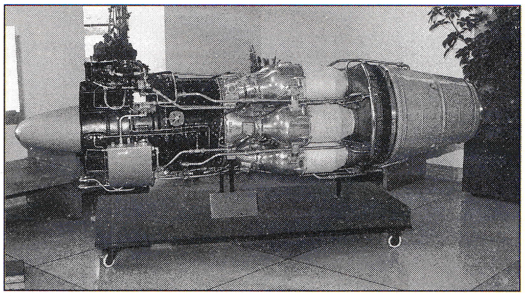
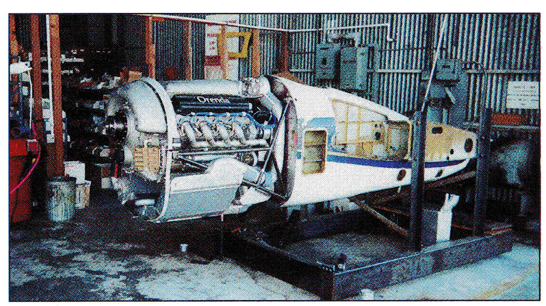
TONY CLEVELAND

Orenda

1946



50 YEARS



1996

Orenda Aerospace Corporation
3160 Derry Road East
Mississauga, Ontario
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Orenda

Celebrating 50 years of service to the world's aerospace industry

October 1996

Introduction and Acknowledgements

A comprehensive story of Orenda's first fifty years is beyond the mandate of this publication. What you will read in this commemorative booklet are some of the highlights from Orenda's past: the engines, the new plant, the advances in technology; and a few glimpses of Orenda today. Many memories are associated with each of these highlights. We hope you are able to bring your own memories into focus as you go through the book.

This publication owes much to newsletters of the past, from *Jet age*, published by Avro Canada, to early and more recent editions of *Orenda News*. We thank especially the writers, editors and publishers of these newsletters, for recording Orenda's history as it happened. Many employees, former employees and retirees sent in photos and stories. These were all sources of inspiration.

Special thanks are extended to the countless thousands of Orenda employees through the years who *are* Orenda's history. Without all of you, there would be no yesterday, no today and no tomorrow.

Celebrating Fifty Years

From Orenda's President...

In 1955, Crawford Gordon, then president of A.V. Roe Canada, said, "In many ways we have been pioneers—and not the least of this pioneering has been in the creation of ever-enlarging opportunities for Canadian skills. This is a direct result of the establishment of A.V. Roe Canada Limited by Sir Roy Dobson and the Hawker Siddeley Group, whose experience in the fields of aircraft and aero-engines provided the base without which we never could have come this far this fast. As for our future, it is bound up inextricably with the future of our country. We are so confident of that future that we have large expansion programs underway to meet the challenge of tomorrow. In that way, I think we illustrate how well all of us know that the first ten years recorded here, with all the pride we do take in them, are still just the beginning.

"But yesterday, today and tomorrow, none of it was, is or will be possible without the people who work here...the men in the shop...the office staffs...the test pilots...supervisors...engineers...the hundreds and now thousands of single individuals who are ultimately and inevitably responsible for the success of our Group and the contribution we are making to Canada's security and her peacetime development."

A.V. Roe and Hawker Siddeley are now only brand names on someone else's products, but they will always be a large part of the foundation upon which Canada's Aerospace Industry has been built. And Orenda, one of the offspring of the union of A.V. Roe and Hawker Siddeley, continues to contribute to the growth of the industry as a wholly incorporated subsidiary of Fleet Aerospace Corporation.

Orenda's name was coined from the Indian word denoting source of power; it is clear that Orenda will continue as a source of power for the next fifty years. Orenda's strength will come from the ideas, designs and inventions of its people, as it did throughout its first 50 years. But in what kind of future will these ideas take root?

If we look at the aero-engines made over the past 50 years, we may have some clues to that future. Fifty years ago, 24 companies were building aircraft engines. Today three large companies and at least four smaller companies are still in business. Those companies have figured out that, to stay in business, they must work together as an industry, while they work alone to develop their own businesses. All indications are that those companies will continue to find ways of cooperating—producing new designs for specific market needs rather than competing for the same markets, as they did historically.

Fifty years ago the business was 100 percent military. Today the commercial markets represent more than 50 percent of the business, and as people continue to travel more, we will see that segment of the aerospace business grow.

