CANADA'S SUPERSONIC FIGHTER FIASCO

A nation pinned its aeronautical future on a supersonic dream machine—but its premature cancellation created a nightmare.

By Rich Thistle

Cool sunlight filtered through a high layer of early spring clouds. Personnel stood at 14 camera stations on and off the airfield at Toronto's Malton Airport—now Pearson International. Their equipment was double-checked and ready, prepared to record Canadian aviation history. Nine thousand aviation workers held their collective breath. It was 9:49 a.m. on March 25, 1958.

Just moments before, A.V. Roe (Avro) Canada Ltd.'s chief development pilot Jan ("Zura") Zurakowski, a former Supermarine Spitfire pilot, had completed his inspection of a brand-new supersonic interceptor waiting on the tarmac. He climbed an unusually tall boarding ladder, eased himself through the open clamshell canopy and settled into the cockpit of the world's most advanced aircraft. A ground crewman tightened the pilot's straps and gave him a final pat on the shoulder, then climbed down and removed the access ladder.

Zura now was alone, faced with a tremendous responsibility. On this day, the plans, hopes and dreams of Canada's developing aircraft industry would be riding with him. Tens of thousands of parts, five miles of cable, hundreds of hydraulic and electronic components, servos and microswitches would have to function almost perfectly. Most of these had been purpose-designed for this aircraft, and all represented the cutting edge of aviation research and technology. And most of that technology was well beyond the pilot's direct control.

Zura completed engine start-up, acquired flight clearance and taxied out to hold at the end of Malton's newly extended 11,050-foot runway No. 32. Once final checks were completed, the aircraft moved onto the runway and began its takeoff roll.

Approaching from above and behind, flaps down and parallel to the takeoff runway, were two Royal Canadian Air Force (RCAF) chase aircraft. An Avro Canada CF-100 Canuck flew on the right, and on the left was a single-seat North American F-86 Sabre. Ahead of and below them, the big, white, delta-wing interceptor responded effortlessly to the throttle, and the pilot lifted its nose wheel. The main gear left the ground, and Canada officially entered the era of supersonic flight.

Avro's sleek new CF-105 Arrow rose gracefully at a controlled, conservative speed and rate of climb. A routine radio check from the Toronto tower laconically marked the historic event, "Avro 201 off at 9:51 a.m. and cleared to company tower." The 9,000 Avro workers who had gathered on the tarmac

An Avro Canada CF-105 Arrow takes to the air for the first time, in Dream Machine, *by Rich Thistle (Rich Thistle/Gallery 164, Stratford, Ontario).*

to watch their creation take to the air breathed a collective sign of relief and began happily congratulating each other.

Zura put the Arrow through a set of mild maneuvers for the next half hour. He checked control responses, engine performance, undercarriage and air-brake operation and aircraft handling at speeds up to 250 knots and at low speed in landing configuration. The automatic flight-control system was tested in normal and emergency modes. The two chase planes stayed close, their pilots keeping an eye on the test maneuvers.

The test pilot later recalled that the Arrow's flying characteristics were similar to those of other delta-wings, such as the British Gloster Javelin and the American Convair F-102, but the Arrow had a more positive response to control movement. Coming down in a fairly tight circuit, the Arrow—speed brakes extended—made its landing approach at 180 knots and touched down at 160. The drag chute blossomed, slowing the aircraft.

The Arrow came to a stop on the apron in front of the Avro plant five minutes later. The first flight was logged as 35 minutes. Zura climbed down the boarding ladder and was immediately hoisted onto the shoulders of the jubilant Avro workers. All smiles for the camera were genuine. The dream machine had tried its wings, and a Canadian aviation legend had been born.

The flight had been almost flawless. Other than two microswitches that had failed to function, the first-flight snag sheet was clean. The engineering department had done its job well, as had the assembly line. The pilot's only complaint was that there was no clock in the cockpit.

At the end of World War II, Canadian thinking was focused on reducing national military forces to a bare minimum—just as it had after World War I. Canada returned to a basic posture of defense behind some of the world's most vast, unpopulated and difficult-to-defend frontiers.

