

- Samoa* (Morrow, New York, 1928); *Am. J. Sociol.* 48, 633 (1943); O. F. Raum, *Chaga Childhood* (Oxford Univ. Press, London, 1940); J. W. M. Whiting, *Becoming a Kwoma* (Yale Univ. Press, New Haven, 1941).
10. In trying to make comparisons between learning skills involved in formal and informal learning, we are limited by a curious discrepancy: most of our knowledge about informal education is based on field work in traditional, nonliterate societies, whereas most of our knowledge of formal education is based on studies of educational institutions in industrialized, literate societies. When we draw on illustrations, it may appear as though we are making comparisons between cultures or societies, whereas we mean to draw attention to the possible differential consequences of the several kinds of education within one culture or society.
 11. Y. A. Cohen, in *Anthropological Perspectives on Education*, M. L. Wax, S. Diamond, F. O. Gearing, Eds. (Basic Books, New York, 1971).
 12. M. Mead, *Continuities in Cultural Evolution* (Yale Univ. Press, New Haven, 1964).
 13. C. B. Caden and V. P. John, in *Anthropological Perspectives on Education*, M. L.

- Wax, S. Diamond, F. O. Gearing, Eds. (Basic Books, New York, 1971).
14. G. D. Spindler, *Education and Anthropology* (Stanford Univ. Press, Stanford, 1955); M. L. Wax, S. Diamond, F. O. Gearing, Eds. *Anthropological Perspectives on Education* (Basic Books, New York, 1971).
 15. N. Miller, *The Child in Primitive Society* (Kegan Paul, London, 1928).
 16. G. Bateson, *Naven*, (Stanford Univ. Press, ed. 2, Stanford, 1965).
 17. T. Gladwin, *East Is a Big Bird* (Harvard Univ. Press, Cambridge, 1970).
 18. Studies we have found stimulating are those of E. B. Leacock, *Teaching and Learning in City Schools* (Basic Books, New York, 1969); A. V. Murray, *The School in the Bush* (Cass, London, 1967); R. Thabault, *Education and Change in a Village Community* (Shoken, New York, 1971); M. L. Wax, R. H. Wax, R. V. Dumont, Jr., *Soc. Probl.* 2, suppl. (1964).
 19. M. L. Wax and R. H. Wax, in *Anthropological Perspectives on Education*, M. L. Wax, S. Diamond, F. O. Gearing, Eds. (Basic Books, New York, 1971).
 20. We are expecting here children whose position in society is such that their families and

- social milieu hand down a basically academic tradition.
21. R. Horton, *Africa* 37, 157 (1967).
 22. L. S. Vygotsky, *Thought and Language* (Wiley, New York, 1962).
 23. J. Gay and M. Cole, *The New Mathematics and an Old Culture* (Holt, Rinehart & Winston, New York, 1967).
 24. G. Bateson, in *Steps to an Ecology of Mind*, G. Bateson, Ed. (Ballantine, New York, 1972).
 25. P. M. Greenfield and C. P. Childs, "Weaving, color terms, and pattern representation," unpublished manuscript.
 26. J. R. Goody, Ed., *Literacy in Traditional Societies* (Cambridge Univ. Press, Cambridge, England, 1968).
 27. P. Dasen, *J. Cross-Cultural Psychol.* 3, 23 (1972).
 28. J. Kozol, *Free Schools* (Bantam, New York, 1972).
 29. P. Freire, *The Pedagogy of the Oppressed* (Herder & Herder, New York, 1971).
 30. Preparation of this article was supported in part by grant OEG-0-71-1965 from the Office of Education and grant 5-29179 from the Carnegie Corporation of New York, both to M.C.

