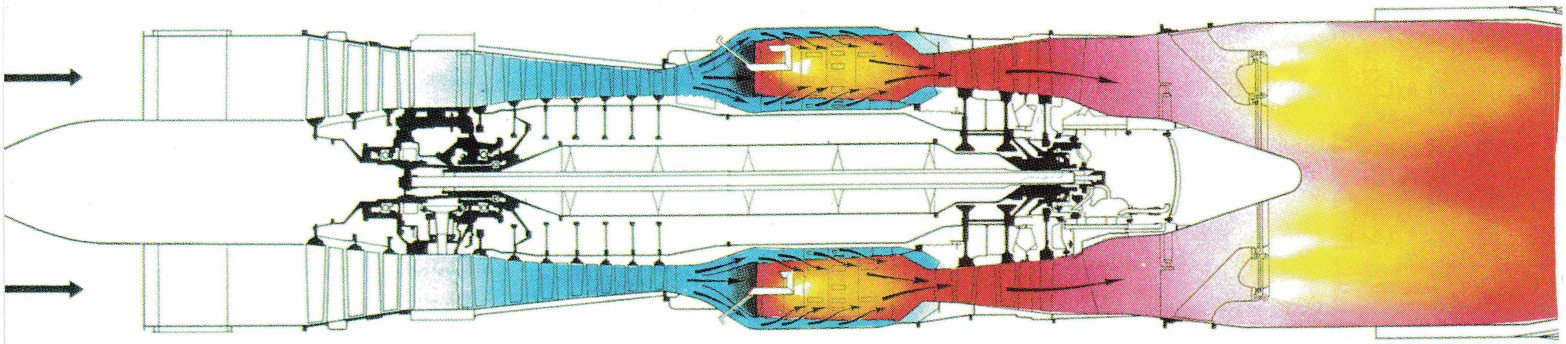


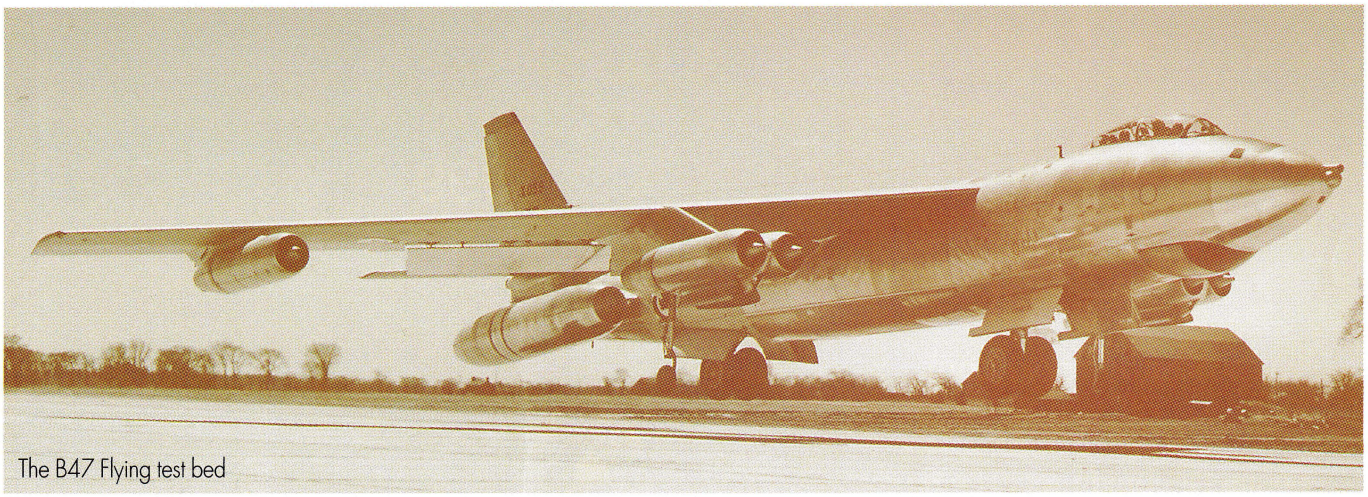
IROQUOIS
THE SPIRIT OF POWER

story by Jack Schofield

Orenda is an Iroquois word. In the legend of that ancient nation of people it refers to the spirit that endows man with power. This name appropriate for an aircraft engine capable of generating immense thrust, was chosen by A.V. Roe Canada it identifying what was, in 1950, the company's most outstanding engineering achievement - the Orenda TR5 gas turbine engine.