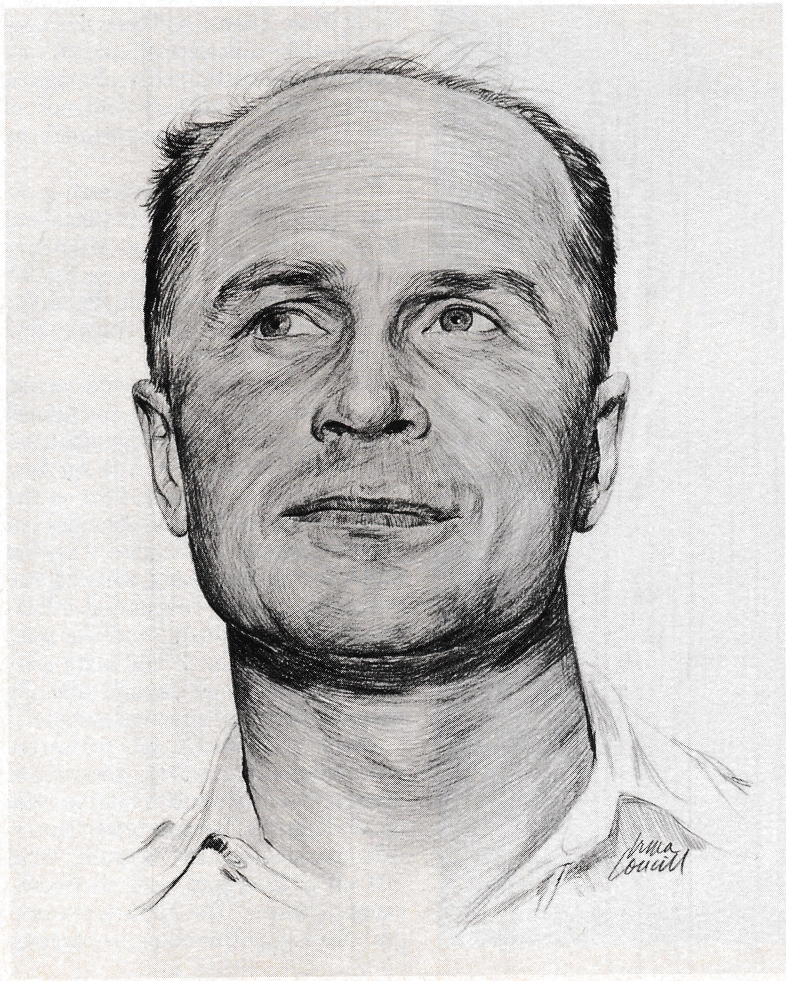
The chief perceived political, economic and military threat was the giant Soviet Union, which lay just beyond the largely undefended stretches of Canada's far north. By 1950, most Canadians assumed that the Soviet Union's aviation industry was up to speed, and that it would be well able to launch a massive conventional and nuclear airstrike against populated areas of North America across the top of the world.

Growing Cold War tensions prompted Canada to search for a replacement for its workmanlike subsonic Canadian-designed and -built Avro CF-100 Canuck interceptor in 1952. The new airplane would have to be capable of operations from widely dispersed bases over vast, rugged terrain, day or night. It would fly in all weather, from near tropical conditions to northern arctic extremes. Furthermore, it would have to possess an automatic fire-control system and state-of-the-art weapons of high efficiency and potency. And the first-pass kill rate would have to be maximized at the exceptionally high closing speeds that would be involved in the head-on interception of supersonic bombers.

A search of Western manufacturers turned up no existing or developmental aircraft that would fulfill the Canadian requirements. Hence the decision was made to develop another all-Canadian interceptor.

Avro began design studies in the spring of 1953 for the most efficient aircraft to meet the Canadian specifications, which included a supersonic combat radius of 200 nautical miles, a combat ceiling of not less than 60,000 feet, a maximum speed at altitude of Mach 2, a climb rate that would allow the airplane to reach an altitude of 50,000 feet in no more than six minutes, an internal armament package, two engines and room for two crew members. Also required was a maneuverability of 2 Gs at Mach 1.5 at 50,000 feet without loss of speed or altitude. Aircraft manufacturers find it difficult to meet that last requirement even today.

