticks as primitive weapons, but chimpanzees are most likely to kill with their hands, feet and teeth. Violence among our own species has been similarly up-close and personal for at least 90% of human history. In the absence of technology to harness other forms of energy, human combat has involved striking weapons whose effective force and range is limited by the inherent capacity of our neuromuscular architecture. Primitive weapons may extend the reach of an aggressor by a few meters, but the lethal application of force remained essentially ultra-local in the premodern context.

Human mastery of such violence attained a kind of homicidal peak with the advent of Bushido, the samurai code of honour, discipline and morality that developed in feudal Japan. From the dark depths of our proto-human lineage – from murder with fists and rocks, to the sublime craftsmanship of a samurai sword – man's line of descent has been connected physically, viscerally, to the fatal blow of his kin, and bushido required the master to be fully present – in mind, body and spirit – with his foe.

There is an intrinsic asymmetry between predator and prey, and the savanna graced its offspring with a throng of anatomical and physical adaptations that could only be matched through technological prowess.The spear was the first great leap forward in bridging that divide, and the use of spears for hunting predates Neanderthal man as exemplified by the extraordinary find at the Schöningen mines in Germany. Concealed behind thick reeds at the lake shore of the lower paleolithic, *Homo heidelbergensis* advanced silently upon his prey, the swift flight

of his finely crafted interglacial spruce extending the reach of his *kill-zone* to perhaps 20 metres. Eight spears, a lance and 16000 bones were excavated from the site, mostly equine, but crucially not of his own kin.

The potential to hunt and kill from a safe distance, without subjecting oneself to immediate danger, marks the origin of a process that I refer to as "*delocalization of the kill-zone*". By "*kill-zone*" I mean a region of spacetime within which an individual may affect lethal force. This notion is highly dependent on the weapons technology at hand. For example, an unarmed combatant may project lethal force only within immediate reach, and for that force to be effective it must be purposefully directed at a specific point. Until the development of ranged weapons, the kill-zones available for both hunting and coalitionary killing were essentially "*point-like*" in nature, and distributed around an aggressor's present location within small radii.

Archaic humans may have hunted with spears and darts as early as 500,000 years ago, but the process of *delocalization* didn't gain pace until anatomically modern humans invented the precursor of the bow. By adapting and tensioning a lance with the sinew or guts of his prey, homo-sapiens learned to store elastic energy through flexion - enough to launch small arrows with finely worked stone tips - and thereby multiply his strike range appreciably further. These early advancements in projectile weaponry may have propelled modern humans out of Africa, and were likely pivotal in creating the asymmetries that led to the demise of our Neanderthal cousines. Although the gains were initially small, several tens of meters was already enough to lighten the psychological stain of murder. As technology developed and the chasm between aggressor and aggressee grew ever greater, it became increasingly facile for man to slay his brethren with impunity. Moreover, the delocalization of force seemingly absolved homo-sapiens from the anguish of close range combat, and our deeper inhibitions towards violence were gradually dismantled as the melee from which war emerged began to take shape. Unlike the swing of an axe or the thrust of a sword, the marriage of violence with ballistic technologies ruptured the sacred visceral connection between predator and prey, assailant and foe.

Within the ramparts of civilization, however, a repository of specialized knowledge was developing whose military applications would soon outflank all the mechanical innovations of antiquity. At the turn of the first millennium AD, chemical energy set alight a new phase in the killing frenzy that besets our technological ascent. Chinese alchemists – ironically in pursuit of the Daoist quest for an elixir of life – had noted the explosive properties of "*blackpower*", a concoction of sulfur, charcoal, and potassium nitrate. This reaction was first put to military use as an incendiary sac attached to an arrow, and only later adapted into a propellant. The advantage of blackpowder as an incendiary is that the

mixture is self oxidising and thus harder to extinguish. In this way small *incendiary bombs* were launched at enemy troops and military infrastructure, but they could just as easily be directed toward non-combatants and their possessions.

Fire has been by far the most destructive weapon since antiquity, and its deployment on ranged weapons facilitated the targeting of anything that burns. Towns, villages and crops burnt just as readily as fortifications, siege engines and ships. Whereas the first phase of ballistic technologies (rocks, darts, spears, arrows and bolts) wrought destruction through the delivery of kinetic energy to a point, this new phase repurposed projectiles as triggers, serving to ignite the latent energy already inherent within a target. Fire magnified the kill zone to engulf whole towns and cities, as well as the lands surrounding them. In this way the spoils of war have come to be sacrificed on an altar of total destruction.

