An Israeli Military Innovation

UAVs

By RALPH SANDERS

t should not be surprising that Israel has become a leader in military innovation given the demands of national security. Among the technologies that it has advanced are unmanned aerial vehicles (UAVs). Even though other nations have conducted experiments with these vehicles, Israel developed and fielded them as battlefield systems. UAVs are non-rocket-propelled aircraft that fly within the atmosphere and do not require humans on board to operate them. With aerodynamic features that enable them to lift and carry lethal as well as nonlethal payloads, unmanned aerial vehicles perform missions such as reconnaissance, command and control, and deception. They are not intended to replace air crews but to augment them for certain missions.

UAVs are relatively simple and sturdy, taking off and landing conventionally under the control of rated pilots located on the ground. They are sometimes preprogrammed and range in design from modern aircraft to missiles. Israel and America have invested heavily in these vehicles because of their combat performance, versatility, and low cost; thus UAVs are entering a new phase in their development.

Certain advantages were sought by using these vehicles. Because of their relatively small population, Israelis have always been particularly sensitive to loss of life. The Merkava tank, for example, was designed with the engine in front to protect the crew. Likewise, UAVs avoid risks to airmen. Israel recalled the plight of its prisoners of war and the way their enemies exploited them

Ralph Sanders was J. Carlton Ward, Jr., Distinguished Professor at the Industrial College of the Armed Forces and is the author of *Arms Industries: New Suppliers and Regional Security*.

1. REPORT DATE **2002**	2. REPORT TYPE	3. DATES COVERED **00-00-2002 to 00-00-2002**

4. TITLE AND SUBTITLE **An Israeli Military Innovation UAVs**	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **National Defense University,300 5th Ave SW, Marshall Hall,Washington,DC,20319-5066**	8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**5**	

for propaganda. Resource constraints also demanded optimum results from military innovations. Consequently, Israel sought the most efficient technologies. For the most part, and despite certain limitations, UAVs are becoming more economical, making them attractive to political and military leaders alike.

Given the fact that Israel has fought six wars and is engaged in counterterrorist operations of major proportions at present, its defense officials can employ UAVs across a range of missions. It should be stressed that these vehicles represent only one of several innovations developed to meet security challenges. Yet advocates are optimistic because of the advent of lightweight composite structures, reliable digital flight control systems, miniaturized sensors, and strong data links.

The Relevant History

During Operation Peace for Galilee in 1982, Israeli aircraft flew over the Bekaa Valley in the Syrian-occupied area of Lebanon to destroy surface-to-air (SAM) missile batteries. Earlier, UAVs had fingerprinted Syrian surface-to-surface radars by gathering their electronic frequencies. The Israelis then programmed the frequencies into antiradiation missiles. When the assault began, UAVs cruised the battlespace emitting dummy signals. Syrian radar operators thought that Israeli planes were attacking and launched most of their SAMs against unmanned vehicles. As the Syrians reloaded and were vulnerable to air attack, Israeli fighters struck with telling effect.

the Israeli military learned vital lessons regarding UAVs during the Yom Kippur War in 1973

In addition, Syrian radars that tracked UAVs alerted the Israelis to devices which emitted signals. With previously gleaned electronic signatures, Israeli aircraft with antiradiation missiles and supporting artillery fire destroyed the enemy missiles. Israel does not use unmanned vehicles in isolation. It fielded sophisticated jamming systems and precision bombs in 1982, which neutralized 19 enemy batteries. Free of SAMs, Israeli aircraft attacked Syrian aircraft. In what unfolded as the largest air battle since the Korean War, Israel claimed 22 kills without a single loss.

The Israeli military learned vital lessons regarding UAVs during the Yom Kippur War in 1973 and applied them smartly in 1982. In fact, in both Lebanon and Syria, Israel was among the first nations to employ such vehicles regularly for reconnaissance in combat, demonstrating that when used effectively they can help achieve combat objectives.

These vehicles played a significant role while Israel occupied a security zone in southern Lebanon. For example, a UAV squadron served before and during the Grapes of Wrath Operation to find concentrations of terrorists and the homes of their commanders. With forward-looking infrared radar cameras, unmanned aerial vehicles saw at night, removing darkness as a cover for Hizbollah fighters.