James C. Floyd, Avro vice-president and director of engineering, led the design team. The preliminary design for the aircraft was completed by the summer of 1954, under project No. CF-105. The resulting aircraft was, to say the least, unconventional. The RCAF required a two-seat



CANADA'S AVIATION HALL OF FAME, COURTESY OF IRMA COUCILL

Test pilot Jan Zurakowski, portrayed by Irma Coucill, had flown PZL P-11c fighters for his native Poland in 1939 and went on to fly Supermarine Spitfires before going supersonic in the cockpit of the CF-105 on March 25, 1958.

design to accommodate a weapons control officer, who could press home an attack even in the event of an automatic fire-control system failure. To handle the large weapons payload required and the huge amounts of fuel necessary for long-range operations, the plane would have to be big—as long as a World War II Avro Lancaster bomber—and two potent engines would be required to power an aircraft of such size.

The tailless, high-delta configuration was the best compromise between a thin wing section, which could offer excellent transonic and supersonic flight characteristics, and a thicker wing-root section to accommodate the landing gear and required fuel capacity. The high-delta configuration also offered easy serviceability and good structural efficiency, allowing for simple engine installation and easy modifications to the engine and armament without affecting the basic wing structure. Fortunately, considerable delta-wing flight experience and data were available from the British parent company, Avro Manchester, which had been testing the 707 delta research aircraft prior to the design of the Vulcan tailless delta-wing bomber.

The Canadian Department of Defense Production originally had issued a design contract for two prototype CF-105s from Avro, but shortly thereafter—because of the project's urgency—a decision was made to skip the prototype stage altogether, and the order was revised. Avro was to go directly to production with several preproduction aircraft.

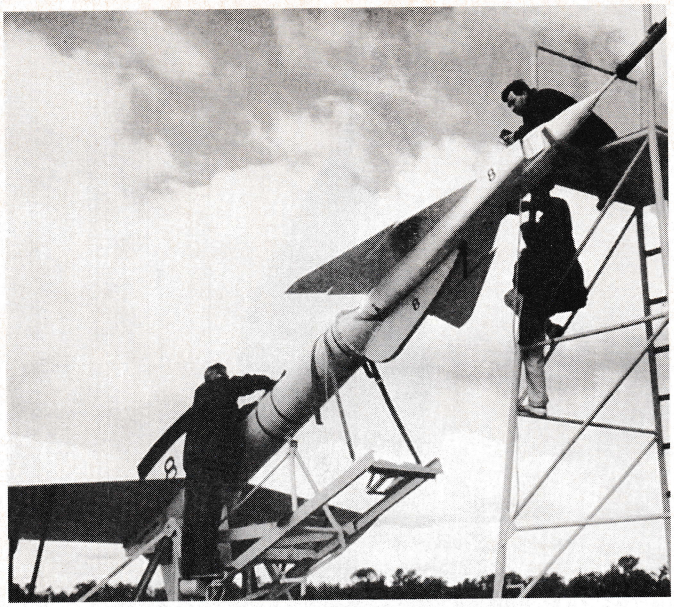
This approach placed considerable pressure on the design team, and a very comprehensive testing program became an obvious necessity. Totally new testing procedures would be used in the Arrow program. Wind-tunnel testing became a priority. Through the test program, the external shape of the Arrow's fuselage was refined by application of the Area Rule, developed in the United States by Richard Whitcomb of the National Advisory Committee for Aeronautics (NACA, the forerunner of the National Aeronautics and Space Administration), to give the new aircraft the so-called Coke Bottle effect in order to reduce supersonic drag.

Models also would play another vital design role. Launched to attain supersonic speeds on Nike rocket boosters, 11 free-flight models were fired between December 1954 and January 1957, and important data on drag and directional stability were collected via telemetric technology. Two firings were conducted at the NACA facility at Langley Field, Va., to take advantage of that facility's state-of-the-art tracking and telemetry equipment. Considerable stress testing was also carried out on models. All told, more than 17 carefully crafted scale models were used in the extensive design process.