NEWS AND COMMENT

Military R & D: Hard Lessons of an Electronic War

It was the very model of a modern electronic war, fought with the best that nonnuclear technology had to offer. Supersonic Soviet SAM's whooshed up from the desert on puffs of white smoke, climbing radar beams into the bellies of supersonic Phantoms. Israeli pilots deployed the best of America's electronic bamboozlery, and when all else failed they fired Shrike and Standard radar-seeking missiles into SAM launch sites. On the ground, hundreds of tanks swirled through the fiercest armored battles since World War II, but this time some of them aimed their fire with laser range finders. Wire-guided Snapper and Sagger anti-tank missiles, made in the Soviet Union, took a devastating toll of tanks made in the United States and Britain; Israel retaliated with the products of Vietnam: smart bombs, cluster bombs, and the Maverick—the latter not a compact car but a new U.S. antitank missile with a television camera in its nose and an uncanny ability to remember what its chosen target looks like.

By the time the fighting ground to an uneasy truce on 22 October, something on the order of \$4 billion worth of high-technology wreckage lay strewn along the Golan Heights and both sides of the Suez Canal. Surveying this costly detritus, a number of military analysts in Washington have begun to

extract some technological lessons that will, or, these observers believe, ought to, influence the course of tactical weapons R & D in the United States and Europe for years to come.

How one interprets the lessons of the fourth and most expensive Arab-Israeli war in a quarter of a century depends to some extent on whether one is inside the Pentagon or out. To some respected analysts on the outside, the handwriting on the wall, in Cyrillic script, says bluntly that missile technology has outstripped any protective countermeasures currently available to tactical fighter aircraft and tanks. If the evident potency of cheap antitank missiles has not rendered the tank obsolete, these analysts say, then at least it is due for a demotion from its present role of offensive spearhead to one of mundane mopping-up operations.

Similarly, Israel's loss of more than 75 planes (about 15 percent of its combat-ready air force) in the first week of fighting is interpreted by a variety of independent observers outside the Defense Department as evidence that the United States does not have an effective response to the best Soviet SAM (surface-to-air missile) defense. Accordingly, they hope, development of a new generation of unmanned drone jets for "SAM suppression" will begin to seem more appeal-

ing to a military establishment that has long been chary of such a radical departure from traditional tactical aircraft.

The Defense Department, while not inclined to view the Middle East war in such stark terms, nevertheless is likely to apply its lessons to good advantage in justifying existing R & D programs. "Whether there are any jarring lessons or not," an aide to Representative Les Aspin (D-Wis.) predicts, "they'll be up here next year to make the point." This source, and several other congressional staffers involved in defense affairs, believe the Arab-Israeli experience is likely to fortify already substantial congressional support for a number of R & D programs in tactical air warfare. The programs most likely to benefit range across the services, from Air Force work on electronic countermeasures (ECM) for foiling SAM defenses, to the Army's antitank helicopter program, to the SAM-D, a sophisticated new antiaircraft missile.

By the same token, though, the Army will probably have a tougher time next year in selling Congress on continuing its \$2.3 billion effort to produce a new "main battle tank" for U.S. and NATO forces in the 1980's. The Army's tank program, in fact, appears to be one of the very few major development programs likely to suffer from the Arab-Israeli experience.

A program with a somewhat checkered career, it began in 1963 as a joint effort with West Germany to produce an ultramodern counterpoint to superior numbers of Soviet tanks arrayed against NATO forces in Europe. As the unit price of the tank (initially dubbed the MBT-70, later redesigned and rechristened the XM-803) climbed past the \$1 million mark,

OTA Gets \$2 Million

After months of delay, the legislative branch's new Office of Technology Assessment (OTA), is finally materializing out of the mists of congressional committees and procedures. Both houses of Congress have approved \$2 million for the OTA as part of a \$605.2 million legislative appropriation for fiscal 1974. The funds were included in a conference report which passed the House on 16 October and the Senate on 18 October. This measure has not yet been signed by the President, but it is not one he is likely to veto.

The sum appropriated is less than the \$3.98 million originally requested for the first year of OTA's operation. But since the \$2 million will be spent over a period of 8 months (from now until the end of the fiscal year next 30 June) instead of a full year, informed sources consider it a respectable sum. It will pay for the expenses of its board (which resembles a joint congressional committee), plus those of the OTA and its advisory panels. The OTA may have a staff of from 30 to 40 people. The board is expected to name a director at its 1 November meeting. Once hired, the director, together with the board, will go about selecting a deputy and then a staff from files of approximately 3500 applicants.—D.S.