Defense Industrial Base

The emergence of unmanned vehicles resembles the early stage of developing computers in the United States. It began when an American, Alvin Ellis, decided that unmanned flight could have a military role. In 1967 he moved to Israel and joined Israel Aircraft Industries (IAI). After analyzing the Yom Kippur War, he found that a drone equipped with a television camera offered clear battlefield advantages. With an IAI colleague, Yehuda Manor, he built a prototype UAV in a garage, not unlike Steve Jobs and Stephen Wozniak, who assembled the first Apple computer.

After being rejected by IAI, the pair sought backing from a government-owned company. Ellis approached Tadiran, a private electronics conglomerate, which funded the project. Once the prototype was flown in 1973, Tadiran signed a contract to develop an operational model known as Mastiff, with a pusher-propeller twin-boom configuration, a feature that would become standard for combat surveillance. While this unmanned vehicle attracted little attention for some time, the Israeli military eventually became interested. Tadiran and IAI engaged in bitter competition for a defense contract to develop and produce the vehicle.

Soon the Israeli defense ministry was acquiring Mastiffs from Tadiran while IAI supplied its Scout model, which had a configuration similar to the Mastiff. With UAVs providing critical reconnaissance information on the Bekaa Valley, America took an interest in unmanned vehicles. Tadiran teamed with IAI and then submitted a proposal in 1984 for a model to meet U.S. military requirements. As a result, IAI formed a division known as Malat to produce UAVs.

IAI has become a leader in finding solutions for integrated UAV-related problems. It has a system for virtually every scenario from tactical to medium-altitude, long-endurance vehicles. The firm has focused on tailoring advances in payloads, data links, and mission control centers to meet customer needs.

Malat later consolidated production of Mastiffs and Scouts and continued to sell slightly different versions for over a decade. Both models have fixed landing gear and generally operate

**Pioneer UAV,
Paris Air Show.**

PhotoLink (Michael Vines)

from runways, performing short landings with an arresting-wire hook. However, they can also be launched from a hydraulic catapult mounted on a truck and recovered by a net. The two models carry imaging sensors in a turret under the fuselage. The Mastiff and Scout remained in service until the early 1990s, when the Malat Searcher became the preferred UAV. Similar to the Scout but over twice its size, the Searcher has a more powerful engine, updated avionics and sensors, greater endurance, and improved survivability. First deployed in 1998, it can fly at 20,000 feet for 14 hours, carrying advanced video cameras for daylight and night observation.

In addition, Malat has explored a smaller UAV, Eye-View, which has fixed landing gear, pusher propeller, and a distinctive tail-boom on the rear fuselage. IAI is promoting Eye-View in civilian markets for detecting forest fires. Another firm, Silver Arrow, a collaborative project of Elbit and Federmann Enterprises, offers large UAVs and two smaller versions, including the Sniper and Micro-V. The former resembles a conventional private aircraft and has an unusual upright vee-shaped tail. The latter is too small to carry a full sensor turret but is equipped with a miniaturized imager in a transparent section within its fuselage.

IAI/Malat has delivered more than 600 UAVs to the Israel Defense Forces and customers overseas. Sales totaled some $200 million in 2001, and the firm held a workshop to advance civil and commercial applications of UAVs during the previous autumn. A private sector firm, Elisra, produces electronics systems for use in UAVs operating in hostile environments. In joint ventures undertaken with IAI, Elisra has proven a valuable partner.

Operational Dimensions

UAVs ease the tasks of commanders on the battlefield and have the potential to become force multipliers—that is, devices that improve effectiveness in combat without requiring more forces or that enable commanders to accomplish missions with fewer forces. In military operations, force multipliers relate to providing commanders with information to make timely decisions. They include battlespace surveillance radar, remotely piloted vehicles, and UAVs.

Yet the future role of unmanned vehicles triggers debate. Some experts suggest that they have a promising future with their potential to revolutionize conventional military operations by the end of the decade. On the other hand, the Center for Defense Information argues that these platforms will not greatly change warfighting. At present many commanders find them helpful, but they have brought only incremental improvement, enabling forces to do what they already do only more effectively. They do not yet give promise of revolutionizing the art of war.