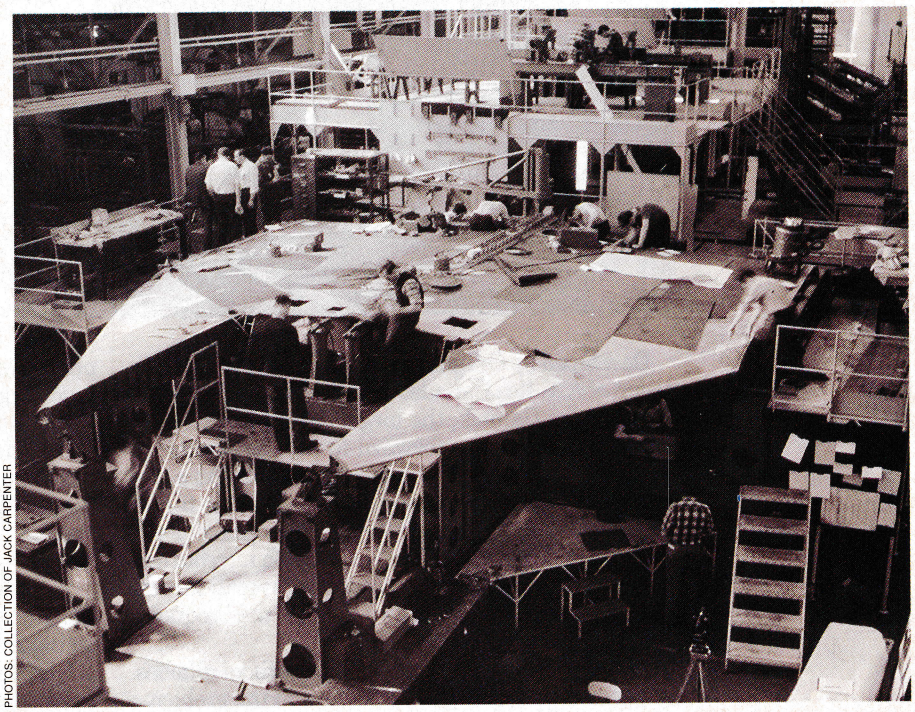
Before production began, a full-size metal mock-up was fabricated to explore ways of facilitating actual production methods. A full-size wooden engineering mock-up was also constructed to check equipment installation, fit and tolerances. Production machinery was designed, ordered and installed. Much of the equipment that was needed to build the new plane was new, huge and unprecedented.

Meanwhile, an Arrow flight simulator, connected to a state of-the-art analog computer system, the largest outside the United States at that time, was helping to gather theoretical flight-characteristics data. This was expected to smooth the way to actual flight of the CF-105.

The development of the power plants chosen for the Arrow is a story in itself. The first design called for Rolls Royce RB 106 engines then under development. When it was found that production RB 106s would be completed too late for the CF-105 program, Curtiss-Wright J-67s were substituted. Then, in 1955, the U.S. Air Force announced that the J-67 program was to be dropped, and Pratt & Whitney J-75s were chosen as a stopgap measure until new Canadian Orenda PS13 Iroquois engines were available.



