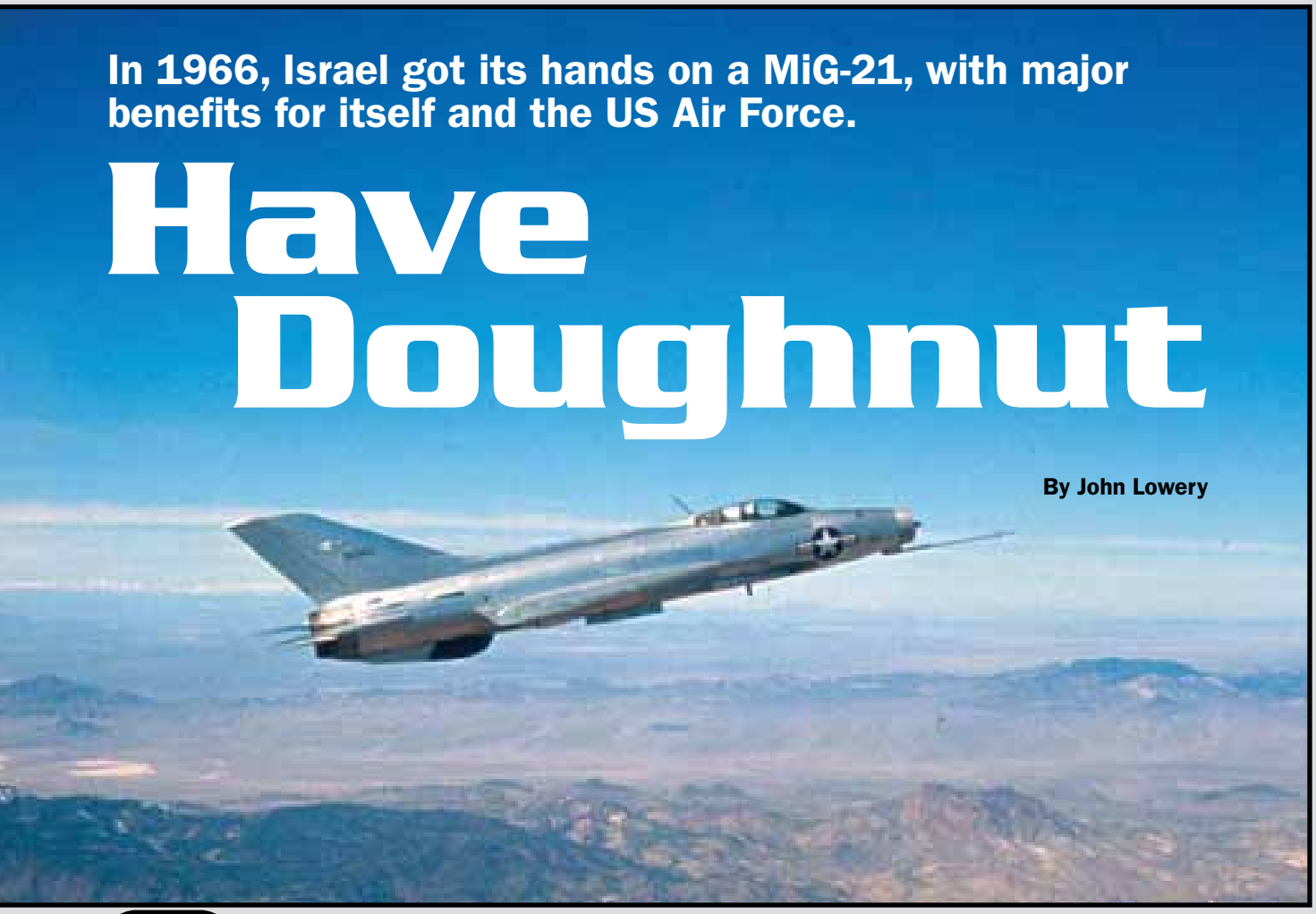
In 1966, Israel got its hands on a MiG-21, with major benefits for itself and the US Air Force.