After a siege lasting almost three years, Scipio may have lamented over the scorched earth of Carthage (146BC), but two thousand years later Curtis LeMay incinerated nearly 17 square miles of Tokyo and over 100,000 people on the first night of his aerial campaign – without ever stepping foot in that city! This is the power of delocalization. LeMay continued dropping vats of jellied gasoline until "*fat man*" and "*little boy*" finally put an end to the nightly incineration of urban Japan.

We are fully justified in continuing to denounce the nuclear obliteration of Hiroshima and Nagasaki – for nuclear weapons continue to pose an existential threat that we have so far contained but barely addressed. Yet hrough fire alone, LeMay obliterated 63 japanese cities and more than a million civilians. After the war he remarked:

> "*Killing Japanese didn't bother me very much at that time. It was getting the war over that bothered me. So I wasn't worried particularly about how many people we killed in getting the job done. I suppose if I had lost the war, I would have been tried as a war criminal.*"

The message is clear – left unchecked, a mastery of delocalization yields absolute impunity.

From the dawn of modernity to the present day, the tools of war have seen revolutions in scale but not kind. Nuclear weapons, remotely piloted drones and hypersonic missiles are just the latest actors in a drama edging precipitously close to its final act. Paradoxically, the more terrifying the character of a new weapon, the more likely it seems to be cast as an instrument of stability, even peace. Alfred Nobel, the inventor of both the first high explosive "*dynamite*" and the smokeless successor to black powder "*ballistite*", was a faithful correspondent of Baroness Bertha von Suttner, the prominent peace activist and author of "*Lay Down Your Arms*". On their first meeting in 1876, von Suttner recalled him

expressing his desire to invent a weapon so powerful that the very possibility of its use would preclude any future military conflagration. In 1891, he famously expressed a similar sentiment about his dynamite factories:

> "*Perhaps my factories will put an end to war sooner than your (peace) congresses: on the day that two army corps can mutually annihilate each other in a second, all civilised nations will surely recoil with horror and disband their troops*."

Nobel died in 1896, but his factories continued to prosper. Von Suttner struggled on with her peace work until her death in 1914, just two months before the outbreak of the Great War she had sought to prevent. Neither succeeded in securing peace, the latter at least did no harm. But what can we say of the former? When his brother Ludvig passed away in 1888, the french newspaper Le Figaro mistakenly announced Alfred's demise:

> *Un homme qu'on ne pourra que très difficilement faire passer pour un bienfaiteur de l'humanité est mort hier à Cannes. C'est M. Nobel, inventeur de la dynamite. M. Nobel était Suédois.* (*Le Figaro, 15 avril 1888. p 1-2*)

The history of innovation in warfare is a successive introduction of asymmetries. Each time we are naive to think that a new asymmetry will end war, but it only escalates the stakes to an ever more terrifying degree. Nuclear weapons currently hold that dubious accolade of being the "most powerful ever invented". Indeed, the arsenals of today's superpowers harbour a capacity for mutual annihilation well beyond anything imaginable to either Noble or von Suttner. Yet the most ardent nuclear zealots fail to adopt even a "*no first use*" policy – preciously guarding their prerogative to affect an apocalypse without precedent.

The primary kill-zone of an optimized 1 megaton air blast extends approximately 3 km from its hypocentre. Depending on the construction, most civilian buildings would be flattened within double that radius. Look around you. Within less than an hour the conscious decision of a single individual could literally wipe out everyone and everything as far as the horizon. The use of such weapons is a terrifying prospect, but we are yet to see any of the *civilized* nations of the world recoil from war in the manner Nobel predicted.

