Incendiary balloons launched toward Israel from Bureji, in the Gaza Strip. Photo: MinoZig (CC BY-SA 4.0)

By Sling and by Stone: A Strategy of Technological Reduction

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In recent decades, scholars have commonly thought of military superiority as contingent on advanced military technology. So did national security establishments, which dedicated an increasing share of military buildup efforts to the development and acquisition of advanced systems. As such, what options are available to the side that suffers from inherent technological inferiority? This article introduces, discusses, and demonstrates a strategy of technological reduction for military force buildup strategy, which calls for the deliberate development of weapons that are simple, compared to the prevailing technology. This strategy has been adopted in several cases in recent years, and seems most popular among those suffering from technological inferiority compared to their rivals. Armed non-state actors and militaries opt to abandon the hopeless technological race and turn to cunning force buildup; in the same way a force in a state of operational inferiority seeks cunning doctrines, such as guerrilla warfare, for contending with a much stronger rival.

Keywords: technological reduction, technological superiority, military superiority, force buildup, force buildup strategy, asymmetric conflict, technological R&D, incendiary kites, armed drones, midget submarines

Introduction

Three fundamental components underlie the measurement of military power: quantity, meaning the number of soldiers and weapons at the disposal of the military; quality, that is, the professional level of the soldiers and the technological level of the weapons; and the operational component, which is also known as "conversion capability,"[1] meaning the ability to plan and carry out a military action with the help of complementary components such as command and control (C&C), logistics, intelligence, and information and communications technology (ICT). Military power can be measured on a certain dimension of warfare (land, sea, air, space, or cyber) or in absolute terms, regarding superiority in all dimensions of warfare, i.e., full-spectrum superiority (JCoS, 2020, p. 90).

Throughout modern military history, military technology has been considered as a foundational element of the qualitative component in military power. Azar Gat states that since the industrial revolution, the side that succeeds in acquiring and implementing technologies that are a generation ahead of those of its adversaries has acquired a substantial advantage on the battlefield, which leads to victory (Gat, 2012).

The approach that technology is capable of leading to military victory peaked in the early 1990s, with the emergence of the Revolution in Military Affairs (RMA) concept, whereby precision strike capability combined with sophisticated information technology, alongside doctrinal and organizational adjustments, enables the defeat of adversaries efficiently, quickly, and at a lower cost in blood and treasure (see for example FitzSimonds & Van Tol, 1994). This is the prevailing approach in the United States and other Western militaries, including Israel.

As a rule, American military superiority relies on advanced technological solutions to diverse threats, whether tactical or strategic (Posen, 2003; Paarlberg, 2004), and is grounded in a culture with a tendency toward technological optimism. Technological dominance is so deeply rooted that some hold that the balance between the qualitative component and the quantitative component in the United States armed forces has been upset. The excessive emphasis on technological quality has led to a drop in the number of combat soldiers, in a way that greatly limits American military options (Lake, 2012).

The United States is not alone. In Israel, for example, advanced military technologies and in-house weapons research and development are seen as key elements in the qualitative component of its military power. Since the IDF was founded, the entire security establishment aimed to enhance quality as a source of strength for the fledgling army instead of quantity, which was lacking. At the outset, heavy emphasis was put on achieving a technological edge (Ben-Israel, 2013, pp. 51-58). The emphasis on technological superiority as the way to achieve an advantage over adversaries intensified over the years (Finkel & Friedman, 2016) and became a fundamental pillar of Israel's national security strategy. Technological superiority enables it to deter and defeat enemies, thanks to advanced weapon systems combined with skilled and well-trained personnel (Meridor & Eldadi, 2018; Amidror, 2020, p. 20).

Some are less convinced of the close ties between elite military technology and true military superiority on the battlefield, and doubt the degree of influence of a technological edge on winning wars (Raudzens, 1990; Thompson 1999). However, on a conceptual level they do not deny the ability to achieve victory through technological superiority, but rather oppose the deterministic approach whereby advanced weapons win wars.

An outcome of viewing technological progress as a key for military power is, therefore, that militaries aspire to equip themselves with advanced weapons as much as possible, and first and foremost weapons whose quality exceeds that of its adversaries. In turn, their rivals aspire to equip themselves with higher quality weapons, and thus in effect a technological arms race is launched.

But what if one of the parties is in a state of inherent technological and resource inferiority, and cannot sustain a technological arms race? What will it do if, for economic or other reasons, it has no prospect of overcoming the absolute technological superiority of the other side?

The fast pace at which technology develops, and the proliferation of asymmetric conflicts in recent decades, has put more and more countries and other fighting organizations in such a situation. The Iraqis against the United States, the Serbians against NATO air forces, the Georgians and Ukrainians against Russia, and Hamas and Hezbollah against Israel are all examples of inherent asymmetry, not only in the military balance of power but also, and perhaps especially, in the technological balance of power.

The specific rivalry, of course, defines the relative state of inherent asymmetry. Even a strong national military can be in a state of inherent asymmetry against a superpower. Israel is an example of a country with inherent technological superiority throughout its close surroundings, but not over Russia, for example, whose air force is deployed in the region. In contrast, the United States as the dominant world power today strives for undisputed military technological superiority in every field and on every issue vis-à-vis any adversary.

