Volume 4 | Issue 8 | Article ID 2206 | Aug 14, 2006

The Democratization of Missile Technology and the Future of War

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The Democratization of Missile Technology and the Future of War

By Mark Williams

[*This is the second article posted on the consequences of weapons, including nuclear weapons, proliferation, for contemporary warfare. It follows Gabriel Kolko's* ***The Great Equalizer. Lessons From Iraq and Lebanon****.*]

I The Missiles of August: the Lebanon War

The events of September 2001 disproved the assumption that only a state could make war on another state. Now Hezbollah's confrontation with Israel has provided further education about how the world is changing. Hezbollah's campaign is a clear sign of how the democratization of missile technology -- cruise missile technology, in particular -- is reshaping global realities.

Assumptions about the Israeli Defense Force's military superiority have enjoyed axiomatic status, especially among laypeople. In fact, the IDF were -- and perhaps still are -- a good citizen-soldier militia, with a small number of units of excellent professional soldiers, and a highly capable general staff. According to a famous, and probably apocryphal story, when asked the secret of Israel's military successes, an Israeli commander succinctly summarized the IDF's method: "Always fight Arab armies."

However, as Hezbollah's leader, Sheikh Hassan Nasrullah, has explained: "We are not a regular army and we do not use the way of a regular army." Hezbollah has displayed a combination of a guerrilla force's decentralized flexibility and a national military's sophistication, fielding weapons like the C-802 **Noor radar-guided anti-ship missile** (an Iranian-made knockoff of the Chinese "Silkworm" C-802) that struck an Israeli warship on July 14. In sum, Hezbullah's arsenal includes the following missiles:

· 122mm Katyushas: range 13 miles, warhead 6 kg
· 122mm improved Katyushas: range 19 miles, warhead, 6 kg
· 220mm Syrian rockets: range 43 miles, warhead 40 kg
· 240mm rockets: range 6 miles, warhead 18kg
· 240mm Iranian Fajr 3: range 26 miles, warhead 50 kg
· 333mm Iranian Fajr 5: range 46 miles, warhead 90 kg
· 302mm Iranian Khaibar-1: range 100 miles, warhead 100 kg
· 610mm Iranian ZelZal-2: range 130 miles, warhead 400 kg

Hezbollah Katyusha Missile

Significantly, according to claims by both Hezbollah and Israel, Hezbollah has held in reserve all of its 200-odd Zelzal-2 missiles, which have a range of up to 200 kilometers -- capable of reaching Tel Aviv. The Zelzal missiles are road-mobile, solid-propellant systems, about which little is known. They are most likely unguided or use a rudimentary inertial system; when properly launched, such rockets would be accurate to within several kilometers of their target, enough to hit a city like Tel Aviv.

Given all that, it's a reasonable supposition that Sheikh Nasrullah and Hezbollah were ordered by their Iranian backers to keep in reserve the Zelzals, as well as a significant number of the Iranian Fajr-5 missiles (of which the Khaibar-1 is believed by many analysts to be a modified variant).

Hezbollah's Katyushas are the furthest thing from the latest designs. Predating venerable weapon systems such as the AK-47 assault rifle and B-52 bomber, these generic short-range rockets were given their name by the Soviet troops who first fired them at German forces during World War II.

For all the Katyusha's vintage provenance, however, it has defeated futuristic attempts at missile defense like the Tactical High Energy Laser (THEL), a U.S.-Israeli attempt to create a high-energy chemical laser that could detonate the missiles in midflight. In fact, it's indicative of the difficulties of short-range missile defense that the THEL prototype was approximately the size of six city buses; according to Subrata Ghoshroy, a military analyst at MIT who studied the project in 1996, not only would the system have been "a sitting duck" on a battlefield, but also any fractures of its fuel tanks would have released potentially deadly gas over its crew and bystanders. Although in 2000 the THEL was able to shoot down two Katyushas simultaneously during tests when no cloud cover impeded it, Katyusha rockets were designed to be fired from truck-mounted launchers in barrages of up to 50. Given the THEL's general impracticality, the U.S. Army ceased funding it in late 2004.

What are the possibilities for missile defense against the longer-range, Iranian-built rockets, such as the Fajr-3 and Fajr-5, with which Hezbollah hit Israel's third-largest city, Haifa, and as far south as Hadera in central Israel?