Congress killed the program in 1971 and sent the Army back to the drawing board. While the chief irritant to Congress was the tank's extraordinary cost, some, including Senator Thomas F. Eagleton (D-Mo.), urged a broader rethinking of tank development, with an eye to rapidly evolving antitank technology. "The role of tanks is becoming more restricted and the tank itself is becoming far more vulnerable," Eagleton said in November 1971, and he added that "there are now mobile, accurate, and inexpensive anti-tank weapons capable of destroying the most sophisticated and expensive tank now deployed or on the drawing boards."

The House Armed Services Committee, meanwhile, reported that its decision to kill the MBT-70 had been influenced by expressions of concern—from within the Army and from independent analysts—"that the tank is nearing the end of its era of combat capability" and that "new antitank weapons, including missiles, have brought about this obsolescence."

The tank's epitaph, however, was premature. The Army has since bounced back with the XM-1, a second-generation offspring of the MBT-70 featuring computerized fire control and thermal imaging for nighttime vision. The Army says it can hold the unit cost of this tank to \$730,000, but Eagleton failed in an attempt this September to give this ceiling the force of law through an amendment to the Defense appropriations bill.

Next year, though, things may be different. There are rumors in military circles that the Army has developed a

new form of armor plating that could substantially increase the "survivability" of its present main battle tank, the M-60, at far less than the cost of a new tank.

"At the least," said one congressional staffer on the House side, "we can trot out these horrible casualty figures [the Israelis are estimated to have lost roughly 500 tanks, a quarter of its combat force] and ask them how they can justify spending so much on tanks that are so vulnerable."

The relevance of the latest Arab-Israeli war to tank development and other weapons R & D in the United States stems partly from its technical sophistication. But beyond this, in its ferocity and overall character—in the massive and mutual deployment of armor, tactical aircraft, missileery, and electronic countermeasures—this conflict came closer than the Vietnam experience to the scenario of warfare in Central Europe which military planners for both NATO and Warsaw Pact forces hold uppermost in mind in developing new weapons systems.

The value of the Middle East as a proving ground for both the United States and the Soviet Union was also enhanced by Soviet willingness to furnish Egypt and Syria with key defensive weapons known previously in the West mainly—and in some cases exclusively—through intelligence, and by watching May Day parades in Moscow. Thus, the Snapper and Sagger antitank missiles, the SAM-3, the highly mobile SAM-6 antiaircraft missiles, and the T-62 tank had never appeared in combat—in Vietnam or anywhere else—even though all are integral parts of