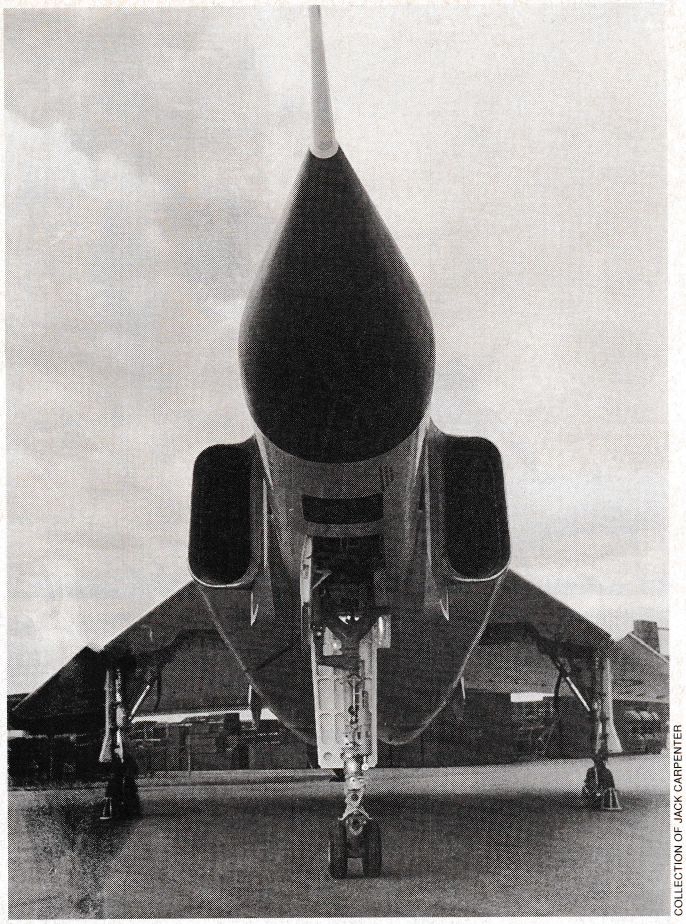
Looking more like an arrowhead than an arrow, one of the 11 free-flight models of the CF-105 is mounted on a Nike rocket booster during supersonic test flights conducted between December 1954 and January 1957.



PHOTOS: COLLECTION OF JACK CARPENTER

The wing of the full-scale CF-105, with contoured milled sections, takes shape on the assembly line at A.V. Roe Canada Ltd. Skipping the prototype stage, Canada's Department of Defense Production ordered Avro to build several preproduction aircraft.

A head-on view of the newly completed CF-105, showing landing gear details. Minor landing accidents caused by undercarriage failure, a blown tire and a nose-gear door's failure to close were the only blemishes on the Arrow's flight-test program.



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Developed by Orenda Engines Limited (later a division of A.V. Roe Canada) to power the replacement for the Avro Canuck, the large, powerful PS13 represented a bold step forward in engine design, in part through its liberal use of titanium. At a dry weight of 4,500 pounds, it would have a 5-to-1 thrust-to-weight ratio, with 20,000 pounds of dry thrust and 26,000 pounds of thrust with afterburner. That would create an unprecedented overall thrust-to-weight ratio of virtually 1-to-1 in the Iroquois-powered Arrow.

The engine's development was not without glitches. It was originally designed in 1953, and the problems were basically ironed out by early 1957. When ground testing was complete, a Boeing B-47 Stratojet was loaned to Avro by the U.S. Air Force as a flight test-bed for the new power plant. One Iroquois engine had more than enough power to keep the B-47 in the air.

A.V. Roe Canada Ltd. was responsible for the airframe and engine development, but the weapons and fire-control systems were in the RCAF's ballpark. At the beginning of the CF-105 project, it was understood that the package of choice was the American Hughes MX 1179 fire-control system and eight Falcon missiles that had been designed for an American fighter program. Against Avro's wishes, however, the RCAF changed its mind in favor of the Douglas Sparrow II missile, then under development for the U.S. Navy, and the RCA Astra fire-control system.

That weapons package would make the Arrow more potent than any interceptor in existence—nothing but the best for the RCAF. But the Canadians soon found that it would not be without cost. It was mid-1955 by the time the RCAF decided upon that state-of-the-art system, and Avro was forced to undertake major re-engineering to accommodate the Astra system. The changes added greatly to the financial burden imposed by the whole project.

Tension at Avro was beginning to increase by that time. Developers knew that the Astra system would prove astronomically expensive to bring on line. Furthermore, now all three components of the Arrow project—airframe, engine and weapons package—were new, unproven and cutting edge. The risks suddenly were much higher.

Then the armament program received a major blow when the U.S. Navy dropped the Sparrow II missile project. Against the best advice from Avro, the RCAF was determined to see the best weapons system possible in the CF-105. Regardless of the huge investment it would require, the whole project—missiles and fire control—was transferred to Canada. That move would have a significant impact on the Arrow program.

Despite the increasing cost of the out-of-control weapons program, and amid growing tension in Avro administration, airframe and engine development continued. The new Canadian interceptor was rolled out of the plant into public view amid glowing speeches from politicians and defense staff on

A.V. ROE CANADA LTD.