2. Iranian missile rocket

Since the 1950s, when Time magazine printed artists' depictions of the majestic umbrella-shaped **shields** that would be created by the Pentagon's anti-missile missiles as they intercepted Soviet ICBMs over American cities,

the U.S. military has kept promising that whatever ABM (anti-ballistic missile) system was then under development, was just a step or two from being perfected. Simultaneously, it has allowed **fudged tests** in order to get favorable results, and ignored the fact that, even if the technology worked perfectly when deployed, such systems would be vulnerable to countermeasures
that would be cheap and easy for attackers to employ.

In 2006, the best hope for tactical missile defense remains the latest iterations of the Patriot interceptor. First deployed in the first Gulf War, the U.S. military initially claimed that this surface-to-air missile had shot down more than 40 of Saddam Hussein's Scuds. In 1992, however, the Government Operations Committee of the U.S. House of Representatives concluded that the Army had no proof that any Patriot had shot down any Scuds. The latest Patriot versions seem to be more effective, with at least eight independently confirmed tactical missile hits in the 2003 Iraq War.

Israel, with the United States, has spent billions on a two-tier ABM system that combines Patriots with Arrow rockets, a homegrown Israeli system. Nevertheless, although Patriot batteries have been set up around Haifa, Israel launched none in the recent conflict with Hezbollah. That's because Patriots cost $1 to $3 million, the Arrow interceptors are similarly expensive, and the supply of both, whether or not they hit incoming Hezbollah rockets, would soon run out -- as with the THEL system, both economics and physics favor the attacker's rockets.

3. Patriot radar, launcher and interceptor

On the ground, Hezbollah has been able to move its rocket launchers rapidly. Indeed, Hezbollah's battlefield agility and flexibility is one of the most striking features of the recent conflict. Objections that Hezbollah has accomplished a "victory" only in that its obdurate resistance has vast propaganda value within the Arab world miss the point that a militia of some 3,000 fighters impeded the advance of what was supposedly one of the world's best armies beyond a few kilometers inside Lebanon. In the process, more than 20 Israeli Merkava tanks -- again, reputedly the world's best -- were damaged by anti-tank weapons, including the Russian-made RPG-29, which have a tandem warhead so that the first explosion blows away a tank's protective shield and the second penetrates it.

Overall, Hezbollah's decentralized, flexible network of small units exhibited the essential aspects of a warfighting style that some military thinkers have predicted would predominate in 21st-century warfare, and which has been described as **netwar** or **fourth-generation warfare**. It's a style of warfare that armies of nation-states, with their massive levels of force, are ill-equipped to fight.

One proponent of this school of thought, John Arquilla, a professor at the U.S. Naval Postgraduate School, has argued: "What happens if you take your large hammer to a ball of quicksilver? That's what these networks are." He continues: "We are trying to wage war as if it still mattered that our forces are comprised of 'the few and the large' -- a few large heavy divisions, a few large aircraft carrier battle groups -- when in fact war is migrating into the hands of the many and the small -- little distributed units. We live in an era when technology has expanded the destructive power of a small group and the individual beyond our imaginations."

These lessons of combat -- now exemplified by Hezbollah's resistance to the IDF -- are not being lost elsewhere in the Arab world. According to a **UPI story**, "Anti-tank Rockets Menace Israelis," appearing on August 14, the day of the cease-fire, a reporter from the Israeli paper Ha'aretz recently interviewed a member of Fatah's al-Aksa brigades in Bethlehem, who said: "The brothers...are no longer interested in games with Kalashnikov rifles; they want anti-tank rockets....When this technology arrives, how difficult would it be for one of the fighters to sit on the Palestinian side of the wall at Abu Dis and fire a rocket at the King David Hotel? With less effort than a suicide bombing or shooting one can fire a missile and get the same results."

4. Hezbollah guerrilla fighters

But not only this level of missile technology is being democratized. As the instance of the Iranian-made, radar-guided, anti-ship missile that hit the Israeli corvette illustrates, more sophisticated missile technology is also spreading. Pakistan, China, North Korea, and Iran, among others, now possess cruise missiles. The United States and its allies are now urging a U.N. resolution that will call for international sanctions against Iran.