Thus, against a force with clear technological superiority, the side suffering from inferiority has no possibility of competing in the technological arms race. Its qualitative component of power is fixed in a state of inherent inferiority. Must it surrender in advance in every clash? Is there no response to technological superiority?

Despite the prevailing consensus today that technological superiority is essential to the achievement of military superiority, the side in a state of technological inferiority has significant strategies for response. The most prominent among them, which are materially distinct from one another, are quantitative compensation as a response to the qualitative gap, or a strategic decision to develop and acquire nuclear weapons, which offsets the advantage of conventional military superiority.

The first possibility is also the most natural, as military might is defined first and foremost by the quantitative component, even if during the past few decades emphasis has actually been placed on the qualitative component. This path is effective as long as the qualitative gap is not too wide, meaning there is no absolute gap between an entirely new technology and its predecessor, but rather a gap between different generations of the same technology. For example, the transition from one generation of tanks to a newer generation, reflected by 120 mm guns replacing 105 mm guns or upgrading command and control systems, creates a technological advantage on the battlefield, but one that can still be overcome with the help of reinforcing forces, or alternatively, by adapting a different method of warfare. In contrast, as the United States proved in the 1991 Gulf War, connectivity between different forces, which enables fast intelligence sharing and targeting, creates a technological advantage that enables local superiority (Biddle, 1996; Mahnken & Watts, 1997) that cannot be overcome merely by an increase in the quantitative component.

At work is intended technological regression and the use of means that make it difficult for the adversary to utilize its technological advantage. We call this approach to force buildup "a strategy of technological reduction."

The second possibility, which is substantially different and more politically challenging, is to acquire nuclear weapons in order to enable the creation of strategic deterrence against an existential threat, even under a state of technological and numerical inferiority. Such a possibility is only relevant for countries, not for non-state actors, and is pursued by North Korea, for example, which is in a state of absolute conventional technological inferiority compared to the United States. However, this possibility is highly difficult to implement, as other examples in the world demonstrate.[2]

But alongside these two prominent possibilities, we identify a third strategy that can be used to offset the advantage of technological superiority. Recent years have shown first signs of this strategy in several cases. It involves abandoning a futile attempt to chase the adversary in a technological arms race, and instead turning wisely to weapons that are technologically very simple; in other words, intended technological regression and the use of means that make it difficult for the adversary to utilize its technological advantage. We call this approach to force buildup "a strategy of technological reduction."

The paper opens with a definition of the concept, followed by a theoretical discussion to analyze this strategy vis-à-vis its operational analog, meaning a type of warfare used by forces that are inferior in military operative terms, usually guerrilla warfare—an ancient type of warfare that has been discussed extensively. This analysis of the similarities and differences between the parallel approaches helps characterize and shed light on the strategy of technological reduction. The paper sketches the possible space along two axes, organizational and technological, where technological reduction can be applied. It then presents three case studies of the use of technological reduction in the space described—a basic case study of Hamas's use of incendiary kites, and two advanced case studies: first, the use of midget submarines by the Iranian navy, and second, the use of armed drones. The case studies are positioned along the said axes. Finally, the paper analyzes the advantages and limitations of the technological reduction phenomenon, and explains whom it might suit and when. We illustrate that a strategy of technological reduction is in essence suitable for a side in a fundamental defensive state[3] that tries to prevent victory from the technologically superior adversary, and it is not a strategy that leads to decisive victory.

This conceptual paper attempts to characterize and theorize a phenomenon that has been evident in recent years and grown increasingly common and relevant in a world in which technology is a central element of countries' national security, and in their military capabilities in particular. The increasing gap between those that are highly technologically advanced and those that are not naturally leads to the development of a new type of force buildup response against the emerging polarity. This will be of special interest to researchers and practitioners who deal with non-state actors, as well as those who research the military strategy of countries standing against forces that are technologically inferior to them, such as the United States, or in the Middle East—Israel.

Technological Reduction: Definition and Theoretical Outline

Definition

"So David prevailed over the Philistine with a sling and a stone, and smote the Philistine and slew him; there was no sword in the hand of David" (I Samuel 17:50). David's victory over Goliath serves to this day as an allegory for the small and weak overcoming the big and (ostensibly) strong. Goliath was equipped from head to toe with the best military technology of the time, while David, inexperienced in such armor, preferred not to try the shields and swords with which he was outfitted by King Saul. In other words: David didn't enter a hopeless "arms race" with Goliath, but rather turned to a primitive technological option—sling and stones—and used them effectively and cunningly to kill Goliath even before the Philistine giant began the battle itself.

In the spirit of the story of David and Goliath, we define technological reduction as a force buildup strategy that given inherent technological inferiority, abandons a hopeless technological race with the adversary, and instead intentionally focuses on an inferior, non-advanced, and sometimes even primitive technological solution, whether by developing it or acquiring it. This solution is cheaper, simpler, and most of all cunning, in that it exploits vulnerabilities in the adversary's reliance on its advanced weapons.