It was equally suitable when, at a later date, the company named an even more powerful "spirit of power," the "Iroquois." This was the engine designed to power the CF105, Arrow. Engineer, Winette Boyd, assigned these names to Avro's series of gas turbine engines, but that was the least of his achievements. It was Boyd who performed much of the original design work on the experimental Chinook engine, the development of which paved the way for the famous Orenda series of gas turbine engines powering the Avro CF100 interceptor and the RCAF version of the North American F86 Sabre jet.

The need for the Iroquois engine was inexplicably tied to the development of the CF105 Arrow, and thus what should have been a happy potlatch turned into something of a massacre. Many questions surround the Arrow controversy but the one that keeps surfacing is why it was necessary to destroy the acknowledged



The B47 Flying test bed

world-beating Iroquois engine along with the aircraft that was supposedly too costly and too everything else for Canada to build? This question above all others poses the possibility of gunboat diplomacy by a foreign power. However, it is not the purpose of this diatribe to add to the Arrow controversy, rather to trace the development of the Iroquois gas turbine engine and describe the features that made it such a significant achievement for A.V. Roe, for the world aviation industry and for Canada.

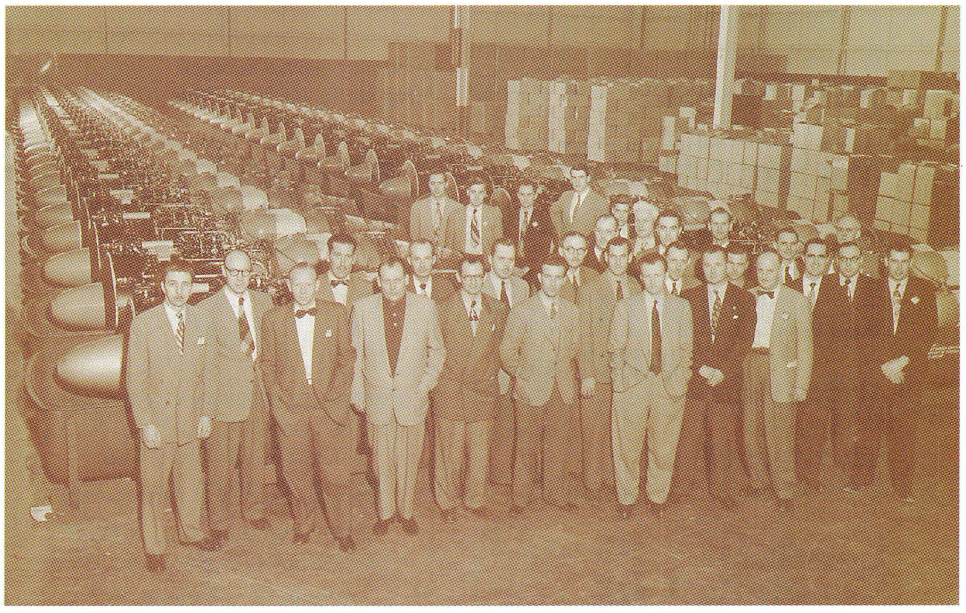
In 1953, the gas turbine division of A.V. Roe Canada decided to commence a project to explore the development of a more powerful successor to their world-acclaimed Orenda engine. This decision was brought about from the knowledge that the Royal Canadian Air Force (RCAF) would soon be calling for a fighter interceptor aircraft to replace the then aging CF100. This private design project was called Project Study 13 (PS13) and was funded, at the outset, entirely by A.V. Roe. The operational parameters of this engine were to power an aircraft to Mach 1.5 to the hitherto unheard of altitude of 50,000 feet - no small achievement for 1953 and far beyond the performance specifications of any known jet engine at that time. In addition, the engine was required to develop take-off power in 60 seconds from a cold start

In a matter of days the Avro engineers achieved the basic layout of the engine to meet the specifications of PS13. Achieving the power to weight ratio of 5:1 was to prove the major problem, the solution was to use parts constructed of strong, lightweight Titanium. Not only were Titanium parts lighter, but their support structure could also be made lighter. Overall, the designers knocked 850 pounds off the engine through the use of this rare metal and through innovative designs such as the use of "shared" bearings for the low pressure compressor and the low pressure rotor; a concept that had never been done before. The use of Titanium itself was highly innovative in that day, as the total world production of the metal was less than what would be required for building the Iroquois. Avro engineers pioneered the use of the material and consequently had many production problems to solve as they proceeded with its application. In particular, the Titanium compressor blades developed cracks very early in their use. It was found that the metal required very exotic treatment to eliminate this problem and ultimately a nickel alloy was employed.