Specifically, UAVs contribute in several ways. They can fly for extended periods without refueling. Moreover, they can loiter at length; the longer they hover over a target, the better the photographs. In addition they are economical to build and operate, though precautions are in order because the cost advantage can evaporate as acquisition bureaucracies inevitably attempt to develop larger, more complex, and more capable models. Third, if an unmanned vehicle is either downed or destroyed, as previously emphasized, no pilot is killed or captured.

Thus far, UAVs have been used chiefly for surveillance and reconnaissance. But lately they have been employed as weapons platforms to destroy selective targets. Unmanned vehicles are smaller, lighter, and less expensive than their manned counterparts. To take full advantage of these and similar innovations, the military must develop new operating concepts and change mindsets on how to fight wars in the future.

UAVs can loiter at length; the longer they hover, the better the photographs

Constraints on Israeli defense spending require a turn toward force multipliers. A growth in Palestinian violence has reversed a downward trend in the defense budget in recent years. The expenditure of $8.9 billion in 2001 has no doubt been increased. UAVs will help get more use out of existing military equipment.

Missile Defense

Five years ago the Israelis began promoting the Moab system, in which unmanned aerial vehicles counter ballistic missiles during their boost phase. This effort involved using UAVs armed with Python 4 air-to-air missiles. Planners argued that an ability to operate at high altitudes and loiter for days virtually immune from attack by either surface-to-air missiles or fighters made them especially useful for engaging theater ballistic missiles soon after launch.

Analysts found that high-altitude, long-endurance UAVs could complement terminal missile defense systems cost-effectively. They began developing the HA–10, a stealthy, long-endurance unmanned vehicle, but never built it, concluding that since American support for such a venture was unlikely, the required financing for the project would not be forthcoming.

One American defense official expressed the reluctance to support the project in the following words: "Targeting a fast-moving missile could be extremely difficult, especially if the UAV is going to see it and then catch it in the first minute or so of its flight." According to critics, communications among vehicles and command and control centers would not be fast enough to make launch decisions on time. The United States has concluded that using UAVs for boost-phase intercept may prove to be too great a technical and financial challenge.

Israel later used UAVs to destroy launch vehicles on the ground, specifically in hunting down Scud missiles. For its part, America has explored incorporating them into missile defense for warhead detection and monitoring. These vehicles may employ infrared sensor and data collection systems, hoping to track missiles during their midcourse flight.

The verdict on using UAVs for theater missile defense is still moot. In the meantime, the Israelis appear willing to pursue the matter, in the hope that additional research and development will someday provide the knowledge that will make them effective antiballistic missile weapons.

Counterterror Role

Terrorism gave prominence to unmanned aerial vehicles because of their reconnaissance, surveillance, and target acquisition capabilities. For example, since they can see at night, darkness no longer cloaks attacks by Hamas, Hizbollah, and other groups. In particular, the role of UAVs on the urban battlefield that terrorists prefer has become important. With aerial photography, these vehicles offer an effective way of finding snipers and generating street plans and relief maps of enemy positions. That information in turn can be relayed to commanders in real time. Unmanned vehicles have become a necessity before sending troops into a city.
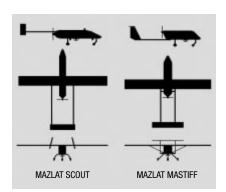
Israeli success in employing UAVs prompted both U.S. military and intelligence agencies to use the same tactics. In November 2002, the CIA deployed a vehicle as a hunter-killer asset. It helped destroy a vehicle carrying al Qaeda operatives after they launched a Hellfire air-to-surface missile near the Yemeni capital. One of the men in the car had participated in the attack on *USS Cole* that killed 17 Americans.

Unmanned vehicles were also used in Afghanistan as coalition forces pursued the Taliban and al Qaeda terrorists over mountainous terrain. But they have their limitations, as demonstrated by the failure to locate Osama bin Laden. As the Israelis learned, UAVs may identify an enemy, but the target often disappears by the time a helicopter or fighter aircraft arrives.