Technological reduction is in essence a force buildup strategy of abandoning the technological arms race. In this it departs from the accepted approaches to force buildup, all of which take up the race and aspire for more advanced technology, even if in different ways and using detours. Azriel Lorber (2016, p. 32), for example, analyzes three approaches to developing weapons: "duplication," meaning the identical development of the advanced technology of the adversary (such as Russia and China's efforts to achieve stealth fighter aircraft following the success of the United States); "bypass," such as developing surface-to-surface missiles as an alternative for airpower, in a state of air inferiority; and "direct response," meaning nullifying the adversary's advantage (such as Iron Dome, an active air defense system against rockets). All of these possibilities that Lorber presents assume that the solution to a certain technological inferiority lies within the framework of developing advanced weapons, within the technological arms race. Isaac Ben-Israel suggests that those who have a substantial technological advantage over their adversaries (e.g., Israel) choose a technological force buildup strategy that aims at achieving superiority in a particular technological dimension in which it has a relative advantage (Ben-Israel, 1997).

Technological reduction is an essentially different concept: no longer participating in the technological arms race, whether by duplicating, bypassing, or pursuing a direct response, or by looking for the technological dimension in which an advantage can be created. On the contrary: technological reduction calls for abandoning the race, for the sake of a completely different strategy that is cunning, simple, and cheap.

Technological reduction does not take the path of competing over technological advancements, but rather advocates leaving the arms race and focusing on technological cunning.[4] In other words: it takes the sting out of the side with inherent technological superiority, which continues to invest enormous resources over long periods of time on technological advancements, while the inferior side moves in a completely different direction. According to the principle guiding reduction, the use of advanced means or the aspiration to acquire them should be abandoned. Instead, simple and cheap means that can be used plentifully at almost no cost compared to the other side's costs are pursued. The achievement of these means may be physically limited but surprising and significant in terms of achieving the broader objective. Furthermore, it is possible to acquire and use other reductive means with relative ease. Technological reduction is not just a compromise. In asymmetric circumstances, it is a conscious choice of simple and cunning arms as a preferred alternative to advanced arms that are expensive, limited in quantity, and require complex development process.

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A weapon that has been developed according to the principle of reduction will require a suitable utilization tactic in order to contend with the more advanced adversary. The sling and stone that David used demonstrate exactly that: a weapon of a previous generation that tactically suited the specific event of the battle against Goliath more than available modern weapons, and together with a suitable tactic—coming close to the target and slinging the stone before the enemy's assault—brought the necessary achievement at that moment: the death of the Philistine giant, to the shock of the entire Philistine army.

Between Technological Reduction and Operational Reduction

A strategy of reduction is better known in the field of force application than in the field of force buildup, even though the term "reduction" is missing from this literature. Operational reduction is the counterpart of technological reduction, and thus insights on the latter can be derived from the analogy. For the sake of simplicity, consider the most common operational reduction—guerrilla warfare. At its core, guerrilla warfare is cunning: it withdraws from conventional warfare against a strong and well-equipped enemy, and develops a primitive but effective form of combat that aims at the vulnerabilities of the enemy military. Guerrilla was adopted by the Hasmoneans during their initial wars against the Seleucid enemy, or by Bar-Kochba and his men against the Romans, as well as by many other groups throughout history. Guerrilla is evident in situations where societies that were conquered, or found themselves needing to defend their land against significantly larger and stronger enemy forces, tried not to surrender. The Viet Cong in Vietnam in the 1960s and 1970s are an especially successful modern example of this, as are the Afghan rebels fighting against the Soviet Union in the 1980s.

The transition from conventional warfare to guerrilla warfare derives from a deep understanding that the gaps in strength do not allow for defeating the adversary in a regular method. Lawrence of Arabia emphasized this in his article on guerrilla warfare, which he wrote after the victory of the Arab tribes under his command over the Ottomans (Lawrence, 2014). Turning to guerrilla warfare constitutes a paradigm shift that emphasizes surprise, agility, camouflage, and attrition—physical and psychological. Guerrilla warfare uses the adversary's strength against it. Size and order are features exploited by guerilla warfare, and guerrilla fighters consciously give up heavy weapons, infrastructure, and organization of forces. Chinese leader Mao Zedong described: "The enemy advances, we retreat; the enemy camps, we harass; the enemy tires, we attack; the enemy retreats, we pursue" (Mao, 1965, p. 124). Mao's approach to achieve victory without defeating the enemy on the battlefield acknowledges the power gap, gives up on frontal combat, emphasizes being on the defensive, and calls for tactics that exploit the adversary's vulnerabilities.

Referring to the Middle East, Brun and Valensi (2010) have pointed out another method of operational reduction, an evolved form of guerrilla warfare, that has been implemented with significant success by Hezbollah in Lebanon and Hamas in the Gaza Strip: warfare of "victory by non-defeat," a doctrine that is closely related to their being "hybrid" organizations. On the one hand, they are not the official rulers of the states or territories in which they are located, and they operate as civilian-military organizations alongside the official authorities. On the other hand, they have also amassed political power and involvement in the public sphere. Hezbollah in Lebanon is involved in the government and constitutes a force that the government of Lebanon cannot resist, and Hamas rules the Gaza Strip, against the will of the Palestinian Authority. The "victory by non-defeat" doctrine is a form of operational reduction. For example, Hezbollah has proven its ability to use armored forces and to maneuver in the civil war in Syria, but against Israel it refrains from this tactic and prefers defensive entrenchment in order to exploit vulnerabilities in Israel's tactics.