For over forty of the last fifty years, we had an East-West political threat People and technology did not move across those political boundaries. With the easing of tensions between East and West, we will see the business expand globally, with technology, designs and markets appearing where people are motivated and eager, and where the financial and natural resources support innovation.

Orenda lost its position as a mainstream manufacturer in the late 1950s, when the Arrow was cancelled and the industrial turbine initiative stalled. However, much progress has been made since then. Orenda redefined its role as a service organization, supporting other manufacturers with manufacturing and repair and overhaul expertise. More recently, the development of a light piston engine aimed at aviation markets will take Orenda back into the mainstream.Well into the 21st century, the Orenda name will be the power behind light and general aviation aircraft—and the company will maintain its traditional place in the gas turbine business in support of others.

As they have throughout Orenda's history, technologies will change. We will see greater use of complex materials, both ceramic and composite. We will see greater use of non-traditional fuels, especially those made from renewable resources, and we will see greater use of computer technology in the manufacture and repair of parts.

The future, of course, depends on people. Sir Frank Whittle, applying an ancient Greek principle, developed Britain's first jet engine in the 1930s. From this engine came the industry in which we participate today. There are still other ancient principles with applications still to be discovered. It remains to be seen if we have a Whittle amongst us who can do the same thing for propulsion technology.

We should celebrate the fifty years gone by and Orenda's remarkable achievements in those years. We should also continue to foster the environment that will make the next 50 years just as eventful!

Richard A. Neill

In the beginning... A.V. Roe Canada

Although Orenda celebrates its fiftieth anniversary in 1996, it really had its beginnings in 1943.

In that year, Sir Roy Dobson, the managing director of A.V. Roe Manchester and the man behind the famous Lancaster bomber, decided to pay a visit to Canada, along with Sir Frank Spriggs, managing director of Hawker Siddeley. The purpose of their visit was to check out aircraft production at a Crown corporation, Victory Aircraft Limited, where superior Lancasters were being built for the war effort. They were met by Fred Smye, director of aircraft production at Victory and escorted on a tour of the existing aircraft companies in Ontario.

As the tour progressed, Dobson hinted that he thought Canadians should have their own self-sufficient aircraft industry. Fred Smye grabbed the idea and from that moment on, believed that it could be done.

The government was anxious to get out of the aircraft business as soon as possible after the war ended. In the early summer of 1945, when the war in Europe was over, Sir Roy reached an agreement with C.D. Howe, Minister of Munitions and Supply under the Liberal government of Prime Minister Louis St. Laurent. They agreed that Hawker-Siddeley would take over Victory Aircraft on a rental-purchase plan. Contracts for production of Lincolns and Lancasters would at first be the business base for the company. On August 1, 1945, Fred Smye moved into an office in Malton, having resigned his government job.

Before the agreement could be signed by Hawker Siddeley, however, the war in Japan ended and the government cancelled all contracts for Lancasters and Lincolns. In England, contracts were also being cancelled and many considered the timing wrong to take on a company across the ocean, whose prospects now seemed very dim.

Other circumstances besides the cancellation of the order for Lancasters and Lincolns conspired against Fred Smye and Sir Roy Dobson. Aircraft plants in early summer 1945 had employed 80,000. By the fall of that year, only 8,000 were employed in the industry and that number was rapidly decreasing. The industry in Canada did not look promising.

Smye and Sir Roy Dobson persisted. Dobson met with C.D. Howe who gave him a chance to back out of the agreement, since prospects for the aircraft industry in Canada now appeared grim.

Sir Roy was considered crazy to persist. "The really amazing thing," said Fred Smye, several years later, "is that here was a man (Sir Roy Dobson) at the peak of his career, riding the crest, with everything to lose, and he was willing to gamble it all on his belief in this country's future. All he worried about was how much of the Victory plant we could handle."

Sir Roy and Smye had further discussions with J.P. Bickell, then the president of Victory Aircraft, and J.S.D.Tory, a well-known lawyer and Victory director. These talks focussed on *how* it should be done, not *whether*.

After much discussion and many meetings, the deal was concluded. A.V. Roe Canada Limited was formed on December 1, 1945, and took possession of Victory Aircraft. A small part, the office building and the first bay, was the beginning. After a meeting between Sir Roy and C.D. Howe, however, they got "the whole damn thing."