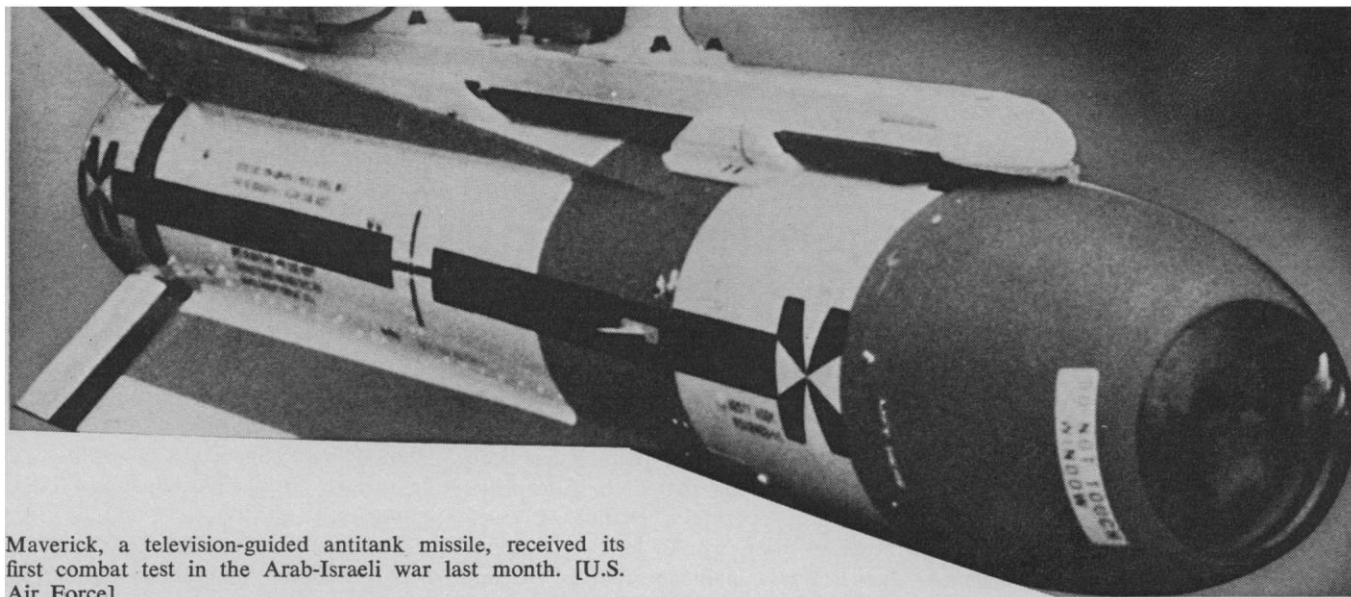
Warsaw Pact defense units.* (Why the Soviets waited as long as they did to battle-test weapons deployed in Europe since the late 1960's is the subject of a great deal of mostly fruitless speculation. Some of these weapons probably were of questionable value to North Vietnam's style of warfare. Soviet reluctance to supply air defense missiles more modern than the SAM-2 may have stemmed from a desire to keep such technology out of Chinese hands.)

The proving-ground benefits of the Middle East war worked both ways, of course, although the Soviet Union trotted out far more new weapons than the United States did; the U.S. appears to have limited itself to letting Israel give the Rockeye bombs and Maverick missiles their first combat tests.

The war also gave the United States its first opportunity to watch the performance (under conditions of more "classical" warfare) of exotic new weapons and munitions developed to meet the special needs of Vietnam. High on this list were laser- and television-guided "smart bombs" and antiradar missiles, both stockpiled by Israel before the war. Moreover, the war provided the United States with an important check on the accuracy of its (and Israel's) electronic surveillance of Soviet weaponry. Accurate knowledge of SAM radar tracking and guidance frequencies, for example, is essential to electronic warning, jamming, and deception.

There is conflicting evidence as to how fair a test of U.S. ECM technology the 17-day war provided, although on balance the test was probably more telling than any in Vietnam. According to military observers in Washington, the Soviet Union not only gave Egypt and Syria more sophisticated SAM's than those supplied to North Vietnam, but also deployed them in a more sophisticated way: Whereas SAM sites in Vietnam tended to be isolated, independent facilities, tracking and guidance systems in Egypt were interconnected to provide a kind of self-sealing umbrella for troops advancing across the Suez Canal. SAM-2 missiles provided high-altitude coverage, SAM-3's covered medium and low altitudes, and the highly mobile SAM-6—a triad of

* The SAM-7, a small, heat-seeking antiaircraft missile used in limited numbers by the North Vietnamese toward the end of that war appeared in quantity in the hands of Arab troops. The SAM-7 can be fired from the shoulder, but U.S. pilots learned that it could be decoyed by ejecting burning flares. Evidently on the theory that one can't fool all of the missiles all of the time, SAM-7's given to Arab troops were fired both individually and in clusters.



Maverick, a television-guided antitank missile, received its first combat test in the Arab-Israeli war last month. [U.S. Air Force]

missiles mounted on a tracked vehicle—stretched the umbrella more than 30 miles east of the Suez. “In Vietnam,” one source noted, “you could knock out a SAM site and that would leave a hole in their air defenses. But here, other sites could cover for those that were destroyed.”