To enforce such sanctions would require control of Iran's offshore waters and particularly of the Straits of Hormuz, through which much of the world's oil moves and where Iran can potentially destroy all shipping. It's not inconceivable to many analysts that Iran, with the missile technology it now possesses, could 'take down' that foremost example of U.S. military power, the aircraft carrier battle group. In a world of proliferating cruise-missile technology, one Pentagon consultant told me: "We have a navy full of ships that will burn to the waterline when hit."

II The democratization of cruise missile technology

For many experts in weapons proliferation, cruise missiles are the most disturbing threat today.

Hezbollah's recent use of an Iranian variant of the Chinese "Silkworm" C-802 **radar-guided anti-ship missile** against an Israeli warship illustrates the larger trend. In the wake of the Soviet Union's collapse, the first Gulf War demonstrated America's unparalleled global power, which flowed, in part, from possession of a new class of weapons with near-surgical accuracy at great distances. Fifteen years later, another shift in the balance of global military power is occurring as missile technology--particularly, the cruise missile technology that was a hallmark feature of U.S. military supremacy--is being democratized.

5. Chinese anti-ship
Silkworm Missile

Cruise missiles can be as sophisticated as the American AGM-129 **Advanced Cruise Missile** and its W80 **nuclear warhead**--which can strike targets 3,000 kilometers away, using guidance systems that hug satellite-mapped terrain--or as simple as small, unmanned air vehicles (UAVs) built from commercially-available kits. The German World War II-era V-1 "buzz bomb" even meets the definition of a cruise missile: an unmanned self-propelled guided aircraft that uses aerodynamic lift to deliver a payload to a target. Still, as Owen Cote, associate director of MIT's Security Studies Program, explains: "Antiship cruise missiles only need a relatively simple inertial navigation system and a radar return from their target, which is within the area the missile is launched at." Consequently, antiship cruise missile systems, being simpler and often shorter range, are generally the first kind of cruise missile acquired by states or organizations, such as Hezbollah.

The Missile Technology Control Regime (MTCR), a voluntary nonproliferation agreement involving 34 countries and supposedly limiting export of unmanned systems that can deliver weapons of mass destruction, defines a antiship cruise missile as having a range of less than 300 kilometers. A cruise missile is a Category II item--meaning, essentially, that it may be exported by any company that manufactures it. (Category I severely limits exports of ballistic missile systems, space-launch vehicles, and land-attack cruise missile systems.) Given that antiship cruise missiles can be converted to land-attack systems, the MTCR is a particularly leaky sieve. But American actions have also inadvertently helped spread the technology. In 1998, when the Clinton administration launched 75 **Tomahawk cruise missiles** at Osama bin Laden's bases in response to al Qaeda's bombing of U.S. embassies in Kenya and Tanzania, six of the missiles misfired and landed across the border in Pakistan. It has long been suspected that these unexploded missiles were studied by Pakistani and Chinese scientists. Ted Postol, a professor of science, technology, and international security at MIT, confirms this: "A Pakistani colleague of mine told me that a significant number of those missiles that we launched at Afghanistan actually landed in Pakistan and those guys reverse-engineered them."

The propulsion system of the Babur missile that Pakistan tested in 2005 definitely resembles that of the BGM-109 Tomahawk. After an initial launch by a solid-fuel booster, a cruise turbo fan engine cuts in, giving the Babur a speed of 880 kilometers per hour and a range of 500 kilometers. That Chinese assistance was a factor in developing the Babur's GPS- and INS-

based guidance system is supported by its resemblance to the Chinese YJ-62 antiship cruise missile and the family resemblance of both missiles to the Tomahawk.

The Babur was, in a sense, Pakistan's predictable response to the test-firing in 2001 of the PJ-10 BrahMos cruise missile by its subcontinental rival, India. Jointly developed by Russia's Mashinostreyenia and India's Brahmos Corporation, the BrahMos's ramjet cruise engine is based on the Russian supersonic antiship Yakhont missile and capable of speeds of 2.5 to 2.8 Mach (three times faster than the Tomahawk). India and Russia ensured that the BrahMos didn't violate the MTCR, however, by keeping its range within the 300-kilometer limit specified for antiship cruise missiles.