It was not a promising beginning. Some areas had an almost ghost-town atmosphere. At one time, 9,600 people had worked day and night in the war effort; armed guards had patrolled the fences, and one Lancaster a day had rolled off the line. Now machines and tools stood exactly where they had been left when contract cancellations stopped all work. On December 1, 300 survivors of Victory Aircraft became A.V.Roe Canada Limited employees.

New management of the company found jobs for these 300 employees to keep them busy: storing Lancasters, making forms for plastic hairbrushes, fenders for trucks and tractors, designing an oil furnace, and dozens of other small jobs, all clearly unrelated to the dream of an all-Canadian aircraft industry.

Then the future began. Sir Roy Dobson was the first president. Fred Smye became assistant general manager. Edgar Atkin came from Avro Manchester as chief engineer. Jim Floyd, who had worked in design teams for the Avro Anson, the Lancaster and the York joined Atkin. The first directors meeting was held, financing was arranged to buy the property and for working capital, and A.V. Roe Canada Limited was on its way to becoming a world leader in the aircraft and jet engine industry.

Orenda

Orenda was originally a small government organization called Turbo Research Limited, established by the National Research Council in 1944 to direct gas turbine research in Canada. In 1944, World War II was still in full battle and the need for more advanced fighter aircraft was the driving force.

This small company, with a cold-test laboratory in Winnipeg and design office in Leaside, had a jet engine at the design stage and the government was faced with a decision: either put a lot more money into production of a prototype jet engine or close the company down.

Sir Roy Dobson of A.V. Roe Canada offered to take of Turbo-Research as part of his company. His offer was accepted and in early 1946, the Turbo Research team became a part of A.V. Roe Canada and moved to Malton to continue with their engine design.

The growth of a company, the growth of an industry

After the war, the RCAF, although officially fed up with war and overloaded with surplus war materials, asked A.V. Roe to work on the design of a training plane and a twin-jet fighter which would be powered by the engine Turbo-Research had been working on.

Late in 1946, the R.C.A.F. cancelled design work on the trainer and revised its ideas about what Canada's first homegrown jet fighter should be. Theengine on which Turbo-Research had been working was called the Chinook ("Warm wind of the West"). It too was almost scrapped as specifications were drawn up for a more powerful engine, the Orenda, to power the fighter aircraft. Paul Dilworth, head of the gas turbine group, thought the Chinook would provide invaluable training for people who had never built an engine, and work on the Chinook continued.

The first Chinook ran on March 17, 1948, two weeks before the end of the government's fiscal year. Its progress to completion had been plagued by threats of government funding cuts, and the race to get the engine out of assembly on time involved even the assistant general manager.

The Orenda had its first official run on February 10, 1949. This engine was the company's first major project to be tested before some of the most important people in Canadian government and the RCAF. This engine proved to be one of the most successful turbojets ever made.

At the same time the Orenda was being developed, work was proceeding apace on the Avro Jetliner, in which TCA (TransCanada Airlines, now Air Canada) had expressed an interest. Design work on this jet-powered, civilian transport plane had begun in September 1946. In Spring 1947, TCA accepted the design produced by Jim Floyd and his engineering staff of less than 40 people. On July 25, 1949, the Jetliner was ready for final inspection, less than three years from concept to finished product, a record that has since been called phenomenal. On August 10, the Jetliner, powered by four Rolls Royce Derwent engines, flew for an hour.

The third Avro Canada project was the twin-jet fighter CF-100, a plane that could operate in the vast frigid ranges of the Canadian north, day or night, all-weather, long-range, heavily armored.

Preliminary design on the CF-100 began late in 1946, under Edgar Atkin, chief engineer. In June 1947, John Frost came from De Havilland to be the project engineer.

With all this activity, A.V. Roe Canada had to grow to keep up with production of the Orenda and the Jetliner, and the CF-100 continued in development. By the end of 1949, A.V. Roe had doubled the number of employees from 1000 two years earlier. New machinery and equipment was brought in and new space allotments were made between the crowded gas turbine and aircraft people.