Have Doughnut

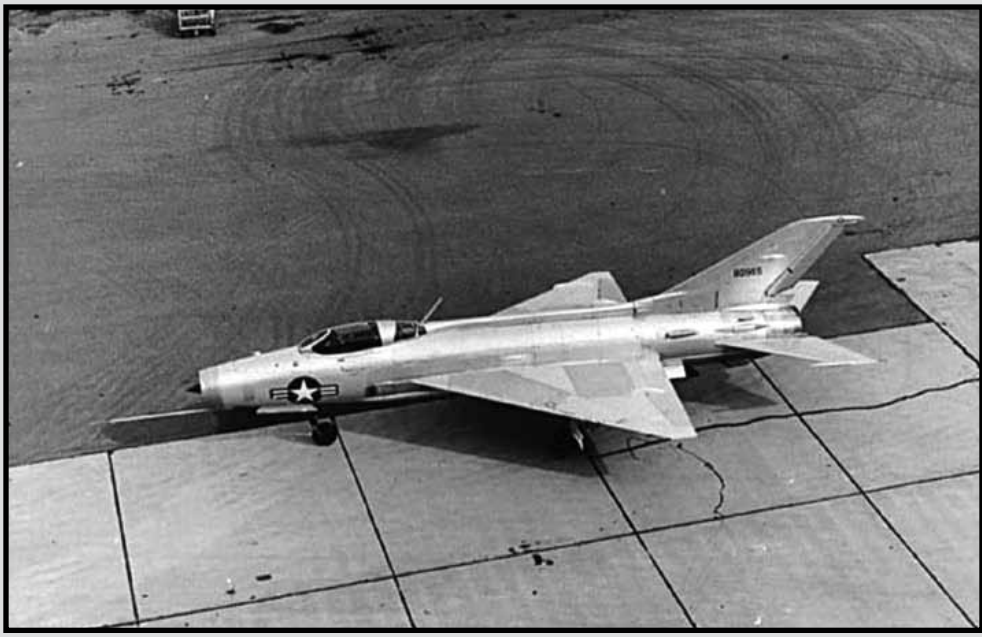
By John Lowery



On Aug. 16, 1966, Iraqi Air Force Capt. Munir Radfa defected to Israel in a MiG-21 jet fighter. The MiG-21 was, at the time, a state-of-the-art Soviet aircraft and the pride of Russia's aircraft industry. The defection, orchestrated by the Israeli government, soon gave both Israel and the United States access to intelligence from a front-line Soviet fighter that the two nations would face in battle in the coming years.

Code-named "Fishbed-E" by NATO, the Mach 2 fighter posed a serious threat to Israel's ability to maintain air superiority in that nation's dangerous and tense neighborhood. In the air order of battle, the Israelis faced down enemy air forces that included 18 Fishbeds in Syria, 10 in Iraq, and 34 in Egypt.