6. Pakistan's anti-ship
Babur Cruise Missile

How many cruise missile types exist in the world today and how many countries have them? Given that reverse-engineering and modification have produced different variants of the major types, some accounts reckon that as many as 130 types exist, with 75 countries possessing them. Not only has the MTCR's permissive handling of antiship cruise missiles aided this proliferation, but some MTCR nations have turned a blind eye when their own companies have exported cruise missiles in defiance of its rules. For instance, Russian defense minister Sergei Ivanov claims that Ukraine, a MTCR signatory, sold the nuclear-capable X-55 cruise missile to Iran and China in 2001 and 2002. John Pike, director of private military information group Global Security.org, charges that many European companies have regularly contravened the MTCR: "They're open for business and they want to make money." As for the most worrisome non-MTCR nations--Iran, North Korea and Pakistan--Pike maintains that their close collaboration on missile technology amounts to "one development program in three different places."

Cruise missile proliferation may soon become bigger news. Last week, Iran--Hezbollah's primary missile supplier--blocked U.N. inspectors from viewing the Natanz complex housing Iranian uranium-enrichment efforts and delivered its nonresponse to the incentives offered by the U.S. and Europe in return for Iran halting its nuclear program. Therefore, America and its U.N. Security Council allies threaten that they'll attempt to pass a U.N. resolution on August 31 that would impose economic sanctions on Iran.

That effort may be of little avail. Firstly, Russia and China, both veto-wielding Security Council members, vigorously oppose sanctions. Secondly, even if America and its European allies finesse Russian and Chinese opposition, it's not clear that the U.S. can sanction Iran more effectively than it has for the last quarter-century.

So while the Bush administration has proceeded with diplomacy, officials repeat that the military option "remains on the table" if that's what it takes to deny the Tehran regime the nuclear bomb. Indeed, many in Washington believe that U.S. Air Force is ready with advanced plans to bomb Iranian nuclear sites.

John Pike maintains that not only is the administration preparing for a pre-emptive attack on Iran, but even without such a move the destabilizing forces already unleashed in the Middle East may escalate into a situation in which Iran will try to obstruct the passage of shipping through the Strait of Hormuz--where the Persian Gulf narrows to only 34 miles and through which 90 percent of Persian Gulf oil exports pass. If, according to Pike, Iraq breaks up into three partitioned regions--Kurdistan in the north, an oil-less "Sunnistan" in the middle, and a Shia-dominated region in the south--Saudi Arabia, already the Sunni insurgency's biggest supporter, will see its fellow Sunnis deprived of the oil wealth that has historically been theirs and will possibly increase its aid to the Sunni insurgency. Iran will respond with increased support for Iraqi Shias. Thence, the struggle could intensify into a conflict resembling the 1980-1988 Iran-Iraq "Tanker War", when both countries attacked oil tankers and merchant ships--including those of neutral nations--to deprive their opponent of trade. As in the 1980s, U.S. naval forces would be drawn into such a conflict between Iran and Saudi Arabia.

This time, though, the Iranians possess at least 300 Exocet antiship missile systems and an undisclosed number of Russian Moskit http://www.globalsecurity.org/military/world/russia/moskit.htm
supersonic antiship systems--and possibly also the improved Moskit version, the Yakhont.

Recent naval history provides a foretaste of what the relatively primitive Exocet missiles could do. In the Falklands War in 1982 between the U.K. and Argentina, Argentinean jets armed with French-made Exocets hit the H.M.S. Sheffield, whose superstructure was constructed of lightweight aluminum. The aluminum melted and the frigate burned to the waterline and sank. Similarly, in 1987, during the Iran-Iraq War, an Iraqi jet launched two Exocet missiles into the U.S.S. Stark, another frigate, and its lightweight aluminum superstructure also caught fire.

