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Sources of Innovation I: Scarcity

Oddly enough, the first major Israeli macro-innovation was not anything the Israelis themselves designed or manufactured. They merely purchased the thing, but in the process, merely by specifying what components and ancillaries (“sub-systems”) they wanted or did not want, they came up with the “multi-role” jet fighter—now almost the only kind of fighter there is, but which was in fact invented by the IDF in the late 1950s, when its “air corps” was still insignificantly small and its resources miserably scant; it had not yet gained the prestige of its large-scale air victory of 1967.

The reason why it fell to the Israelis to invent the “multi-role” fighter, designed to be equally capable for both air-to-air combat against other fighters or bombers and for air-to-ground delivery of bombs, rockets, and anti-surface missiles, is that the leading air forces of the time—American, Soviet, British—had all come out of the Second World War with an array of aircraft highly specialized for different roles. Each category was much less capable in any other role, and they long persisted in these differentiations, sustained by ample Cold War budgets. All three air forces believed that a mix of light, medium, and heavy bombers was the best way of delivering bombloads efficiently over varied ranges against varied targets, and that air combat likewise required three different kinds of tactical aircraft: very fast “interceptors” that could quickly take off and fly up to engage incoming enemy bombers but with little or no ability to bomb or strafe targets on the ground; two-seater “night-fighters” equipped with radar, not yet available for single-seaters’ and “escort fighters” with enough range to follow and protect bomber formations. As bigger aircraft, they could also carry bombs themselves, thereby becoming “fighter-bombers,” but there was no special effort to develop them as such.

When Israel’s *Heyl Avir* “air corps” had its precarious start in the 1948-1949 War of Independence, the recent victory of Anglo-American airpower provided a fully proven model of what it should become, if only on a very small scale: a *balanced* air force, with interceptors, night fighters, and both light and heavy bombers, even if medium bombers were skipped.[[1]](#endnote-1) That model could scarcely be applied while Israel’s first and longest war was still underway because the United States and Britain refused to sell the Israelis any combat aircraft at all, forcing them to buy whatever they could find on sale. Right through the war, from May 15, 1948, until the 1949 armistice agreements, it was only by the strenuous efforts of mostly self-taught local mechanics, the priceless expertise of war-veteran volunteers from abroad, and the drastic cannibalization of a variegated inventory that flyable aircraft in twos and threes could be made ready for each day’s air operations, with surges that barely reached squadron size.

Nevertheless, the *Heyl Avir* did gradually gain air-combat superiority—ironically most clearly evident in accidental air combat on January 7, 1949, when RAF fighters on a reconnaissance patrol were engaged over the Sinai desert, with three British *Spitfires* and one *Tempest* shot down by Israeli *Spitfires* without loss, (There was no British retaliation because this intrusion in the fighting between Israel and Egypt had not been authorized by the British government).[[2]](#endnote-2)

Only after the 1949 armistice could Israeli airmen look up from the daily urgencies of combat to start building a proper air force, which would of course seek to emulate the Anglo-American model, for which bombers, fighter-bombers, fighter-interceptors, and radar-equipped night fighters would all be needed, albeit on a tiny scale, with one or at most two small squadrons of each type.

In a poor country of less than two million inhabitants, many of them penniless refugees from Europe, North Africa, and Iraq, there were no funds to pay for such ambitions. Yet by buying odd lots of discarded aircraft, something of a “balanced” force with both fighters and bombers was beginning to emerge by 1953, though with very low sortie rates for want of replacement parts, when a 32-year-old fighter pilot, Dan Tolkowsky, ex-RAF and with a clipped British accent, became chief of staff of the Israeli Army’s Air Corps.[[3]](#endnote-3)

The Air Corps of 1953 was scarcely more independent than the artillery, hence Tolkowsky could make no big decisions without the approval of his fellows on the General Staff, all infantry officers but for the equally beleaguered commander of the Sea Corps. That was a problem, because Tolkowsky flatly rejected the “balanced air force” consensus reaffirmed every day by the American, British, French, and Soviet air forces. He declared night-fighters obsolete because radars would soon equip all fighters. More controversially, he believed that the *Heyl Avir* should have neither bombers nor fighter-interceptors, but only a single tactical aircraft for all combat roles.

At the time, the United States was developing the *Delta* interceptors as well as the phenomenally fast F-104 *Starfighter,* with no provisions at all for ground attack or bombing. The British put two engines one on top of the other to accelerate their *Lightning* interceptor to medium altitudes, again with no provisions for bombing, and the French—the only ones who might sell aircraft to Israel—were also designing a fighter to quickly climb high enough to launch air-to-air missiles at Soviet bombers, with no cannon, bomb racks or underwing racks, all of which would slow down an interceptor.

It is to the credit of the infantry officers who dominated Israel’s General Staff that they were even willing to give a hearing to the young Tolkowsky as he contradicted the British air marshals and American generals who had so recently won the world war by arguing that air superiority could best be won by destroying enemy aircraft on the ground with an all-out surprise attack against their air bases, not by engaging in air combat piecemeal, in defensive attrition operations. That would require every combat aircraft available, and therefore all combat aircraft had to be able to carry some bombs—ruling out the interceptors prioritized by the major air forces.

