The Pentagon's Flying Saucer Problem

The weapon system that could have made the enemy die laughing

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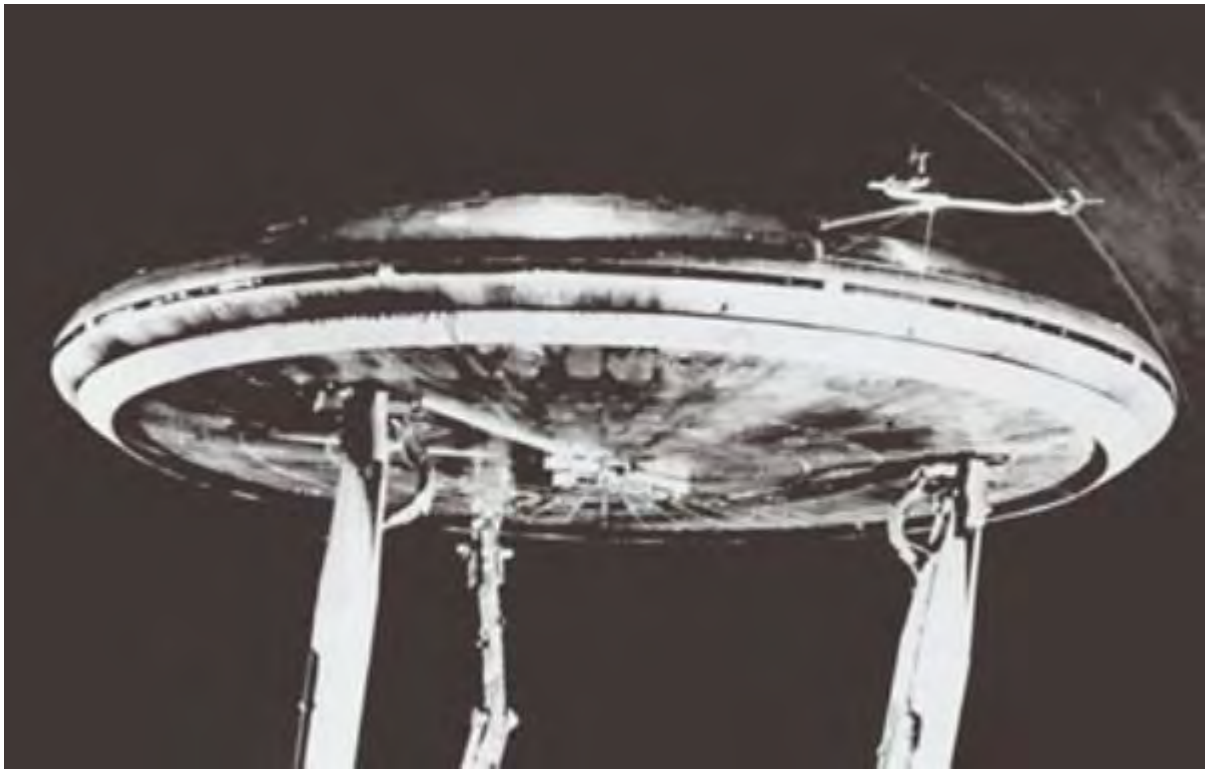

Tests at a NASA wind tunnel showed that the Avrocar would not be stable at high speeds. (U.S. Army Transportation Museum, Fort Eustis, Virginia)

Bearing both U.S. Air Force and U.S. Army markings, the waist-high disc was introduced to the press by Avro Canada, its builder, in a promotional film that showed it skimming a few feet above fields, grass and dirt swirling around it. “This unconventional circular vehicle, known as the Avrocar, rises vertically and travels over the ground on a cushion of air,” intoned the film’s narrator. “It will be able to operate without prepared bases and travel over terrain beyond the present capability of wheeled or tracked vehicles.”

Here, then, was a machine that promised to be as useful in the cold war as today’s unmanned aerial vehicles are in Afghanistan—and one based on the same idea: a platform that could either hover or fly, depending on the mission. The saucer was touted as capable of watching the enemy or darting off to intercept his aircraft and shoot it down.

But what the vehicle actually did could in no way be called “flying,” says Fred Drinkwater. He should know; he tried to fly it. “This one violated every aerodynamic stability and control concept imaginable,” the retired test pilot recalls.

Disappointing performance eventually doomed the military’s interest in the disc, but some of the technologies developed for the craft survive today in more successful vehicles. One such

offspring, a small aerial robot called the Moller Aerobot, has been given the job of inspecting bridges for the California Department of Transportation.

And the public continues to be fascinated with both the concept and its history. Recently, Canadian librarian Bill Zuk delved into the details of the somewhat mysterious program, eventually authoring the exhaustive history Avrocar: Canada's Flying Saucer. MidCanada Productions and Discovery Canada are preparing a documentary on the project—"Avrocar: Saucer Secrets from the Past"—for broadcast sometime this spring.