Victory Aircraft of Toronto, Canada, a Canadian Crown corporation, built 437 Avro Lancaster Mk. X bombers during World War II. Because of the outstanding quality of these aircraft, Victory caught the attention of the management of British A.V. Roe of Manchester. On December 1, 1945, shortly after the war's end, Victory Aircraft was reborn as A.V. Roe Canada Ltd.

Within a year, A.V. Roe Canada had acquired Turbo Research Limited. The latter was another Canadian Crown company that was engaged in jet engine research and development. In 1955, A.V. Roe Canada Ltd. was split into separate companies: Avro Aircraft Ltd. and Orenda Engines Ltd., with A.V. Roe Canada Ltd. (Avro Canada) as the parent company. The Orenda division produced a first-class jet engine, the Orenda, which would power the Avro airframe division's innovative designs and also the license-built Canadian F-86 Sabre. The Sabre, built by Canadair of Montreal, was designated the CL-13 and considered by many pilots to be the best Sabre of all. Orenda also would develop what was at that time the world's most powerful jet engine, the PS13 Iroquois, specifically built to power the Avro Arrow interceptor.

During its first years, Avro Canada produced North America's first jet transport, the prototype C-102 Jetliner. That air

October 4, 1957. According to the speakers that day, the new interceptor's capabilities would prove more than enough to cancel out the Soviet bomber threat for the next decade.

An event of even greater global importance overshadowed the grand unveiling, however. On that same day, the Soviet satellite *Sputnik* was successfully launched into orbit—an event that resulted in instant hysteria in the West. The Soviets had clearly leapfrogged to the technological forefront again.

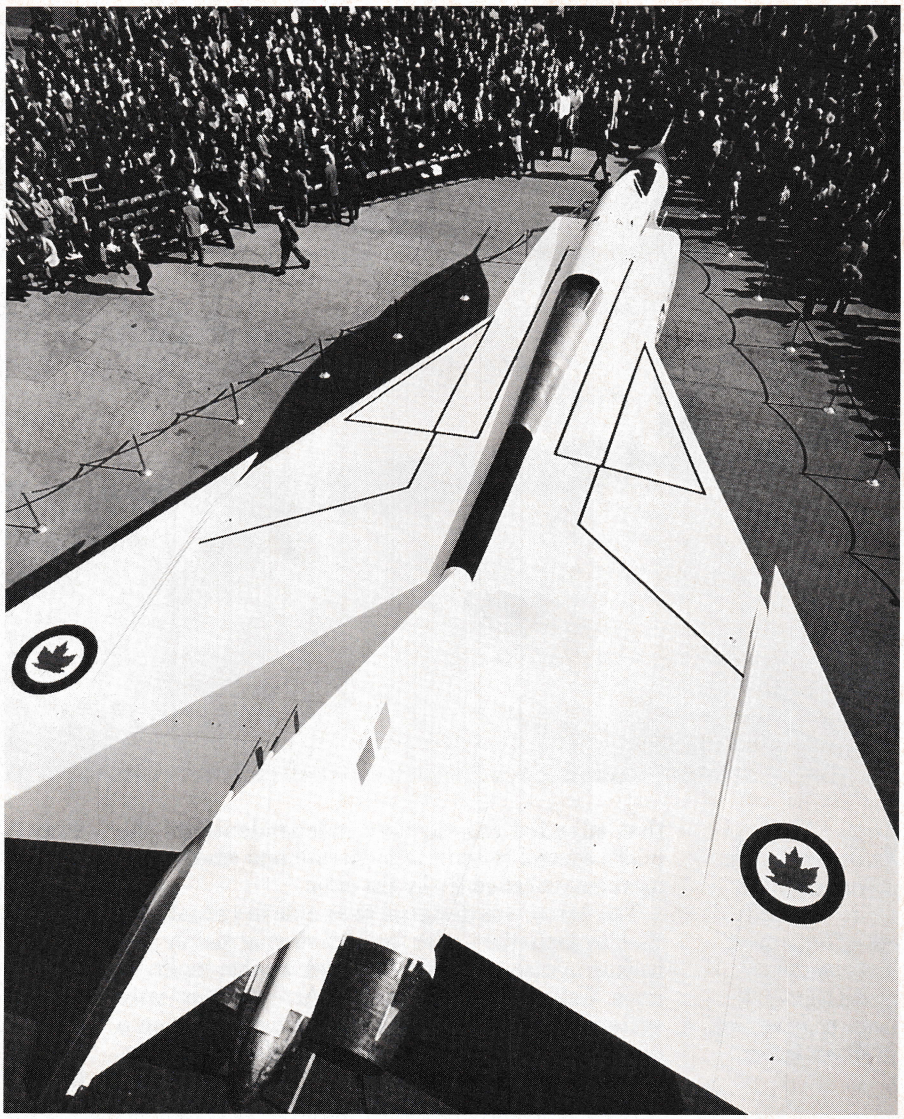
It was ironic that, as spiraling costs conspired to sink the whole Arrow project, the successes of the testing program mounted steadily. Ground and taxi trials proceeded smoothly, and Zurakowski flew Arrow 201 for the first time that sunny morning late in March 1958.