On January 19, 1950, powered by two Rolls Royce Avons, the CF-100 took off on its first flight. Attending this breathtaking event were a group of government representatives headed by Defence Minister Brooke Claxton, Chief of Air Staff W.A. Curtis and several RCAF officers. The plane jumped into the air in less than 500 yards, climbed, flew for 40 minutes, and came down, braking to a full stop within 450 yards of touchdown.

In June 1951, the first flight of a CF-100, powered by Orenda engines, was made successfully. On October 17, Minister of Munitions and Supply C.D. Howe at a ceremony at A.V. Roe Canada said: "It is my privilege today to deliver to the Royal Canadian Air Force a CF-100 military aircraft equipped with twin Orenda engines. The airplane and its engines were designed, developed and built in Canada by Canadian workmen using Canadian materials. Not only is this the first aircraft to be completely designed, developed and produced in Canada, but the Orenda engine is the first airplane engine to be designed, developed and produced in this country.

"The aircraft as it stands before us is a notable Canadian achievement, marking as it does a new milestone in Canada's industrial advancement."

Work on the new engine production plant in Malton had begun in 1951. Three years later, on December 2, 1954, two new companies were announced, with A.V. Roe Canada as the parent company. Noting that Canada had emerged in a very short time as one of the world's four leading nations in air power, Crawford Gordon, President and General Manager of A.V. Roe Canada forecast an ever-enlarging future for Canada's aircraft industry and for A.V. Roe Canada Limited as its largest enterprise.

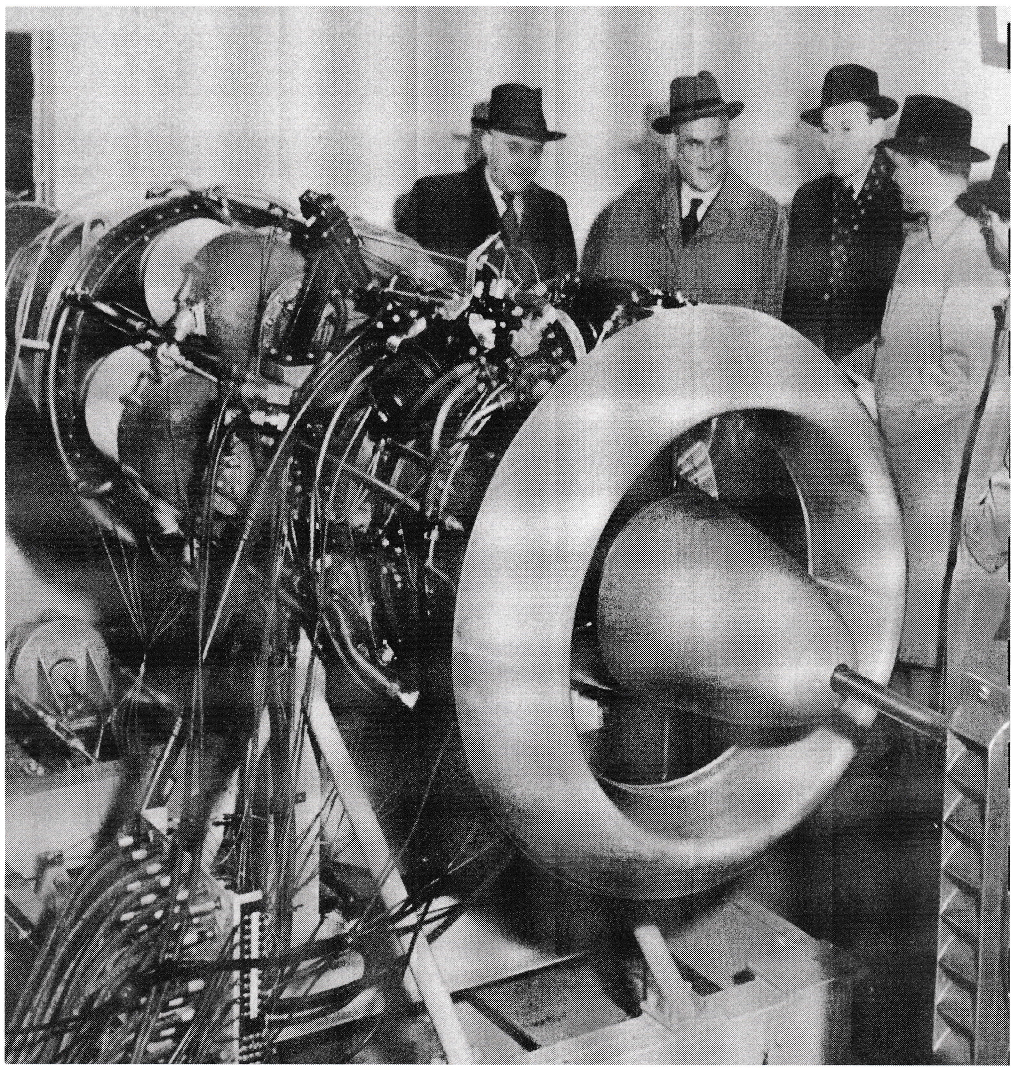
Walter McLachlan, who had joined the gas turbine division in 1953, was named to head Orenda Engines, and Fred Smye became vice-president and general manager of Avro Aircraft. At the same time, A.V. Roe acquired Canadian Steel Improvements Limited, making engine forgings. In September 1955, the company grew even larger with the acquisition of Canadian Car and Foundry. Can-Car was a leading manufacturer of railroad rolling stock as well as of aircraft and parts.