In the ensuing debate, both sides tried to prove their case by citing the 1940 Battle of Britain. Tolkowsky argued that the Germans lost that contest for air superiority because they prematurely switched their offensive effort from the RAF airfields to the bombing of London. Had they kept bombing airfields, parked aircraft, personnel housing, ready rooms, and maintenance hangars, the Germans would have won. His opponents insisted that the great lesson of the Battle of Britain was that the defending RAF *Spitfires* and *Hurricanes*, rising fueled up to intercept aircraft that had to reach them from a distance, had worn down the Luftwaffe in a cumulative process—a much more reliable method, they argued, than a single all-out strike against enemy airfields that could go wrong for any number of reasons, from adverse weather to early detection that could turn a surprise attack into an enemy ambush. In the end Tolkowsky and his number two, Ezer Weizman, a much more exuberant ex-RAF fellow pilot, persuaded the General Staff to go along with their high-risk/high-payoff operational method, the all-out strike with almost nothing kept in reserve if things went wrong—the future Operation *Moked* of June 5, 1967.

Having won the debate, Tolkowsky and Weizman faced the hard task of actually building an air force whose combat squadrons would be equipped entirely with multi-role fighters that could both fight other aircraft and deliver decent bombloads. At the time, 1953-1954, that seemed impossible because the only aircraft that could do the job was the piston-engine P- 51 *Mustang,* an accidental wartime development that had unexpectedly proved to be exceptionally effective in both air-to-air and air-to-ground combat, but it was a fluke nobody was trying to emulate in the jet age.[[4]](#endnote-4)

That the United States was developing no such aircraft was of no immediate relevance because it was still US policy to sell no weapons at all to Israel, let alone combat aircraft, even as remarkably good Soviet *MiG* fighters started to reach Arab air forces. The British only offered jet interceptors, being especially wedded to the idea that bombing should be done by bombers—which, however, they refused to sell.[[5]](#endnote-5) That left the French, whose aircraft companies lacked the prestige of American and British manufacturers, but they were very eager to sell to anyone.

The Israelis duly purchased the subsonic first-generation *Ouragan* fighter, the almost-supersonic *Mystère*, and later the supersonic *Super-Mystère,* albeit in small numbers. The Israelis were very glad to have them, because the Soviet Union was supplying air forces with the remarkably fast and maneuverable Mikoyan and Gurevich fighters, culminating in the eternal MiG-21.[[6]](#endnote-6) This still left the *Heyl Avir* with the unfavorable arithmetic of too few aircraft with too-small bombloads for its ambitious “all-out” strike plans, because the French too preferred dedicated bombers to do their bombing and did not design their fighters to carry much ordnance in underwing racks, nor were their engines powerful enough to carry decent bombloads.[[7]](#endnote-7) By the time a possible solution emerged with the prototypes of the future French *Mirage III* fighter in 1958, Dan Tolkowsky had retired at the ripe old age of 37 (to lead Israel’s advance into technology as an investment banker) to be succeeded by the irrepressible 34-year-old Ezer Weizman, who long remained younger than his years.[[8]](#endnote-8)

It was during Weizman’s eight-year tenure that the Air Corps finally acquired the aircraft it needed: the delta-winged *Mirage IIICJ,* which—only because of Weizman’s persistence in forcing the designers to meet Israeli requirements—became the world’s first genuine “multi-role” fighter since the accidental *Mustang*, agile enough for air combat against the formidable *MiG-21* while also adequate for ground attack with its two 30mm cannon and a bombload that could exceed three metric tons.

Weizman’s problem when he took over in July 1958 was that the eventually very suitable *Mirage IIICJ* did not actually exist because the French air force, like its American and British counterparts, wanted an interceptor with an innovative liquid-propelled booster rocket to propel it to high altitude extra-fast, with air-to-air missiles instead of cannon and no bomb racks at all. Such an aircraft would have been useless for Tolkowsky’s grand air strike concept. What the French aircraft did have was a good engine that allowed a speed of Mach 2.2 to be reached in October 1958—a record for Europe. It was certainly fully up to date with its “area ruled” wasp-waist cross-section for supersonic flight, a good air intercept radar, all the needed avionics, and a drag chute to shorten the landing roll.[[9]](#endnote-9)

What ensued was an extended debate between absurdly ill-matched antagonists. The French manufacturer Dassault badly needed the Israeli order, because by dint of saving and scraping on everything else, including its already Spartan housing, uniforms, and food, the IDF could order 72 aircraft all at once, a big order for what was then still a small company. But Dassault’s managers and aviation engineers simply could not bring themselves to take seriously Weizman’s specifications: he seemed determined to drag their revolutionary Mirage back into the past by preferring bomb racks to their splendidly innovative liquid-fuel rocket booster, and by insisting on fitting old-fashioned 30mm cannon instead of relying on the ultra-modern air-to-air missiles just becoming available.