The short flight-test program was almost trouble-free. A couple of minor landing accidents, caused by an undercarriage failure and a blown tire, and a nose-gear door's failure to close seem minor in comparison to the teething problems experienced in many other fighter development programs.

Nevertheless, the Arrow program never progressed past its infancy. Between them, the five flying CF-105 Arrows would accumulate only 66 flights and 70 hours in the air. The fact that there were no serious problems with the aircraft itself is still a testament not only to the young Avro company and its design team but also to the four test pilots in the program.

The flight-test program lasted less than 12 months, but it proceeded very smoothly and efficiently. The program was expedited by the use of ground and on-board telemetry data gathering, a technology then in its infancy. The capacious internal weapons bay of the Arrow was crammed with test equipment that allowed immediate in-flight feedback to the pilot and those on the ground. Today this is called a "real-time" system.

The Arrow could have been further developed. The introduction of microchip technology to replace the heavy, on-board vacuum tube computers would certainly have gained the Arrow a weight and space advantage that could have resulted in substantially greater speed and range. Another technology then in its infancy was the flight-control system popularly known as "fly-by-wire." The Avro Arrow was one of the first service aircraft to use that system, in which the pilot's control movements were translated, via sensors, into electric signals connected by wire to hydraulic actuators that produced movement in the control surfaces themselves. Superimposed on this system was a sophisticated parallel damping system



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An overhead view illustrates the appropriateness of its sobriquet, as the Arrow makes its first public appearance on October 4, 1957—the same day that the Soviet Union launched Sputnik.

craft flew for the first time on August 10, 1949, a scant two weeks after the British-designed de Havilland Comet rose from the runway to become the world's first commercial jet to fly.

The Jetliner was the first product of a young, progressive aviation company that was destined to exist for a relatively short time in the rarefied air at the cutting edge of aircraft design and development. The C-102 flew eight years before Boeing's 707 and represented a quantum leap in the commercial aviation field. It had all the earmarks of great success—speed and altitude capabilities twice those of existing propeller-driven airliners.

The Korean conflict intervened, however, and the Canadian government ordered Avro to concentrate all of its production on its new two-seat CF-100 Canuck long-range jet fighter. Although the development of the Avro Jetliner came to an end, the prototype flew on successfully until it was ordered scrapped in 1956. A stuck landing-gear that forced a belly landing on its second flight proved to be the only serious problem encountered during its lifetime. Nearly 10 years would go by before any other aircraft matched the Jetliner's performance.

The Avro CF-100 Canuck, begun in 1946, was designed to help defend Canada's vast territory. The first jet fighter prototype flew in 1950. The aircraft entered squadron service in the RCAF in 1953 and also served in the Belgian air force. By 1958, 692 twin-engine CF-100s had been built, powered by a series of Orenda engines.

A year before the subsonic Canuck entered service, however, the RCAF had set out upon a search for its replacement. This would eventually lead to Avro Canada's greatest achievement, the CF-105 Arrow. Ironically, its greatest achievement also proved to be the ultimate downfall of A.V. Roe Canada Ltd. **R.T.**

COLLECTION OF JACK CARPENTER

Arrow RL 201 during early flight testing. Only five CF-105s actually got off the ground, accumulating a grand total of 70 hours of flying time in 66 test flights.

that adjusted the surfaces independently of the pilot's control column to moderate and smooth out movements called for by the pilot.