In its first ten years in Canada, Hawker Siddeley had permanently invested over $16 millions of capital in this country's economy. All earnings were re-invested in the further development of the company, and A.V. Roe Canada Limited, with its four diversified companies, became one of the largest single British industrial developments in Canada with 5.4 million feet of floor space and 22,000 employees.

Orenda's Engines

In its first decade, Orenda was a world leader in jet engine design, development and production. Following are highlights from those years.

The Chinook - first at Orenda, first in Canada



First run of the Chinook, March 1948

The TR4 Chinook ("Warm Wind of the West"), the first engine built by Orenda,was the first gas turbine engine to be completely designed and developed in Canada. Work on the Chinook was begun by the team at Turbo-Research and moved with that group to A.V. Roe Canada in 1946.

In September 1946, the RCAF almost cancelled the Chinook when it ordered specifications for a more powerful engine. Paul Dilworth, who was the head of the gas turbine group at the time, convinced the RCAF that the Chinook would provide invaluable training for people who had never built an engine, and work on the Chinook continued.

In March 1948, twenty-one months after the cost estimates had been delivered, the first engine was assembled and delivered to the test house. In the next twenty months, the engine logged over 1000 hours of test bed running. Four sets of parts were made and three engines were actually built and tested, each attaining a thrust of 3000 lb. The Chinook, weighing 1250 lb., had a 9-stage axial compressor of 4.5:1 pressure ratio, a single-stage turbine, and six combustion chambers.

Nearly two years later, in January 1950, all work on the engine was stopped. The Chinook was never intended for quantity production. The program did provide for the development of engineering and manufacturing skills, the establishment of shop facilities and of subcontract sources capable of producing the high quality of workmanship demanded by this new type of engine.

The Orenda

In late summer 1946, the RCAF requested what had now become the Gas Turbine Division of A.V. Roe Canada, to design and develop a turbojet engine with a thrust equal to that of the largest engines then on the drawing boards of any British or American companies. The engine had to be dependable in flight, with endurance life, and it had to be competitive, both in performance and in cost.

The program requirements were clearly specified: efficiency in production; the ability to handle design changes in reasonable time periods; ever-lower production costs; alertness in properly applying and using new technological advances in materials, processing, production and manufacturing techniques.