While operational reduction takes place on the level of force application, technological reduction is on the level of force buildup, but it is similar in its approach: it implements the principles of guerrilla warfare within the world of force buildup. It constitutes a paradigm shift in the accepted way of thinking about weapons development. Instead of competing in a technological arms race whose outcome is a foregone conclusion, those who adopt reduction give up on superiority and defeat of the enemy. They prefer simplicity, proliferation, survivability, and damage to the adversary's morale.

Furthermore, technological reduction, like guerrilla warfare, achieves an important psychological achievement against an adversary with a technological advantage, because it enables harming it precisely in the dimension in which it feels strong. Just as size, order, and organization become an obstacle in the face of guerrilla warfare, the reliance on advanced weapons and confidence in their ability to bring about victory lead to psychological despair in the face of technological reduction. When simple and cunning weapons bypass advanced defense measures, create resilience over time, or harm targets that are many times more valuable, the results of the damage they inflict are amplified. Against the simplest measures, technological superiority or a tendency to rely on advanced solutions on the battlefield could prove to be useless.

The Space for Application of Technological Reduction

The space for application of technological reduction can be charted in an area that extends over an entire quadrant within two intersecting axes. One dimension positions those who adopt this strategy on the spectrum between an improvised force and an institutionalized military. This is the organizational axis. On another axis we can classify the cunning weapons according to their level of technological innovation, from primitive and ancient weapons, to early industrial technology (motor vehicle, simple submarine, light aircraft), to state-of-the-art weapons based on computerization or miniaturization technology. This is the technological axis.

Technological reduction can be manifested in ways that are very different from one another, depending on where these cases are positioned in the quadrant. However, all of the cases in the space have a prominent common denominator: all describe force buildup in a technologically asymmetric conflict that focuses on weapons with reduced capabilities compared to their advanced alternative.

This article reviews three case studies. The first is Hamas's use of incendiary kites, which is the most basic example of a strategy of technological reduction. In its technological characteristics, it is closer to the sling and stone than to the rocket; with respect to who uses the strategy, it is a hybrid terrorist organization that wields governing power in a small territory; and in terms of the overall achievement of using this strategy over time, it has shaken Israel and caused prolonged psychological damage.

The two other case studies represent progress along the two axes of applied technological reduction. The first case, midget submarines in the service of the Iranian navy, demonstrates that technological reduction is used not only by non-state actors, but in certain circumstances is also adopted by institutionalized militaries. It also evinces a higher level on the technological axis, with the Iranians focusing on industrial technology, albeit decades-old, which is more developed than kites. The second case, the armed drones in Gaza, does not represent a significantly different application on the organizational axis, but on the technological axis it demonstrates a considerable change. Drones, even if they do not have the sophistication of other aerial weapons, illustrate the use of modern developments as part of a strategy of technological reduction.

Figure 1 charts the space for application of technological reduction, its axes of development, and the positions of the three case studies described below. On the organizational axis: starting from a small terrorist organization (Palestinian Islamic Jihad) to a hybrid terrorist organization (Hamas) to an institutionalized military (the Iranian navy). On the technological axis: from an ancient and primitive technology (kites) to an industrial technology (midget submarines) to a modern technology (drones).

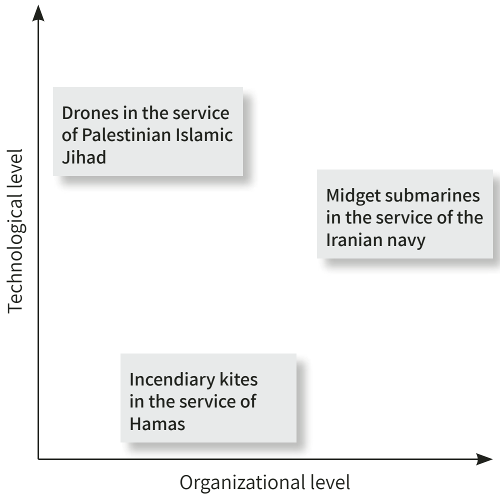

Figure 1. Space for application of technological reduction
Organizational and technological levels

The figure charts distribution of the area for application of technology reduction between two axes (organizational and technological), and the positions of the three case studies in the article. The distribution emphasizes that there is a variety of ways of applying technological reduction.

Case Studies

Incendiary Kites in the Service of Hamas

A clear example of technological reduction are the incendiary kites, which were launched toward Israel beginning in April 2018 and at their peak caused several fires per day in the Gaza envelope region, and prompted concern and fear among residents of the region and anger among the general public at the lack of response to such a primitive measure by the IDF, the strongest military in the region.

The launching of incendiary kites by Palestinians in the Gaza Strip began against the backdrop of the wave of Palestinian protests near the border fence, first held in March 2018 under the banner of the Great March of Return. The first launch took place on April 13, 2018. The early kites were built in an improvised manner by civilians, including youths, from simple, readily available materials that connected Molotov cocktails or hot charcoal to kites in order to set fire to fields near the fence. By June the improvised incendiary kites developed into helium balloons carrying explosive devices. The explosive kites flew to greater distances, such that they could be launched at a distance from the fence, and they also expanded the range of the threat within Israeli territory. Because they carried explosives, they constituted a danger to residents who encountered them and not only to agricultural produce (IHCC, 2018a; Zych, 2019).