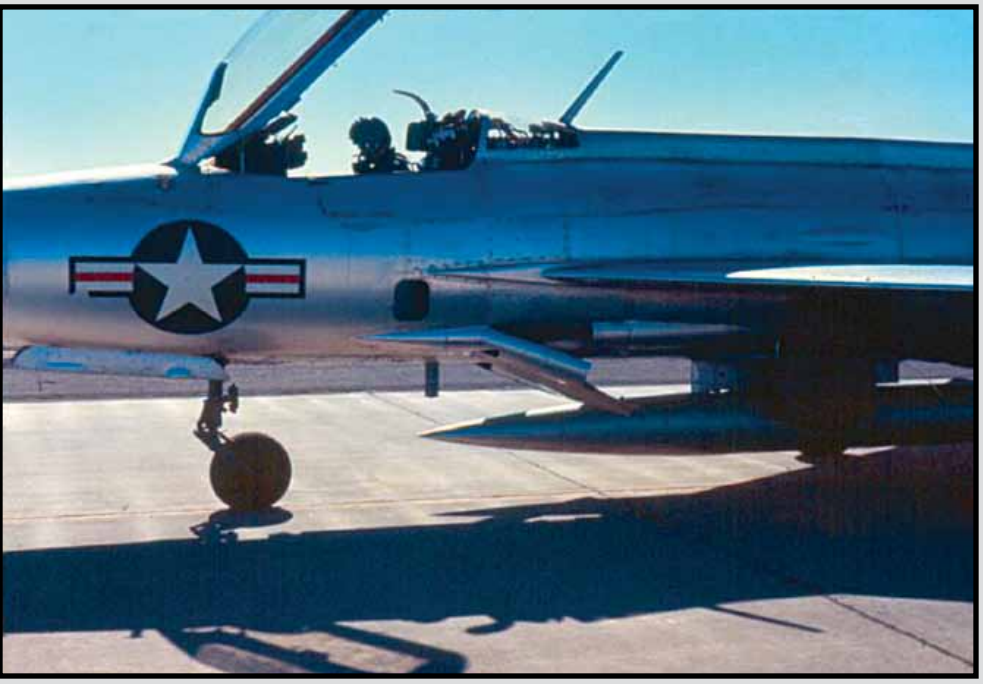
At the time, the Israeli Air Force had nothing comparable to the MiG-21—the IAF was equipped with slower French-made Vautours and Mirage IIIC fighters. A 20-year arms embargo imposed by the US Congress had denied Israel modern aircraft such as the Lockheed F-104 Starfighter and the newer McDonnell Aircraft F-4 Phantom.



Top: The MiG-21 demonstrates slow flight over the Nevada desert. Above: The aircraft at Groom Lake flight test center.

Following orders from then-Prime Minister Levi Eshkol, Israel's ultrasecret Mossad intelligence agency had orchestrated the Iraqi pilot's defection. Mossad officers reportedly cultivated Radfa's frustration on being passed over for promotion due to his Christian origins.

In addition, Mossad officers learned that—following completion of a US military training course—Radfa had become excited about life in the West.



A test pilot carefully performs a preflight check. Testers were tasked with evaluating the aircraft's effectiveness in comparison to US fighters.

On the morning of his fateful training-flight-turned-defection, Radfa's MiG was fitted with a 108-gallon auxiliary fuel tank. This ensured he would have adequate fuel for the 560-mile flight to Israel.

After climbing to 30,000 feet, Radfa departed Iraqi airspace with no problem, but over Jordan, he was intercepted by two Royal Jordanian Air Force Hawker Hunters which attempted to make radio contact.

Although they got no reply from Radfa, they allowed him to continue on, presumably because of the Iraqi insignia on his aircraft.

As prearranged, Radfa was met at the Israeli border by two IAF Mirage IIIs whose pilots escorted him to a safe landing.

With Radfa's assistance, Israeli test pilot Dani Shapira began a detailed evaluation of the MiG-21, according to a later account published in *Israel News.*

After testing in Israel, the aircraft was moved to the US government's secret Nevada airfield commonly known as Area 51 or Groom Lake. It was here—birthplace of the Mach 3-cruising SR-71 "Blackbird" and the stealthy F-117—that the US had the opportunity to put the MiG-21 through its paces.

Redesignated as the YF-110, the Fishbed's test and evaluation project was code-named Have Doughnut.

Because the MiG-21 was then doing battle in Vietnam, US analysts sought urgently to determine the MiG's performance, compared to select US aircraft, and to formulate tactics for both defensive and offensive maneuvering. The Have Doughnut test objectives were to evaluate the airplane's effectiveness as a day fighter-interceptor and its secondary role in ground attack.

What DIA Found

While its armament was adequate for an interceptor, US analysts found the Fishbed's gunsight deficient.