Conceived in 1952 by a talented British engineer named John Carver Meadows Frost, the concept was initially funded by Avro Canada. However, when development costs were projected to exceed $200 million (in 1952 dollars), the company backed off.

Then a customer with deep pockets stepped up: the U.S. Air Force. It was the middle of the cold war, and the Air Force liked Avro Canada's vision of the saucer one day soaring to 100,000 feet, dashing off at 1,500 mph to bring down a Russian bomber, and returning to a vertical landing. In 1954 the service agreed to bankroll feasibility studies for variations on Frost's design.

In response, Frost's team, named the Special Projects Group, dreamed up a series of ever-wilder supersonic vertical-takeoff-and-landing flying saucers. But experiments with test models repeatedly failed. Avro needed to come up with something convincing, a proof-of-concept vehicle that would inspire the Air Force to increase funding.

Meanwhile, the U.S. Army had emerged from the Korean War craving an all-purpose flying jeep, a platform that could hover and fly close to the ground for reconnaissance, light battlefield resupply, pursuit, or harassment. In 1957, Avro, learning of this interest, drew up a proposal and presented it to both the Army and the Air Force: The company would develop a saucer-shaped flying machine that could maneuver as precisely as a helicopter but, with its more streamlined shape, achieve much greater speeds.

The following year, Avro inked a contract with both the Army and the Air Force in which it agreed to build two identical prototypes. The specifications: maximum weight, 5,650 pounds; powerplant, three Continental J69 engines producing 927 pounds of thrust each; maximum speed, 300 mph; range, 80 miles; and most importantly, the ability to hover out of ground effect—the phenomenon in which lift is assisted by the cushion of air under the craft. Officially designated VZ-9-AV, the design was dubbed the Avrocar.

While the Special Projects Group got busy converting the specs into blueprints, one of the members had the foresight to buy up lakefront property in Ontario's cottage country, two hours to the north. Now retired, Don Whittley spends the warmer six months of the year there. Today, he and I are having coffee and enjoying the view of the shimmering lake as he looks back on his days as an aerodynamicist assigned to work on the Avrocar.

At first, Whittley recalls, the team could not work up much enthusiasm for the vehicle. Frost had initially envisioned a hypersonic craft that could touch the edge of space, but the Army/Air Force incarnation was decidely less dazzling: "The Avrocar was really a fall-back

program," he says. But, the team figured, "at least now we finally had an opportunity for some full-scale testing."

The group brainstormed into the evenings. First it decided that giving the vehicle a disc shape, rather than the spade shape Frost had first proposed, would improve its ability to both hover and maneuver. With a circular shape, "you could send air out in any direction," says Whittley. But exactly how would you harness the jets' blasts to do this? The team settled on the idea of a controllable flap around the entire circumference of the saucer—the members called it a focusing ring.

The next question was how to direct the three engines' thrust evenly around the ring. The team devised an internal ducting network that carried the exhaust through a 90-degree turn and then took it out to the circumference of the saucer (see diagram, opposite).

Calculations showed that the jet exhaust could also be harnessed to drive a separate rotor in order to generate more thrust. The jets were therefore arranged so their exhaust was directed at the tips of a five-foot-diameter rotor mounted horizontally in the saucer's center. Thus driven at high rpm, the rotor sucked air from above. The ducting network carried that air, along with the jet exhaust, outward. For hovering, the pilot would use the stick to actuate the focusing ring, which directed the exhaust evenly downward. For transitioning from hover to forward flight, the team designed two control surfaces: "transition doors" redirected the flow in the aft third of the saucer from downward to rearward, and control vanes would then deflect it up or down for pitch or roll control.

But the engineers predicted that as the Avrocar transitioned off its cushy ground bubble and picked up speed, it would be unstable in pitch. The pilot would be continually jockeying the stick back and forth to prevent it from stalling nose-up or pitching nose-down into the ground. In most conventional airplanes, the horizontal stabilizer looks after that. The Avrocar had no tail, so the team designed an ingenious mechanical connection that automatically deflected the control vanes up or down, simulating the effect of a tail. Slight horizontal motions in the spinning rotor would automatically control those vanes, so the pilot could occupy himself watching for the enemy.

So far, so good. After the rollout fanfare, Avrocar No. 1 was mounted in a test rig to put theory to practice. Engines were fired up. But as the throttles were advanced to full power, elation fizzled. The J69s' combined thrust, 2,700-plus pounds of it, wasn't producing the effect predicted.

The engineers deduced the problem: The air sucked in from the rotor was cold and the jet pipe exhaust was hot, and when the two were mixed, the resulting flow was turbulent and would not stick to the duct's inside walls. The result: 30 percent of the thrust was lost.

The team tried various tricks, but nothing budged the Avrocar out of ground effect. Though the Army had firmly required that achievement, the company "decided to carry on and fly the Avrocar at a reduced thrust level in the ground cushion, and modify the duct at a later date to pick up the missing thrust," Frost later wrote.