The Iroquois gas turbine reached final development in December, 1954; an amazing design achievement attributed to engineers, Charles Grinyer, Harry Keast, Burt Avery and Dr. A. Muraszew. Shortly after the original light-up of the Iroquois, the engine recorded over 19000 pounds of thrust. By the summer of 1956 running time had reached 1000 hours and the afterburner was lit for the first time, developing 26000 pounds of thrust - unheard of power for the day.

In the interim, the US Air Force had donated a B47 atom bomber to the RCAF for the Iroquois test program. Provisions were made to attach the Iroquois to the fuselage under the starboard side horizontal stabilizer of the big plane.

Mike Cooper-Slipper was to perform the test flying for this project. He and his crew, Len Hobbs and Johnny McLaughlin took their training from the US Air Force Strategic Air Command (SAC) in Wichita on the mammoth craft. "That's an airplane one flies strictly by numbers," Mike attests, "with drag chutes employed in the downwind leg and on the landing roll." In addition to all other flight considerations, Mike had to handle the effect of the Iroquois developing this huge block of thrust from this unusual positioning.



Orenda turbine engines ready for shipment provide an appropriate background for staff of Orenda Engines Ltd. Circa 1954. photo courtesy David Marshall

Mounted as it was, on one side at the rear, the asymmetric thrust imposed on the B47 must have been a handful as were the landing characteristics with the engine pod located astern.

During the flight testing of the Iroquois, one of the test engines blew up, spraying turbine blades and other parts through the side of the B47. In a typical understatement, Cooper-Slipper admitted this caused a moment of concern, particularly when his co-pilot ended up with a turbine blade in his hair. "It had cooled down considerably by that time," said the pilot, dryly.

During the subsequent test phase the Iroquois developed the highest thrust ever achieved by a turbojet on this continent. Following the completion of 5000 hours of bench testing and 31 hours of B47 high altitude tests, the Iroquois was ready for installation in the Avro Arrow, five of which were now built and flying. Number 6 awaited installation of the two Iroquois engines.

The infamous scrapping of the Arrow program ended this saga of singular engineering achievement and the "spirit of power" that embodied the concept was snuffed on the eve of its triumph.

David Marshall, who was in charge of the engine test cell, vividly recalls Feb. 20, 1959, "Black Friday," as the Arrow project cancellation was later termed. One of the Iroquois engines was being run up in his test cell, when the following announcement came over the factory public address system:

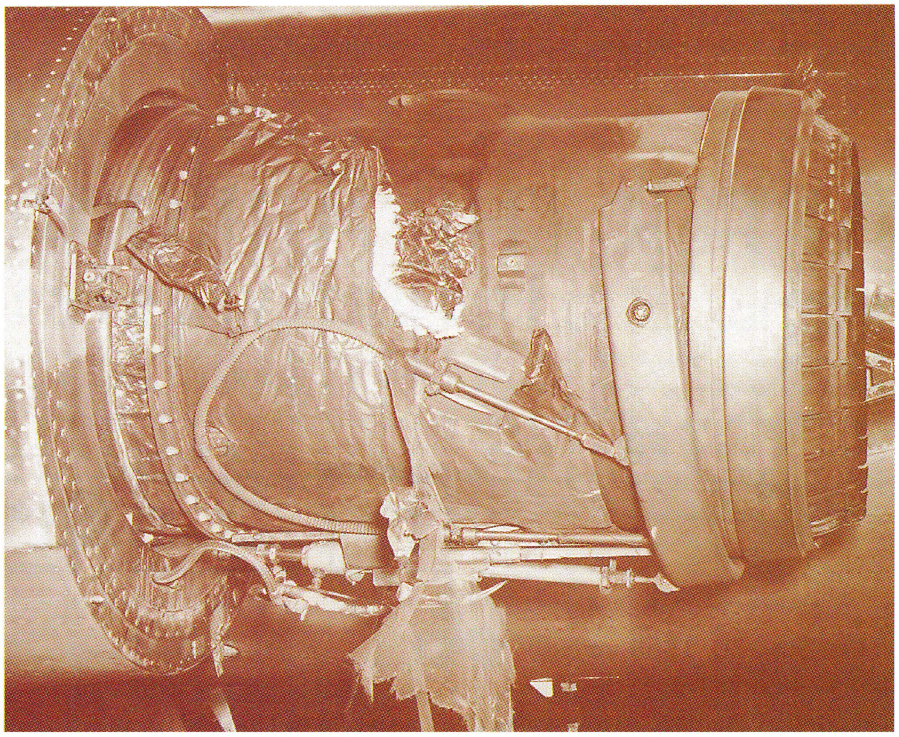
An announcement has just been made over the radio that the government has canceled the Arrow and Iroquois project. We, the management of the company have had no prior knowledge of this cancellation. The cancellation of the project has been confirmed by Mr. Hore, the Department of Defense Production representative here. It is impossible to give you any further details until such time as I receive the official announcement from Ottawa.