"The tracking index drifts off the bottom of the windscreen when tracking targets in excess of three Gs," reads a declassified report from the Defense Intelligence Agency. Typical of delta-wing aircraft, the airspeed bleed-off during high-G turns was excessive. This speed-bleed decreased the MiG's turn radius, however, and the G force could be sustained at slower speeds than comparable US fighters.

Obviously, in a turning fight, this gave the Fishbed a tactical advantage.

The DIA assessment identified several major aerodynamic limitations in the MiG-21. These included:

- Exceptionally heavy pitch force required above 685 mph.
- Severe buffeting below 15,000 feet when approaching 685 mph or a .98 indicated Mach number.
- Exceptionally slow engine acceleration from idle to full military power.
- Poor directional stability in turbulence.

The heavy pitch forces at high speed limited the pilot's ability to recover from a diving attack or maneuver while approaching and departing the target area. This was no doubt intended to prevent overstress problems during pull up from a target. However for a fighter-bomber it made "high pitch rates difficult or impossible to achieve."

Thus, the US analysts determined, recovery during dive-bombing, strafing, or air-to-ground rocket firing was problematic.

One of the most significant findings was the discovery that below 15,000 feet, the aircraft could not go supersonic. At low altitude, the severe buffeting simply prevented it from exceeding airspeeds of 685 mph or .98 Mach. This airspeed limitation was a major exploitable design flaw.

Later in the Vietnam War, US F-105Ds and F-4s typically approached an aerial target at 633 mph then departed well in excess of 702 mph—often supersonic.

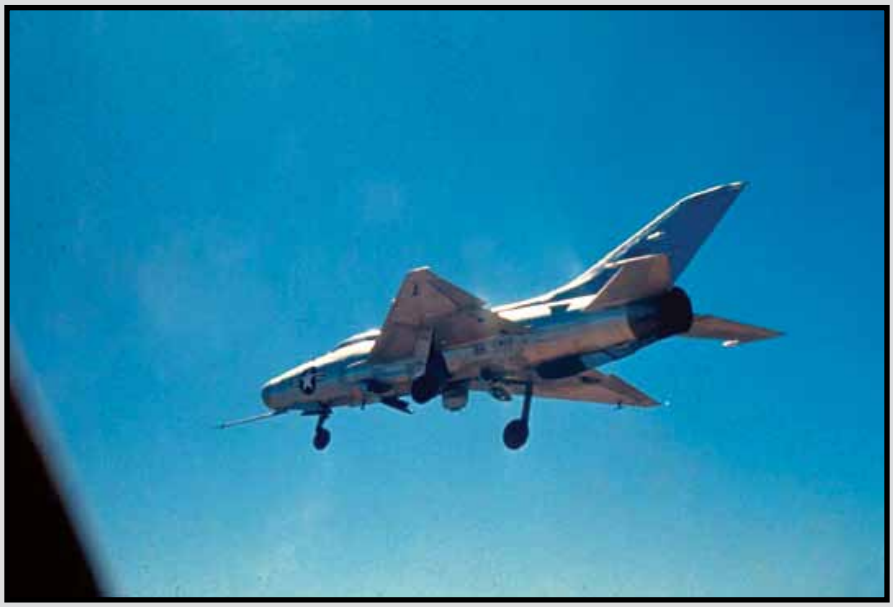
The exceptionally slow engine acceleration was a characteristic that had been corrected in American jet engines in the 1950s. The MiG-21 engine was technologically behind its US counterparts, so spool-up from idle to full military power required 14 seconds, with a tendency to hang up in the process. This could lead to hot compressor stall or engine overtemperature.

Another exploitable discovery: The Fishbed's afterburner marked the aircraft's location by producing white puffs of unburned fuel when it was engaged or disengaged. This was small consolation, however, because the MiG pilot's ability to visually acquire his own aerial targets was similarly aided by the smoke trail left by the engines of all contemporary American jet fighters.