Within the spectrum of physical abilities represented across the animal kingdom, the hominid is not particularly remarkable, and even amongst her fellow primates, homo sapiens stands out as particularly feeble. Our cognitive function, however, sets us apart, both in the capacity to coalesce at high population densities, as well as the ability to fashion nature to our own design – most notably through art, science and technology. Nevertheless, coercion, mass violence and war continue to disrupt social progress, and we now find ourselves at a new

threshold in the evolution of human conflict. For the first time in human history, our species has the ability to outsource its cognitive function to machines. In other words, we possess the technology to mechanize and industrialize our cognitive labour. The unique quality that sets humans apart and has allowed us to dominate the animal kingdom, can now be mechanized and industrialized for economic, political and military gain.

There is no doubt that the leading industrialized nations of the world will seek to consolidate their spoils through the weaponization of such technologies, and a struggle for dominance of this new power will ensue. This revolution, and the type of warfare it engenders, introduces a novel aspect – which is different in character – to all previous advances in military innovation.

The crucial difference between *lethal autonomous weapon systems* (LAWS) and other types of military hardware is that LAWS can *learn* to identify and engage targets *autonomously.* In the case of full autonomy, artificial intelligence will permit targets to be acquired and destroyed at very high frequency, avoiding even the delay incurred by sending a signal to a human supervisor and waiting to receive back some degree of authorization. This is a fundamental corollary of automation, and an asymmetry that will not be ignored in future real-time great power conflict.

For example, consider the analogy with high frequency trading in a commodities market, where superfast algorithms/connections/computers are employed to process large volumes of information and exploit minute deviations from market equilibrium. A war of speed rather than sophistication develops between a cartel of deep-pocketed participants, and the ability of regulators to enforce rules becomes greatly diminished. Indeed, since exchanges are themselves entities that seek to maximize profits, those with the most lenient regulators are favoured, and meaningful oversight of trading activity is irrevocably lost.

We might expect a similar "*ecosystem*" to emerge from weapons with advanced cognitive abilities whose sole purpose is to control and kill. However it might begin, the architecture we set in place will not remain of human design. For it is inconceivable that the ability of lethal autonomous weapons to self organize will be forsaken. A kind of trophic-information pyramid will emerge in which data is exchanged and repurposed at different levels of a self-organized hierarchy – with human command and control (C2) at the bottom!

In conventional warfare an actualized kill-zone may be delocalized to some degree while remaining fundamentally localized in my sense, i.e, there always exists some physical mechanism that mediates *human* agency – linking a conscious decision to kill to the event of being killed – be it the hand that guides a sword or the missile that delivers a warhead. In the parlance of special relativity,

a kill-zone in conventional warfare may be remote from C2, but remains within its *future lightcone* – the boundary of its causal future. If a (light) signal originating from C2 can reach a target, that is, if we can communicate with it, then that target represents an accessible kill-zone for an observer present at C2 – at least in theory. On the other hand, a point in spacetime is said to be "*space-like*" separated from C2 if no signal can reach it. The speed of light is fixed – a fundamental constant of nature – and as Einstein explained, designates the ultimate speed limit of the universe. Nothing can travel faster than 300,000 kilometers per second, even in the most pristine vacuum found in outer space.

The weaponization of AI technologies opens up a "*final*" phase in the process of delocalization by severing the link between human agency and its lethal manifestations. In the race for exploiting momentary asymmetries arising in the deployment of military assets, our cognitive load may be outsourced and human agency sacrificed for strategic advantage. Although conscious intention may still designate the class of targets to engage, such commands will be both transformed within, and exchanged between, groups of autonomous agents in a manner that is not human intelligible, let alone accountable. Such an autonomous theatre of war will not ground individual kills nor coordinated strikes in conscious deliberations. This is because autonomy means the application of lethal force can become completely decoupled from human cognition. In fact no command and control will be possible – even in theory – because the identification of targets as well as decisions concerning when and where to engage will be taken through a field of autonomous agents acting across space-like separated regions of spacetime.

Indeed, it is sobering to reflect that the canvas of spacetime is not amorphous, but has geometrical properties that impose fundamental constraints on what we can both do and know. Weaponizing AI is like seeding our tomorrow with a field of landmines, but not ones that are fixed by geography or hidden beneath a thin layer of soil. Rather, a field of LAWS will have the potential to act without warning at some future place and time, buried deep beneath an incomprehensible matrix of data and computation. If you believe in banning landmines, you must work earnestly to prohibit LAWS before they are widely deployed. A future hegemony of a field of killer robots is a nightmare we can and must avoid!

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