The success of the popular arson terrorism led Hamas to sponsor the launches and even to institutionalize them. First, Hamas committed to protect those launching kites and balloons, and later it took an active part in producing the kites, arming them, transporting them to the launch point, and timing the launches. Furthermore, a unit specializing in launching incendiary kites and explosive balloons was established. In the cognitive sphere, Hamas's media outlets waged a campaign to leverage the achievement of the launches and emphasized the organization's auspices (IHCC, 2018b).

In the summer months of 2018, the number of launches and resulting fires increased, with an average of 12 fires per day. According to the Israel Nature and Parks Authority, by December 2018 over 32,000 dunams (about 8,000 acres) of groves and agricultural produce had been set on fire. According to one of the estimates, the economic damage in the summer of 2018 was about $3 million (Zych, 2019, pp. 75-76).

Aside from the physical and economic damage, it seems that the effectiveness of the incendiary kite attacks was measured mainly in the cognitive sphere. As in any terrorist attack, the arson terrorism created fear among the population of the Gaza envelope region, especially given the lack of an operational response by the IDF to this primitive weapon. The fear and helplessness led to popular protest, which peaked with a march from the Gaza perimeter to the Knesset in Jerusalem. Subsequently as well, the local public continued to experience terror and despair, similar to the feelings that resulted from the launching of rockets over the years (Tzuri, 2018, 2019; Zych, 2019, p. 76).

The incendiary kites are a weapon with an indirect trajectory and are inferior to the rockets, which were developed and produced by Hamas over the course of years. The kites and balloons are the primitive response to the Israeli Iron Dome system, which made the routine rocket fire ineffective and almost irrelevant, aside from the tension that it continues to arouse. Compared to rockets, incendiary kites have significant distance and precision limitations. At the same time, kites have considerable advantages over rockets: first in the Iron Dome's inability to intercept them, which left Israel without effective active defense against the arson terrorism. In addition, the cost of a kite is more than a hundred times lower than the cost of producing a rocket, and its preparation is simple and quick. Another important difference between rockets and incendiary kites is the way Israel responds to the attack. Rocket fire is seen as a significant military action, which is met with an Israel military response as part of the balance of mutual deterrence between the sides. In contrast, Israel's legitimacy to respond with force to the launching of incendiary kites is considerably lower, as is its legitimacy to strike those launching them.

Hence, the use of a more primitive measure actually succeeded in fulfilling the military objective. The reduction enabled terrorizing and harming the Israeli home front, while fostering a certain sense of helplessness on the Israeli side regarding response possibilities. In this way the strategic purpose of gaining attention for the conflict in the south and the need to reach political agreements was achieved, all at very low costs to the Gazan side.

Midget Submarines in the Service of the Iranian Navy

Iran's use of midget submarines represents a higher level on the technological axis, and in addition, shows an application of a technological strategy at the other end of the organizational axis. Several series of submarines operate in the ranks of the Iranian navy (Singh, 2011): three Kilo-class submarines—large Russian-made submarines that were built in the 1990s; two Fateh-class submarines—domestically produced medium submarines; and 27 midget submarines—four Yugo-class submarines acquired from North Korea and 23 Ghadir-class submarines, an Iranian development of the North Korean Yugo series from the 1960s. Most of the Iranian acquisition and development in this field lies in midget and medium submarines that operate mainly in the continental shelf off the coast of Iran, in the Persian Gulf and the Strait of Hormuz. In other words, they can be called littoral submarines (HSDL, 2009; NTI, 2019).

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The Ghadir-class midget submarine is armed with two torpedoes. Its tiny size provides stealth and high maneuverability, which enable it to operate within ports, but it is big enough to carry frogmen or to lay naval mines. Alongside its advantages, the midget submarine is very limited in the quantity of weapons that it can carry, and in the possible duration of its mission and the depth of its operation (Reich, 2009). Accordingly, this submarine is used mainly to defend the coast against invasion, but in the Iranian case it is also part of the range of measures for developing the ability to block the Persian Gulf easily and with a very low footprint, as well as to ambush ships at ports in the Gulf.

The three Kilo-class submarines, which Iran acquired in the 1990s and are also used by the Russian and Indian navies, weigh about ten times as much and can carry more weapons. They can undertake prolonged defensive and offensive actions far away from the coast of

Iran, and carry advanced systems. However, they have difficulty operating effectively in the shallow water of the Strait of Hormuz. In addition, their maintenance is expensive and complex, and generally necessitates assistance from the Russian producer (Singh, 2011).

Thus from a purely technological perspective, Iran possessed advanced submarines before it started to acquire Ghadir-class submarines, which are based on an old platform and whose capabilities are limited. Still, Iran chose to focus its force buildup efforts on Ghadir submarines, which are seemingly from an earlier technological generation (Roblin, 2019). The prevailing assessment is that Iran chose to do so as a result of an asymmetric doctrine that it developed.

Iran, a country that is preparing for conflict with a great power, is working under a clear assumption of built-in operational and technological inferiority and has formulated an integrated doctrine of technological reduction with asymmetric warfare.