One hour later all was confirmed and instructions were given in no uncertain terms that all contracts and sub-contracts were to be canceled forthwith. A.V. Roe was faced with no alternative but to lay off everyone on the floor from top man to sweepers - 14000 (we say again, fourteen thousand) employees of the aero space industry went home that night and told their wives and children that they were out of work and on the street. The aviation industry in Canada was totally disassembled and the "brain drain" from Canada to the USA went into high gear less than one hour later. US aerospace companies siphoned off the top engineers and

Mike Cooper-Slipper second world war fighter pilot and Avro test pilot pictured here in an F86 Orenda powered Sabre jet.
photo courtesy Mike Cooper-Slipper

designers and everyone who could use a slide rule from A.V. Roe and other sub-contracting companies. These people would help the United States put a man onto the moon and help catapult the US military-industrial complex on to even greater achievements while Canada's aviation industry would slump from first place into obscurity.

The political ineptness of the handling of the Arrow cancellation will remain, forever, a blot on Canada's copy book. The immediate effect on the industry is aptly described by professional engineer, Andrew Zakrzewski in the following article reprinted by permission of Engineering Dimensions, the publication of the Professional Engineers Association of Toronto, Ontario.



One of the Iroquois engines blew-up while mounted on the B47 flying test bed. Test pilot, Mike Cooper-Slipper admitted it caused a "moment of concern." photo courtesy Mike Cooper-Slipper

AFTER THE ARROW:
an industry quivers

by Andrew S. Zakrzewski, P. Eng.

On Sep. 20, 1958, exactly five months before the cancellation of the Avro Arrow project, The Financial Post (FP) published a cautionary front-page article titled "Your Business and the Arrow's Fate." It predicted "a far and deep" impact if the federal cabinet doomed the Arrow. The authors, Franklin Russell and FP staff writers,estimated that about 650 suppliers to A.V. Roe Canada Ltd. would be affected, including 30 main suppliers (with about 8500 employees). The article stated that, above all, the cancellation would deal "a shattering blow to our entire scientific community." How prophetic.

Avro Aircraft Ltd. and Orenda Engines Ltd., the airframe and engine branches of A.V. Roe, employed more than 2000 engineers and scientists. There was no immediate demand for them in Canada after the government ordered the cancellation of the Arrow project.

Thirty top Avro engineers joined the National Aeronautics and Space Administration. More than 100 went to North American Aviation, and others went to such American firms as Boeing, Vertol, McDonnell Aircraft and Grumman. A few went to Europe to join Fokker Aviation in Holland, or to work on such projects as the future Concorde.

To quote from the American book *Apollo, the Race to the Moon:* "As the space task group's burden was threatening to overwhelm it, the Canadian Government unintentionally gave the American space program its luckiest break . . .The contribution [of the Canadians] was incalculable . . . They had it all over us, in many areas." Not a bad testimonial for a team so maligned in Canada.

The workforce at Avro and Orenda (14,000) and their subcontractors included thousands of highly skilled trades workers and technicians. Many of them also left Canada and would be sorely missed later on, when the Canadian industry turned to more complex products.

From the moment British-owned A.V. Roe set-up shop in Canada, it pursued an aggressive "buy Canadian" policy. Subcontractors participated in the development of many complex components, hydraulic and electronic controls, and other sophisticated technologies. By the time of the cancellation, many of these companies had already applied their newly gained knowledge to the development of other products and obtained initial export orders.

A new high-tech Canadian industry had begun to grow, nurtured by hundreds of highly entrepreneurial small companies. The sudden cancellation ruined many subcontractors and convinced others that there was no future in coming up with innovative ideas in Canada.

Subcontractor's plight

The plight of Pneuma-Serve Ltd., a small engineering and manufacturing company in Toronto, was probably typical of the fate of many small subcontractors. The company had obtained two orders relating to the initial 37 Arrows. The first order was for the development, testing and manufacturing of a control and release mechanism for the Arrow's landing parachute. The specification called for intricate tooling and very close tolerances.

The second order was for an electro-mechanical control device that was called the Dirpot. It was the brain-