Initially the French were confident that older and wiser heads in Israel would overrule the 34-year-old pilot who wanted to spoil their aircraft. Only gradually did Dassault’s managers realize that the State of Israel had indeed delegated what could easily become a life-or-death decision to young Ezer Weizman, an unsettling discovery for men used to dealing with French four-star generals in their sixties, who, moreover, deferred to their expertise.[[10]](#endnote-10)

In the end Weizman won out because he had the raw power of any buyer, however ill advised, and more than his share of sheer effrontery, though it was only the sensational success of the 1967 air offensive, when the *Mirages* and older French aircraft were used to destroy some 400 Egyptian, Jordanian, Syrian, and Iraqi aircraft in some 50 hours of air attacks with cannons and only a few missiles, that finally vindicated the Tolkowsky-Weizman theory of how air wars should be fought and by what kind of aircraft. (Incidentally, the Dassault company earned a fortune, and their sales greatly increased around the world—though not to Israel, because the unsentimental Charles de Gaulle abruptly changed sides in June 1967, so that Israeli-specified, indeed co-designed, Mirage Vs were sold to Arab air forces, while all deliveries to Israel were halted.[[11]](#endnote-11))

In the aftermath, every air force wanted what became known in English as “multi-role” fighters, armed with cannons and not just missiles —thereby making the still very small Israeli air force a global innovation leader in tactical airpower, a role now reaffirmed by the *F-35*’s reliance on Israel-developed air-combat technology.[[12]](#endnote-12)

The US air chiefs soon accepted the validity of the new multi-role concept, but because their existing aircraft were all specialized—F-104 and F-106 as pure interceptors, while the heavy F-105 fighter-bomber lacked maneuverability for air combat, faring poorly against MiG-21s over Vietnam—the USAF was forced to acquire the Navy’s versatile F-4 *Phantom* to serve as its first multi-role fighter since the *Mustang,* retired long before. The humiliation was severe, and the next USAF fighter, the F-16—which would remain in production for decade—was inspired by the success of Ezer Weizman’s version of the Mirage III.

It was a remarkable sequence: because the structure of the IDF favored innovation, not least because its two-careers model kept even its generals young, and because its small air force could not hope to prevail without aircraft that did not yet exist, its young chief used his momentary commercial power to browbeat a European aircraft manufacturer into producing an aircraft that became the global model of what a tactical aircraft should be, even though the pre-1967 *Heyl Avir* was still an insignificant presence in world aviation.

1. *Heyl Avir,* “Air Corps” is now officially *Zro’a HaAvir VeHahalal,* “Air and Space Arm.” A “force” not a separate service, it still relies on IDF-wide support and remains subject to the IDF General Staff. [↑](#endnote-ref-1)
2. See the revealing account by ex-RAF Derek O’Connor at https://www.historynet.com/spitfire-vs-spitfire-aerial-combat-israels-war-independence.htm*.* [↑](#endnote-ref-2)
3. Tolkowsky served in the War of Independence, retired, and rejoined in 1951. He was Air Corps chief in command during the 1956 Sinai campaign. [↑](#endnote-ref-3)
4. Jeffrey L. Ethell, *Mustang: A Documentary History of the P-51* (London: Jane's Publishing, 1981). [↑](#endnote-ref-4)
5. Mikoyan and Gurevich, who exceeded other Soviet designers in utilizing captured German technology, surprised the US with their *MiG-15* (faster than the US *F-86* in Korea), then the *MiG-17*, followed by the radar-equipped *MiG 19* and then the globally successful *MiG-21.*  [↑](#endnote-ref-5)
6. It applied the best German swept-wing technology, with a Tumansky R-11 axial-flow engine derived from the German BMW 003, and remained in service for some 60 years. [↑](#endnote-ref-6)
7. The Sud-Ouest Aviation *Vautour II* light bomber; the *Heyl Avir* reluctantly purchased 31 by 1967 for want of anything better. [↑](#endnote-ref-7)
8. Weizman was a War of Independence air ace, IDF Deputy Chief of Staff in 1966, Minister of Defense in 1977-1980, and Israel’s president, 1996-2000*.*See Ezer Weizman, *On Eagles' Wings* (New York: Macmillan, 1977). [↑](#endnote-ref-8)
9. The *Atar 09B* afterburning turbojet with 13,200 lbf of thrust, another derivative of the German BMW 003. The DEFA 30mm cannon were likewise derived from the German Mauser. [↑](#endnote-ref-9)
10. Ze’ev Lakhish, &, Meir Amitai, A *Decade of Disquiet: Studies in the history of the IAF 1956-1967* (Tel Aviv: Ministry of Defense, 1995). (H) [↑](#endnote-ref-10)
11. Dassault never replicated the global success of the *Mirage III*. [↑](#endnote-ref-11)
12. The F-35 helmet-mounted display sub-system, developed in Israel and produced by a joint venture. [↑](#endnote-ref-12)