Iran's threat reference in this context is an American attack or an attack by a coalition of countries that would include the massive presence of naval forces off the coast of Iran, whether for the purpose of landing forces (amphibious warfare), providing fire support (aircraft carriers and missile boats), or imposing a naval blockade that would harm the export of Iranian oil (Arasli, 2007). In other words, the main scenario that the Iranian navy is preparing for is a confrontation with a stronger navy. Iran has neither the resources nor the pretensions of building a navy that is strong enough to be comparable to the strength of the attacking navy, especially if it is a great power's navy. This means that unequal forces, both operatively and technologically, constitute the Iranian premise when formulating an operational doctrine (Haghshenass, 2008).

Therefore, in order to repel a naval attack, Iran must be cunning. This will be manifested in an asymmetric defense system, that is, one that does not aim to fight against the adversary using the same methods that the adversary uses, rather, in our terms, through a force buildup strategy of technological reduction, accompanied by operational reduction in the use of force. The Iranian naval defense system aspires to be covert, decentralized, and not dependent on central operation, with the ability to cause significant damage to the adversary, even if not to defeat it, in a way that harms its morale and the drive to continue the attack. In light of this operational doctrine, Iran has focused its naval buildup on acquiring many midget submarines, even if they have limited capabilities, along with developing other operational tools such as fast boats ("mosquito fleet") and naval mines (Arasli, 2007; Singh, 2011), and with them, a suitable strategy.

The large Kilo-class submarines are capable of sinking large warships. However, due to their small number, it is likely that at an early stage of the war the opposing navy would succeed in disabling them. In contrast, the adversary would have much more difficulty locating the dozens of midget submarines. Thus they could defend Iran's coast over time and take a high cumulative toll on the attacking navy.

In conclusion, Iran, a country that is preparing for conflict with a great power, is working under a clear assumption of built-in operational and technological inferiority and has formulated an integrated doctrine of technological reduction with asymmetric warfare. This is in order to deny the great power significant achievements in the field over time until the attrition of the enemy's forces, in the hope that the repeated attacks would harm morale and influence decision makers on the other side to retreat from their initial objectives, or at least to limit them considerably.

Armed Drones in the Service of Palestinian Islamic Jihad

In recent years there has been extraordinary acceleration in the development of inexpensive advanced drones with a wide variety of functions, some of which can be used for diverse military needs, from photographing intelligence targets to carrying warheads and homing in on targets.

The first unmanned aerial vehicles (UAVs) were in effect cruise missiles in the shape of an airplane, which were developed between the two World Wars. They were similar to an airplane in their horizontal flight path, but were very different in that they served as a bomb and not as a guided platform for carrying a load (weapon, camera, or person) (Pearson, 1969). UAVs resurfaced in the 1970s in operational use by the United States in Vietnam (Hall, 2014), and since then have gained great momentum in their military uses.

There are two primary areas of use: the first involves advanced UAVs for intelligence gathering and attack missions, which are capable of staying above remote hostile territory for prolonged periods; the second refers to tactical collection UAVs for accompanying maneuvering forces. Their small dimensions allow them to be carried by the fighting force, but naturally their capabilities decline accordingly. Both advanced UAVs and tactical UAVs are generally produced by military industries, and their development takes place in accordance with the stringent requirements of militaries. Consequently, their cost can be very high, from tens of thousands to tens of millions of dollars; their development can take many years; and their distribution remains limited due to foreign and defense considerations.

The development of drones by civilian industry has opened the way for new operational possibilities, both for armies and for armed organizations. Drones in effect constitute a third family of modern UAVs, whose development accelerated in the 21st century. Unlike military UAVs, the main producers of drones are private companies. Despite their civilian nature, a considerable potential military threat is inherent in drones (Lifshitz & Meents, 2020). Aside from the threat to the airspace of airports, a drone can be converted into an explosive drone relatively easily (Yishai, 2020).

For example, two incidents on the Gaza-Israel border involved the use of a civilian-produced drone to drop munitions on IDF forces. In May 2019, Hamas used a drone produced by DJI to drop an anti-tank warhead at an Israeli tank. That same month, a Palestinian Islamic Jihad drone also dropped an explosive device toward an IDF tank (Zeitun, 2020).

Technologically, a drone from the model that Hamas used, the Matrice 600 produced by DJI, can carry a load of up to six kilograms, and its maximum speed under optimal conditions is about 65 km/h. Its operational duration ranges from 15 to 40 minutes, depending on the load and other variables, and its performance can be highly affected by the weather (DJI, n.d.). Compared to this state-of-the-art drone, a military UAV with attack capabilities has much better figures. For example, the model MQ-1B Predator American drone, which was launched in the 1990s, can carry a 200 kilogram designated load and reach a range of 1,200 kilometers. Its maximum speed surpasses 200 km/h and it has the ability to drop laser-guided precision munitions. Needless to say, the UAV can be controlled out of sight, and its communication is secured (USAF, 2015).

The comparison between a military UAV and a drone indicates enormous gaps in their capabilities, to the point where one might wonder if they should be compared at all. Nonetheless, they follow each other and evince a series of technological developments, as they address a similar operational need. This statement should of course be qualified, but even if we look only at the following basic operational need, we will realize that this is the same family of platforms: an unmanned, remotely controlled aerial means for precision kinetic attack (dropping munitions or "suicide"-type bombs). This operational objective, general as it may be, can be implemented by an armed drone or by a UAV with attack capability. While modern UAVs were developed in the 20th century by military industries, are used by militaries, and continue to evolve in this direction, drones were developed in the 21st century by civilian industries and armed for the purpose of warfare by militaries as well as armed organizations.