The Arrow was designed to be able to virtually fly itself by computer—with the pilot serving mainly as a backup in case of electrical failures or other malfunctions. Well ahead of its time, the Arrow's fly-by-wire system would not be used again successfully on a combat aircraft until the first flight of the General Dynamics F-16 Fighting Falcon in 1974—16 years later.

Representatives of the Canadian government traveled to the United States in August 1958, ostensibly to sell the Arrow or to raise funds to support the program. They returned home without accomplishing either mission; they had, in fact, become the target of a strong American sales pitch for Canada to use U.S. aircraft, rather than the Arrow, in concert with the then-untested American Bomark nuclear surface-to-air missile, to counter the Soviet threat.

Meanwhile, amid American offers to defend Canadian airspace if the Arrow program was indeed canceled, the Canadian government pointed to the costs of the project and downplayed the menace of the Soviet bomb threat. By March 1959, the politicians drew closer to terminating the Arrow program with the announcement that the Bomark was coming to Canada and that the interceptor program was being reduced, subject to review.

Avro responded to the government's warnings of impending cancellation of the program with an offer of $3.5 million per Arrow, based on delivery of 100 aircraft. Avro's vice president for engineering, James C. Floyd, later called that price "the deal of the century." Included would be the more powerful Iroquois engine and the Hughes/Falcon weapons system just offered to the project by the U.S. Air Force at no cost. The Sparrow/Astra system had finally collapsed under its own financial weight.

Then, on February 20, 1959, a date still known as "Black Friday" to many Canadians, the CF-105 program was officially canceled. With the announcement came the loss of 14,000 jobs at Avro and Orenda and another 16,000 jobs with Avro's suppliers throughout Canada. It has been calculated that Avro was involved in almost 75 percent of all Canadian research and development at the time.

The Orenda Iroquois engine program was another casualty. With the cancellation of the Arrow, the considerable international interest that had been generated by the big engine immediately dried up.

At the time of cancellation, Arrow 206, the first Mk.2 with the Iroquois engine, was two weeks away from its first flight and a short time away from an inevitable attempt at a new world speed record. The Arrow Mk.2 never flew.

Everything that related to the Arrow program was ordered immediately destroyed, scrapped, cut up and carted away. All drawings, tools, photographs, instruments, production machinery, laboratories and all 37 aircraft—five complete and flying, one ready to fly in just two weeks and the others in various stages of completion—were ordered destroyed.

Thousands of talented Canadians who had worked on the project were immediately recruited by companies in other countries. Many former Avro employees, for example, helped NASA to put men on the moon. Some of them, including James Floyd, went overseas to work on the Concorde project. A body blow had been delivered to Canada's fledgling aviation industry.

On Thursday, April 25, barely two months after Black Friday, Jan Zurakowski was driving home from the Avro plant at Malton on Highway 401. In his rear-view mirror he noticed a truck, pulling a flatbed trailer, overtaking him in the passing lane. As the truck pulled alongside, Zura casually glanced at the load. There seemed to be something vaguely familiar about the stack of jagged white metal pieces trussed under the tie-downs.

Suddenly, as he looked more closely at the heap of metal, Zura made a startling discovery. There were the numbers "2," "0" and "1" painted in black on the jagged white metal pieces. Here, almost unrecognizable, was all that was left of the CF-105 he had test flown just 13 months before.

The Avro Arrow was dead, but it would not be forgotten. Even today, the legend of this revolutionary aircraft lives on in the hearts of many Canadians. □

Rich Thistle is an internationally respected aviation artist, gallery owner and author who writes from Stratford, Ontario, Canada. For further reading, try: The Fall of an Arrow, *by Murray Peden;* There Never Was an Arrow, *by E.K.Shaw;* The Arrow, *by James Dow;* The Avro Arrow, *by a four-author consortium calling themselves The Arrowheads; and* Shutting Down the National Dream, *by Greig Stewart.*