The team members pressed on toward a first flight. At least they'd have some kind of milestone to crow about. Avrocar No. 2 was chosen for the attempt. To prevent another surprise, the team used three stout cables to tether the saucer to within a few feet of the ground.

In September 1959, company test pilot "Spud" Potocki climbed in and lifted off for the first time. He spent the next six weeks feeling the Avrocar out on its leashes. By early December he was ready to throw off the tethers.

From a hover, he eased the stick forward. Canopy off (in case a quick exit was called for) and engines screaming, the Avrocar skittered over the tarmac, blasting dust and debris, rocking and dipping like a Frisbee in slow motion. It was an amusing spectacle, but not terribly impressive. Potocki could not get the saucer to exceed 30 mph, or to rise up more than three feet into the air and off its ground cushion.

The team faced a Catch-22. Avro could ask for more funds to cover a pricy redesign of the ducts, which might help the saucer lift out of the ground effect. But the effort would be wasted if the company couldn't demonstrate stability. And how could the engineers determine stability if they couldn't get the vehicle out of ground effect?

The solution turned out to reside with NASA. The Air Force had the Avrocar brought to the agency's Ames center in northern California for testing in the facility's 40- by 80-foot wind tunnel. To see how stable the craft would be in free flight, NASA set it up on 12-foot legs, like a creature from The War of the Worlds, and equipped it with movement-sensing instruments.

The testers cranked up the wind to simulate airspeeds over 30 mph, and stability did in fact deteriorate. To see if a pilot could keep the craft level at such speeds, the engineers sent NASA test pilot Fred Drinkwater to Toronto to try flying the other Avrocar.

Today, relaxing on his deck in California and eyeing the hummingbirds among the hibiscus, Drinkwater recalls inheriting the flying saucer from his predecessor: "I met Spud, he briefed me, and within an hour I was flying —hate to use that word—first tethered, then a free flight."

Drinkwater says the saucer wasn't difficult to operate. "To lift off you just added full power. It hovered easily." Then he tried to gather enough speed to escape the ground bubble. "Desmond Earl [Avro Canada's chief aerodynamicist] insisted you could get out of ground effect by charging forward and suddenly pulling up," he recalls. "But after repeated tries, I never could get it to do that. It just kept going like a wobbly saucer."

I ask if the wobbling could have been caused by PIOs—pilot-induced oscillations—a phenomenon in which the pilot's attempts to correct pitching motions actually increase their amplitude, rather than diminish them. Drinkwater laughs. "You couldn't get it to PIO," he says. "It wasn't that responsive."

Avro tried yet another angle: getting a pilot with no helicopter or VTOL familiarity—one who could approach the flying without bringing potentially counterproductive habits to bear. Avro test pilot Peter Cope strapped in and tried. Flying it four times, he had no more luck than the previous two pilots. "It was a very dirty thing to fly," he recalls today from his Bellevue,

Washington home. “The canopy would ice over, so I had to fly it with an open cockpit.” As the saucer flew past at 30 mph, it churned up ice and water from puddles on the tarmac, drenching Cope in spray. “You could hardly see anything,” he says.

His attempts did, however, succeed in entertaining the passengers of Viscount turboprops passing by on Malton Airport’s nearby taxiways. “I could see all their faces pressed to the windows,” he says.

Over the course of 10 years, Frost’s dream had shrunk from a saucer tearing off at 1,500 mph and 100,000 feet to one chugging along at 30 mph and three feet. In December 1961, having spent a total of $10 million on the program, the Pentagon canceled it.

But as the Avrocars sat around attracting little more than dust, their legacy lived on. In 1961, when the saucer was turning heads at Malton Airport, a 24-year-old named Paul Moller was working at Canada’s Defence Research Board; because he had a security clearance, “I was therefore able to study the Avrocar in detail,” he recalls. “I immediately committed to a design of my own.” At the University of California at Davis in 1966, he built and flew a one-seat VTOL saucer. Since then, he has produced ever-more-complex VTOL vehicles. Today, his company, Moller International, offers the Aerobot and the M400 Skycar, “the first and only feasible, personally affordable, personal VTOL vehicle,” in his words.

Moller says that he has learned important lessons from the Avrocar. He believes the design was doomed at least in part by the 90-degree turn the exhaust had to make—a turn that caused the exhaust to detach from the duct’s walls and therefore lose thrust. In his Skycar, no such turns are necessary. The propellers are in pods, which can be tilted almost vertically to achieve hover.

Avrocar No. 2 is now being restored for an indoor display at the U.S. Army Transportation Museum at Fort Eustis, Virginia. The other one is at the National Air and Space Museum’s Garber facility in Suitland, Maryland, awaiting a rebuild and a nicer home at the Museum’s new complex in northern Virginia, currently under construction.

So despite test pilot Fred Drinkwater’s tales of disappointing performance, the Avrocars still made it into aviation’s halls of fame. And even if, in his estimation, the saucers didn’t really “fly,” he has to admit: “The whole idea sounded really great.”