It is Iran's Moskits, though, that are the real concern for American ships. These ramjet-equipped missiles, flying two and a half to three times the speed of sound and as low as five feet above the water, were specifically designed by the Russians to overcome the Aegis defense systems
and SM-2 and SM-3 defense missiles protecting American aircraft-carrier groups. The maximum theoretical response time to a Moskit launch is 25 to 30 seconds, leaving little time for jamming and countermeasures--let alone bringing to bear missiles and quick-firing artillery. Unlike past decades, when U.S. warships were constructed with aluminum superstructures (which were 35 to 45 percent lighter than steel and assisted a vessel's speed and maneuverability), current American warships, like the Arleigh Burke-class destroyers that are primary components in a U.S. carrier group, generally have steel superstructures. Nevertheless, al Qaeda's attack on the U.S.S. Cole in 2000 provides some insight into what a Moskit can do. The Cole, an Arleigh Burke-class destroyer
with steel armor, was docked in Aden harbor when a small craft exploded against its port side, putting a 40-by-40-foot (12-by-12 meter) gash in the Cole's flank. That explosion was the result of as much as 600 pounds of explosive. The Cole's vulnerability suggests that any of Iran's Russian-made Moskit missiles, and their 750-pound warheads, are potential ship-killers.

The Falklands War has been much pondered by military analysts. John Arquilla, professor at the

U.S. Naval Postgraduate School, says: "The Exocet missile definitely proved the vulnerability of the slow-moving big ship." The key to the U.K.'s Falklands victory, Arquilla continues, was that the British calculated how to put their two aircraft carriers beyond the range of Argentinean air attacks while still enabling British aircraft to hit Argentinean forces. That lesson has applications for the challenge that the U.S. Navy may soon face in the Persian Gulf. Yes, the Gulf's north shore belongs to Iran and is potentially a platform for their cruise missiles. True, any ship within the Gulf, including ships docked at the U.S. Fifth Fleet's base in Bahrain, could theoretically be targeted from across the Gulf or from speedboats and helicopters that the Iranians have purportedly adapted as mobile platforms for their missiles. In practice, however, America has and will maintain complete air dominance.

That means that if America stands off its naval assets over the horizon, the Iranians have three options: they can aim their missiles at targets in visible range, employ radar-guided missiles to acquire over-the-horizon targets, or else use sea-based platforms to launch missiles. In all those cases, they will immediately become vulnerable to U.S. retaliation from the air. The Iranians would likely only get one chance at launching their cruise missiles before their platforms were destroyed.

Yet what if the Iranians could launch swarms of hundreds of missiles simultaneously? All bets might be off. In such a scenario, the Iranians could conceivably devastate an American naval force. Do the Iranians possess enough missiles to do that? The truth is that we don't know, as the congressional report released on Thursday, August 24, concluded. In terms of the threat level, independent analyst John Pike puts it this way: "Iran is a riddle wrapped in an enigma."

In the longer term, the trend seems clear. Iran developed its first indigenous 32-bit microprocessor last month. Like mounted cavalry faced by the machine gun in 1914 or the battleship confronted by aerial attack in 1941, the U.S. aircraft carrier battle group seems likely to become increasingly a giant, slow-moving target when an enemy can fire swarms of self-guiding cruise missiles from hundreds of miles away. "Sixty-odd years ago, the German admiral Durnitz had in his office a picture of the ocean with a few gulls and a sunlit sea," John Arquilla says. "Durnitz would point to this picture when his U-boat skippers visited him and say, 'That is the future of naval warfare--there will be no great vessels, only submarines and aircraft.' In 21st-century sea warfare, expect the rise of sea power without a navy."

Regarding the democratization of cruise missile technology generally, Arquilla continues: "When cruise missiles are as widespread as AK-47s, we will truly have the war of all against all." As for the strategic prospects in such an era, Arquilla says, "I always send people back to Jean Bloch's The Future of War (1898). Bloch was a banker and he looked at society, security, and strategy all together. Before World War I, he understood that technological advances were creating systems of enormous destructive capacity, but the societal systems that were emerging would be capable both of taking great damage and of continuing. Because everybody had these capabilities, you would end up with a long attritional war, which both sides would lose. I think we're in a similar situation to the one Bloch described, where the barriers to entry have dropped sufficiently so that, as long as anyone has the will to fight, they'll be able to continue fighting. I think that's the strategic picture that's most pertinent to our time."

Mark Williams is a contributing writer to M.I.T's Technology Review.

*This **two part article** appeared in The Technology Review on August 16 and August 29, 2006. Posted at Japan Focus August 29, 2006.*