A special limitation for the day-visual conditions fighter-interceptor was the front and rear visibility. Forward visibility through the gunsight was restricted by the combination of a bulletproof glass slab and the windscreen.

Visibility in the 50-degree tailcone, meanwhile, was handicapped by the protective seat flap over the pilot's head and the narrow design of the ship's canopy and fuselage structure.

For the point interceptor role, the MiG-21's basic weapons included a 30 mm cannon loaded with 60 rounds of ammunition and two AA-2 "Atoll" heat-seeking missiles.



Flaps and gear down, the MiG comes in for a landing during tests in Nevada.

The Soviet-built Atoll missiles were copies of the US-made AIM-9 Sidewinder. Communist forces had obtained a Sidewinder when a Nationalist Chinese F-86F pilot fired one at a MiG-17. The AIM-9 failed to explode—but lodged in the MiG-17's fuselage. Using reverse engineering, the Sidewinder was copied by the USSR and became the standard Soviet air-to-air missile for the MiG-21 and other fighters.

Unaware Victims

In the air-to-ground role, the MiG-21 had the 30 mm cannon and could carry two pods containing a total of 32 57 mm folding-fin aerial rockets.

The cannon proved potentially lethal against tanks. When strafing, however, DIA analysts found there was considerable pipper (gunsight) jitter during firing. The aircraft's high speed-low altitude stability in rough air was also deemed unsatisfactory.

It is noteworthy that by the time the US became heavily engaged in the Vietnam War, the Soviet sponsors and North Vietnamese Air Force commanders very effectively planned around the Fishbed's limitations. They never committed their fighters unless there was a good chance of success and subsequent escape. In fact, in 80 percent of the North Vietnamese Air Force kills, the victims were unaware they were under attack.

As USAF's "Red Baron" study of aerial warfare in Vietnam determined, before the US obtained effective radar coverage of North Vietnam, the winner of an air engagement usually initiated the combat from a position of nearly unbeatable advantage.

Typically, DIA found, the Fishbeds were "vectored into the rear hemisphere for a high-speed, single-pass attack," generally from a cross-course intercept.

For example, when US fighters were bombing targets north of Hanoi, such as the Paul Doumer Bridge, enemy MiG-21s would be vectored by ground control intercept radar from Chinese airspace to a position behind the Phantoms.

As the F-4s pulled up from their target, the MiGs would launch Atoll missiles and zoom back to political sanctuary in China. Air forces called these attacks "blow-throughs."

At high altitude the Fishbed's small size made it very difficult to visually acquire or keep in sight while maneuvering. In a frontal or trailing attack, its slight silhouette also made it difficult to acquire on radar.

Seriously complicating air superiority efforts was the fact that North Vietnamese airfields, parked aircraft, command centers, and main radar installations were forbidden targets.

During the late 1960s, thanks to this combination of technical strengths, tactical advantages, and political pro-

The aircraft was kept inside a hangar much of the time, the better to avoid Soviet reconnaissance satellites.

Maj. Fred Cuthill, a test pilot, straps into the Have Doughnut aircraft's cockpit. Assisting is Maj. Jerry Larsen.

tections, MiG-21s shot down more American F-4s and F-105s than the US was able to kill in return.

Despite its sleek shape, the MiG-21's performance at high altitude was found inferior to the F-4, F-105D, and F-104. The Fishbed's top speed was Mach 2.05, whereas the F-4 and F-105D were both capable of about Mach 2.14.

The F-104 Starfighter was limited only by a rise in skin temperature that took place at about Mach 2.21.

Despite being heavier, both the F-105D and F-4 were found basically superior to the MiG-21. Maintaining a high airspeed and avoiding turning engagements was the key to US success, although the F-4 was also aerodynamically superior in a vertical contest.

The Have Doughnut tests showed the F-4 had the capability "to control an engagement below 15,000 feet by exploiting the MiG-21 airspeed limitation and airspeed bleed-off characteristic at high G." In a visual encounter, the recommendation was to get behind the MiG and operate "in the vertical" during air combat maneuvering.