However, can we relate to an armed drone as an example of technological reduction? The development of such a drone uses state-of-the-art technologies, based on making advanced communication, navigation, and computer components cheaper and smaller, causing a dual effect: creating significant differentiation between those that are technologically strong and others (polarization), as well as distributing advanced components and technologies to sub-state organizations (democratization) (Gat, 2012). This is precisely the case with drones.

However, we contend that from the perspective of developing military weapons, we can also relate to these technologies as technological reduction, compared to the quality and capabilities of unmanned aerial vehicles developed by defense industries. Someone who comes to the battlefield with a tank does not see an electric scooter, sophisticated and modern as it may be, as part of an arms race against it in the field of armored vehicles. And the party who brings to the battlefield a cutting edge knowledge of unmanned aerial vehicles that can reach considerable distances, communicate with encryption, carry advanced munitions, avoid tracking, and carry out missions autonomously, does not see a cheap and simple civilian-produced drone as part of the arms race against it.

The development of armed drones as a technological reduction of UAVs enables addressing the basic operational objective presented while maintaining secrecy, at a much lower cost, with a broad distribution and without the need for a military industry.

Discussion and Analysis

The three case studies describe different applications of technological reduction: the Palestinians make use of civilian technology—in the case of the kites, it is ancient and is used for attack, and in the case of the drones it is contemporary, and is used for both attack and defense. In contrast, the Iranians rely on decades-old industrial military technology and use it for defense. In all of these cases, the technological reduction is adopted in a fundamental defensive state. These are not effective means for offense and decisive victory. However, on the tactical level (as opposed to the operational and strategic levels), it is clearly possible to employ technological reduction for both attack and defense, depending on the kind of weapon or the way it is used. Hence, technological reduction may constitute a central force buildup strategy that provides means for a wide variety of tactics.

Both the Palestinians and the Iranians possess more advanced weapons in the same dimension of warfare than their reductive alternative. However, neither the Palestinian rockets, nor the UAVs in the Gaza Strip (Rossiter, 2018), nor the Kilo-class submarines can deliver the desired result, due to their technological deficit. Reductive weapons, in contrast, are simple weapons that can evade the advanced defensive measures of the adversary, which were not designed for this kind of threat. This is especially true of the incendiary kites vis-à-vis the Iron Dome active air defense system, true of the drones that are difficult to intercept using the standard air defense, and also true to a certain extent of the covert midget submarines.

The relatively few resources that reductive weapons demand compared to their advanced counterparts enable proliferation. More kites enable sowing chaos in large areas of the Gaza envelope. More midget submarines provide the naval defense line with survivability and resilience to stand up to a prolonged attack on the coast of Iran. More armed drones constitute a broad, material threat to Israeli forces, and not just to a local threat. Proliferation is therefore not just a by-product, but also a substantial objective in choosing to develop reductive weapons.

Since we are essentially discussing arms, it is necessary to discuss the expected potential damage of reductive developments compared to standard weapons. As a rule, it seems that the damage expectancy of reductive weapons is lower. For example, incendiary kites threaten the lives of Israeli civilians less than rockets with an exploding warhead or shrapnel. While the midget submarines can sink a ship of any size, they only carry a tiny amount of torpedoes, and this greatly limits their hit probability and the number of ships that they can attack in a single journey. With regard to the armed drones: while their precision capability is high, their limited payload capacity greatly limits their ability to cause damage.

Nevertheless, reductive weapons allow significant damage, and their absence would have led to much less cumulative damage in a certain dimension of warfare. While incendiary kites have lower damage capability than rockets, the psychological damage that they succeed in causing, despite the superiority of Israeli active defense, is invaluable for the Palestinian organizations. In the naval warfare dimension, Iran can maintain an ongoing threat and extract a painful toll over time from any strong attacker that comes close to its coast, due to the large number and stealth of the midget submarines. While a drone can only carry a small explosive charge, it is capable of striking precisely, for example, an Israeli tank. This kind of threat has so far been posed mainly by advanced and expensive anti-tank missiles, which the organizations were forced to smuggle into the Gaza Strip at great effort and risk. On the operational and psychological level, IDF soldiers now also face a threat from above, and not just a ground threat.

To understand the effectiveness of technological reduction, it is highly necessary to consider the life expectancy of its cunning. In other words, how much time does it take for the adversary to develop a response to the reductive weapon, from the moment it is discovered? It will be considered a response when the marginal utility achieved thanks to the reductive weapon is neutralized or significantly reduced. The response can be technological, doctrinal, or deterrent. At least in terms of the technological response, the assumption is that the adversary has a qualitative technological advantage, so presumably it could succeed in overcoming the reductive development at a certain stage. In addition, the relative simplicity of the reductive weapons is an inherent weakness, as they are less resistant to various responses.

Reductive weapons allow significant damage, and their absence would have led to much less cumulative damage in a certain dimension of warfare.