Capability and Limitations

Compared with high-performance aircraft, UAVs move more slowly over hostile territory to collect information, exposing them to enemy fire. Unmanned vehicles also lack the instinct of self-preservation that piloted aircraft possess when evading enemy defenses. Although the number of

vehicles which Israel lost over the Bekaa Valley in 1982 or during other operations is unknown, NATO lost 22 during the war in Yugoslavia. In addition, UAVs cannot use terrain for protection against hostile fire. Once damaged, they lack redundant onboard systems like other aircraft.

Unmanned vehicles have restricted data-link technology, which limits both their range and flexibility in activities such as terrain masking. Moreover, as operational experience grows and the vehicles become better known, new instruments will be designed to counter them. Israel is developing measures to correct such problems. When their signatures are reduced, UAVs are more difficult to locate. New multispectral sensors will enable them to operate in inclement weather. When the range of their sensors is increased, unmanned vehicles can remain at some distance from threats. Changing their flight profiles makes them less predictable as well as harder to hit. Finally, other innovations—including countermeasures which interfere with air defense guidance systems—will improve their overall UAV performance.

MAZLAT SCOUT   MAZLAT MASTIFF

Foreign Military Sales

Israel must sell arms to other nations to subsidize its own defense industrial base. With the downturn in the global demand for military hardware, it must carefully select which products to market. UAVs are likely candidates for foreign military sale for a variety of reasons. They meet general security needs, performing missions such as counterterrorism, protection against theater ballistic missile attacks, and conventional warfare. They can be designed for a range of military roles, from overhead surveillance to launching lethal weaponry. Finally, they are not as costly as many other systems. Among the countries that have become Israeli customers are Chile, India, Singapore, and the United States.

America has long collaborated with Israel in defense matters. But because the Pentagon is reluctant to buy weapons from overseas, foreign manufacturers normally team with U.S. firms. For example, AAI Corporation is making the Israeli-designed Pioneer UAV for both the Army and Navy. IAI has assisted TRW Avionics and Surveillance Group to produce the Hunter UAV, which was originally developed by IAI. Since this cooperation began, Malat has developed more advanced battlefield UAVs in collaboration with U.S. partners.

The Marine Corps has also been testing Israeli UAV prototypes. It is especially looking into their potential for urban warfare. IAI has recently teamed with Raytheon Missile Systems to promote a combat unmanned target locate and strike system called Cutlass.

Both India and Israel face hostile neighbors. As India confronts Pakistan over Kashmir, Israel has become one of its major weapons suppliers. A report in *Asia Times* suggests that India is Israel's second largest defense customer. In fact, an article published in *Iansa*, an Indian journal of strategic studies, claimed that Israel may replace Russia as the principal source of military hardware. Whatever the validity of these reports, Tel Aviv is becoming a major arms dealer in New Delhi. Washington is concerned that such sales can have an adverse effect on the region. Consequently, the United States asked Israel to downplay these transfers.

After India opened its mission in Israel, a delegation from Malat visited India to discuss the sale of military technology. A short time later, Israel offered to sell third-generation Searcher long-endurance multi-role UAVs to India as well as multipurpose tactical unmanned vehicles. The Searcher can remain airborne for 16 hours and has a range of 159 kilometers, which makes it suitable for operations in the Himalayas.

After being caught offguard by incursions in the Kargil region of Kashmir, India decided to buy unmanned vehicles from Israel. Specifically, New Delhi wanted to stop infiltration along the line of control and reportedly acquired 100 UAVs for $750 million, a deal that some indicate could be doubled. In late 2000, the Indian army deployed its first group of 25 Searcher Mark IIs on its frontier with Pakistan and China. It may also order more expensive Searcher IIs, which are capable of operating at 15,000 feet.

Many militaries around the world have become enthusiastic over unmanned vehicles. They have seen the Israelis develop UAVs to meet their security requirements from missile defense and conventional operations to counterterrorism. These vehicles enable commanders to see more of the battlespace, and knowing an enemy goes a long way toward defeating it. Moreover, no one can be killed or injured flying them. As enemies become familiar with the strengths and limitations of these vehicles, they will find the means to reduce their effectiveness in some environments. Yet Israel is convinced that such systems improve military capabilities at a modest cost. Unmanned aerial vehicles will certainly continue as a major export item for its defense industries. **JFQ**