The Soviet fighter's slow engine spool-up was a special handicap. The 14-second acceleration from idle to full power made formation flying difficult for the MiG pilots, and formation maneuvers required constant use of speed brakes and rapid throttle movement.

Using full military power up to about 30,000 feet, the F-4 accelerated much faster than the MiG-21. Below 15,000 feet, the advantage was even greater as the F-4 could easily accelerate to above the Fishbed's subsonic top speed. In the zoom maneuver—from low altitude to 30,000 feet with full military power—the Phantom had a significant advantage. In afterburner, the F-4 held a slight advantage in a zoom to 20,000 feet.

In instantaneous hard (high-G) turns that the MiG-21's delta wing allowed a tight turning radius superior to all the major US fighters in Vietnam. Have Doughnut's DIA analysts therefore warned against participating in "prolonged maneuvering engagements," aka dogfighting. Analysts recommended that pilots press an attack only if they had an initial rear-hemisphere advantage. In particular, F-105 Thunderchief pilots were advised to emulate the MiG-21's hit-and-run tactics.

The Results

This advice was confirmed by the actual combat results in the skies over North Vietnam. "The American fighters flew faster than ours: We had to force them to turn," North Vietnamese MiG ace Luu Huy Chao told Ralph F. Wetterhahn, a former F-4 pilot. When US fighters got sucked into turning engagements, their superior speed "did not matter," he said. "We just made use of an appropriate angle to cut their [circle], and our guns became effective."

The F-105D proved surprisingly effective against the Fishbed-E. The Thunderchief could easily exceed the MiG's top speeds, but maintaining high speed at low altitude was the key to survival. "Thud" pilots regularly departed heavily defended targets at supersonic speed.

The final USAF MiG kill of the Vietnam War occurred Jan. 8, 1973. The engagement took place in Route Pack 3, 80 miles southwest of Hanoi—after the cessation of the Christmas bombing in the north under Linebacker II. Capt. Paul D. Howman and weapons system officer 1st Lt. Lawrence W. Kullman were leading a predawn MiG CAP, protecting B-52s bombing surface-to-air missile sites around Vinh.

Red Crown, the Navy's shipborne radar control platform, identified a MiG-21 65 miles to the northeast, but the MiG came off the radar scope. Howman found it again when he spotted the flame of the Fishbed's afterburner and was able to maneuver behind the MiG.

The engagement ended the way the Have Doughnut analysts had suggested years before: "By orienting an attack towards the Fishbed-E's blind [rear] cone in lag pursuit-type maneuvering, ... the F-4 can defeat the MiG-21."

USAF finished the war Jan. 28, 1973 with a two-to-one overall kill-loss ratio. The Air Force had downed 137 MiGs, with 65 aircraft (including bombers) lost to MiGs.

The North Vietnamese pilots were carefully trained and competent warriors. Their top ace, Nguyen Van Coc, was credited with seven aircraft and two Firebee unmanned aerial vehicles destroyed. His aircraft victories included two Air Force F-4s, one Navy F-4B, two "Wild Weasel" F-105Fs, one F-105D, and the only F-102A kill of the war.

Enemy command and control was excellent, too. North Vietnamese interceptors were expertly guided by their ground controllers, who set up the MiGs perfectly to ambush the American fighters. MiG interceptors used their advantages in ambush and hit-and-run tactics to great effect.

Despite facing worthy opponents and severe political constraints throughout the war, Air Force fighter crews ended the war with a positive kill-loss ratio. The bulk of the credit for this goes to USAF's airmen, but the knowledge gleaned by testing a front-line MiG-21 borrowed from Israel surely contributed to the success. ■

John Lowery is a veteran Air Force fighter pilot and freelance writer. He is author of five books on aircraft performance and aviation safety. His most recent aricle for Air Force *Magazine, "Zoom Climb," appeared in the February 2005 issue.*

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