As for incendiary kites, Israel has not found a doctrinal solution that prevents the arson terrorism, but it has succeeded at times in deterring the Palestinian organizations from using this means. Technologically, as early as the summer of 2018, only a few months after the arson terrorism began, Israel introduced the ability to intercept incendiary kites using drones. Thus, in effect, a simple response was given to a primitive threat. It is for good reason that the intercepting drones were called "shekel and a half" (Ziegler, 2018). Alongside the simple response, Israel also demonstrated advanced technological answers to the arson terrorism—the same technology that it uses to fight the drone threat. As early as 2018, the Sky Spotter optical positioning system developed by Rafael Advanced Defense Systems was set up, which is capable of locating incendiary balloons and drones and tracking their flight (Dvori, 2018). In addition, the Israel Police operates the laser defense system Lahav-Or for intercepting incendiary balloons, also an Israeli development (Yagna, 2020). In comparison, developing a response to the threat of rockets and missiles was more challenging. For example, the development and deployment of the David's Sling system for coping with medium and long-range rockets and missiles lasted about a decade (State Comptroller, 2009; Levav, 2017).

As for the Iranian midget submarines, figures have not been published on their depth range, but we can assume that it is limited. If this is the case, this limitation places them in danger, despite their miniature size, which provides them with stealth. And as for the armed drones, aside from the Sky Spotter system and the Lahav-Or system that threaten them, they are exposed to cyberattack or electronic warfare. For example, DJI is capable of preventing drones produced by it from operating in designated regions of conflict (Corfield, 2017). Hence, in cases in which the reductive weapon is based on civilian technology, it is more exposed to a response developed by civilian industry.

Ignoring technological reduction as a real strategy could exact considerable tolls of strong militaries, which ought to understand this rationale when deciding to develop and acquire more advanced and expensive generations of military technologies.

Conclusion

The extensive preoccupation with technological quality as a central component of military superiority can make us forget that many militaries and non-state actors in the world are unable to seek superiority through elite technology, because of their inherent technological inferiority compared to their adversaries. This inferiority can be a result of a lack of resources, skilled technological personnel, or long-term technological industrial depth, but sometimes simply due to the fact that the adversary is significantly stronger.

The technologically inferior side can give up in advance, or in contrast, it can adopt one of the following strategies: quantity as a response to quality; acquisition of nuclear weapons as a regime "protector;" or—what seems to be an increasingly common strategy among those that cannot achieve technological superiority—a strategy of technological reduction. In the realm of force buildup, this strategy is the equivalent of guerrilla warfare and the attempt to achieve victory through non-defeat.

Technological reduction is a deliberate choice to abandon the arms race in favor of primitive technological means that are simple to use, cheap, and easily acquired, and which strike the vulnerabilities of adversaries that rely on technological superiority. These means do not enable defeating the enemy on the battlefield, yet although they are not decisive capabilities, a series of marginal achievements can also have great impact. Technological reduction ironically enables transitioning from defeat to a state of tactical advantage, albeit temporary. It enables achieving strategic objectives at an affordable price and preventing the other side, the side with technological superiority, from reaching a decisive victory with ease.

Furthermore, the more asymmetric conflicts there are and the more the use of civilian technology for military purposes increases, the more common the strategy of technological reduction in force buildup is expected to become. Therefore, ignoring technological reduction as a real strategy could exact considerable tolls of strong militaries. They ought to understand this rationale when deciding to develop and acquire more advanced and expensive generations of military technologies, and to specify clearly their strategic objective.

On the other hand, the limitations of technological reduction must also be understood. It is not an ultimate solution against elite technology. Its use is limited to the side that is mainly on the defensive, and not for defeating the other side. It has a short shelf life, and over time it cannot compensate for substantial military and technological inferiority, except at specific times and in specific scenarios, and mainly against a strong side that, due to various limitations and constraints, not necessarily operational, does not operate with all of its force to defeat the weaker side.

Looking toward other dimensions of warfare, it will be interesting to look for cases of technological reduction in the cyber dimension. Will militaries adopt civilian developments and utilize relatively simple malware for causing significant damage to cyber powers? Will more basic malware be developed, to the point that it will not be possible or worthwhile to develop a response to them? Could the cyber domain in general, in which elite technology is such a dominant component, enable the application of technological reduction? Focused research on these and other questions is valuable, in light of the conclusions of this article.

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Notes

1 From "conversion capability" (Tellis et al., 2000, p. 143), which refers to the ability of a country to convert national resources into military power.

2 For example, over the course of two decades (the 1970s and 1980s and the beginning of the 1990s) Iraq attempted to achieve nuclear capability, but failed. For over two decades Iran has tried to achieve this capability and paid heavily for this effort, which so far has not succeeded.

3 Being on the defensive is a fundamental state on the operational and strategic level, which is opposite of a fundamental state of being on the offensive. When on the defensive, the military force is given the task of defending its territory from the enemy's attack. During defense it is also possible to use various types of warfare to attack and defend, and thus it is important not to confuse between being on the defensive and defending as a type of warfare.

4 Yaakov Amidror (2007) on the principle of cunning in the IDF's principles of war: "Surprise serves as a basis, but the main thing is identifying the vulnerability and the point of victory, and exerting most of the effort toward it" (p. 6). "The essence [of cunning] is exploiting the surprise to create the ability to strike the enemy at its vulnerable point" (p. 8). Because we deal with inherent technological inferiority that forfeits military decisive victory, we adopt Amidror's emphasis on the connection between cunning and vulnerability (and in the technological sphere, technological cunning that is aimed at a technological vulnerability), and not the emphasis on victory.