Accustomed to flying in close support of its armored forces, the Israeli air force sped confidently into the teeth of these SAM defenses and promptly lost nearly a fifth of its strength. In so doing, Israel appears to have confirmed the findings of a Defense Department study, in the latter phase of the Vietnam war, that examined the feasibility of concentrated air attacks on SAM defenses. “We were surprised to learn that the rate of attrition was simply not worth it,” a former senior officer told *Science*. “When we looked at the price, we couldn’t do it, even with the Shrike.”

Initial news reports attributed Israel’s heavy losses to difficulty in foiling the SAM-6 radar and to a lack of the most up-to-date ECM equipment from the United States. The 10 October arrival at Oceana Naval Air Station in Virginia of a lone Boeing 707 bearing Israeli markings gave credence to the latter explanation. Bombs reportedly were loaded on the plane, but in fact these were probably bomb-shaped pods of ECM gear for Phantom or Skyhawk jets.

If Israel was caught up short by Arab SAM defenses, however, it was not by surprise. And if Israel was not quite at the cutting edge of ECM technology, it was not far behind. Installation of SAM-3 sites began in Egypt shortly after the 6-day war of 1967. By the

August 1970 cease fire, Israel had flown deep into Egypt on raids and surveillance missions against these sites; Israeli jets suffered heavy losses. Moreover, according to one recent and prophetic analysis of the military balance in the Middle East, there was substantial evidence more than a year ago that Egypt had SAM-6’s on hand.† “Any future conflict,” according to this analysis, “would most likely pit Israel’s offensive aircraft and its highly sophisticated ECM equipment against an ultrasophisticated air defense, possibly manned by Russians.”

Well before the arrival of SAM-6 missiles in the Middle East, Israel had developed what is widely regarded as an impressive expertise in ECM technology, fostered by cooperative research and surveillance programs carried out with the United States. According to one observer familiar with Israeli capabilities, “they seem to have just about everything NATO has” in the way of ECM technology, thus suggesting that the 17-day war was a “pretty fair test” of Western anti-SAM measures.

If that is the case, countermeasure technology would seem to have come off second best. One reaction in the defense community may be a fresh new look at the attractions of “remotely piloted vehicles,” or RPV’s, as drone aircraft are called.

Unmanned, expendable drones, costing about \$300,000, have been used for combat reconnaissance in Vietnam, and both the Defense Department and Israel’s military have studied the possi-

bility of equipping RPV’s with bombs and television-guided missiles for “SAM suppression.” Israel, however, reportedly abandoned its RPV project some time ago, and interest in the Defense Department has been low key.

Adherents of the RPV see its attractions as both economic and humanitarian. Combatting a relatively cheap weapon (the SAM) with a manned fighter costing up to \$15 million makes little sense, they say. And besides, it saves pilots. “If you suffer 50 percent losses with an RPV, well, it doesn’t matter. You just launch twice as many,” notes Richard Garwin, a former Defense Department science adviser and a longtime advocate of drone technology. The military, however, has been reluctant to pursue RPV development, seemingly for much the same reason that it insists on building a new tank. “It’s tradition,” says an aide to Eagleton. “Tradition says that to be a general you have to command an armored division. To be a pilot you have to fly dogfights by the seat of your pants, not from some distant TV screen.”

Garwin agrees: “The problem is machismo, and I presume the Israelis have the same problem we do. Congress is going to have to force the military to accept this technology.”

Congress, of course, is bound by its own traditions. To the extent that it governs military technology at all, Congress has traditionally confined itself to trimming costs. The principal lesson of the latest Arab-Israeli war, however, would seem to be that the nature of military forces, not just the cost, deserves closer congressional attention.

—ROBERT GILLETTE

†Dale R. Tahtinen, “The Arab-Israeli Military Balance Today,” published by the American Enterprise Institute for Public Policy Research, Washington, D.C. 20036, 8 October 1973. \$2.