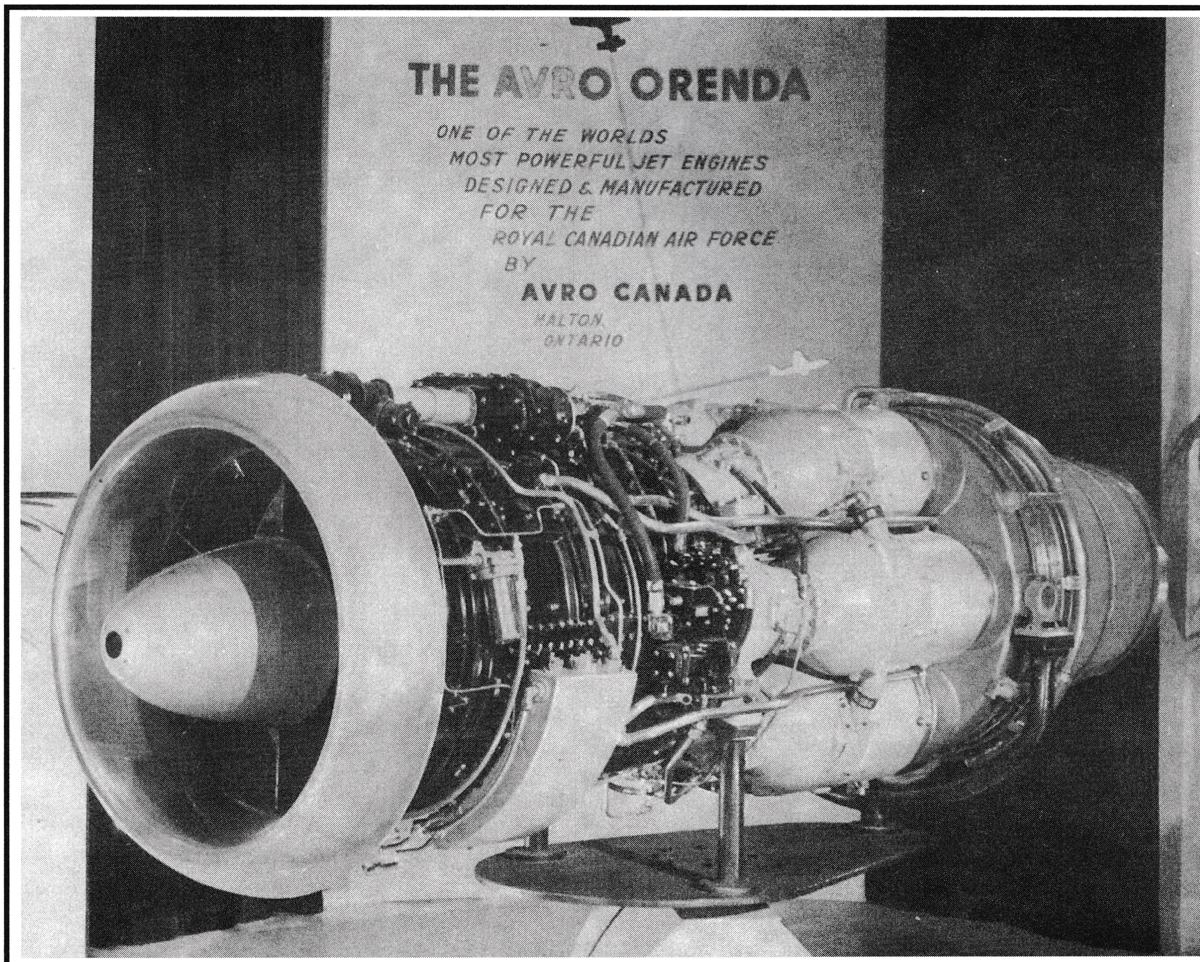
Cobalt, nickel, chromium, and tungsten, all available in Canada, were essential materials in the manufacture of the engine. They were required in the special high-temperature steel alloys used on the "hot-end" parts of the engine. The engine incorporated a 10-stage axial compressor, driven by a single-stage turbine and six separate combustion chambers. In appearance it resembled a large Chinook.

This engine, designated TR-5, and later called the Orenda, first ran on the test bed in February 1949, thirty months after design work had begun. In July 1950, a Lancaster bomber was converted into a flying test bed with two Orenda engines providing power.

The engine was unveiled to the public in 1950 at the Canadian National Exhibition. To the amazement of those at this event, the engine had a dry thrust rating greater than any other engine in production in Britain and in the United States.

In October that year, another prototype Orenda was used to power an F-86A Sabre aircraft.

The first production model, the Orenda 2, was to be used in the CF-100 all-weather fighter aircraft designed and built by the Aircraft Division of A.V.Roe Canada. In April 1951, a US F-86 Sabre with an Orenda Series 11 engine flew from Minneapolis to Toronto in one hour and eight minutes. The first Orenda-powered CF-100 flew in June 1951. In February 1954, the one-thousandth Orenda was tested and handed over to the RCAF. In July 1958, the last one was handed over.



The Avro Orenda is unveiled at the Canadian National Exhibition in August 1950.

Ramping up for Orenda production

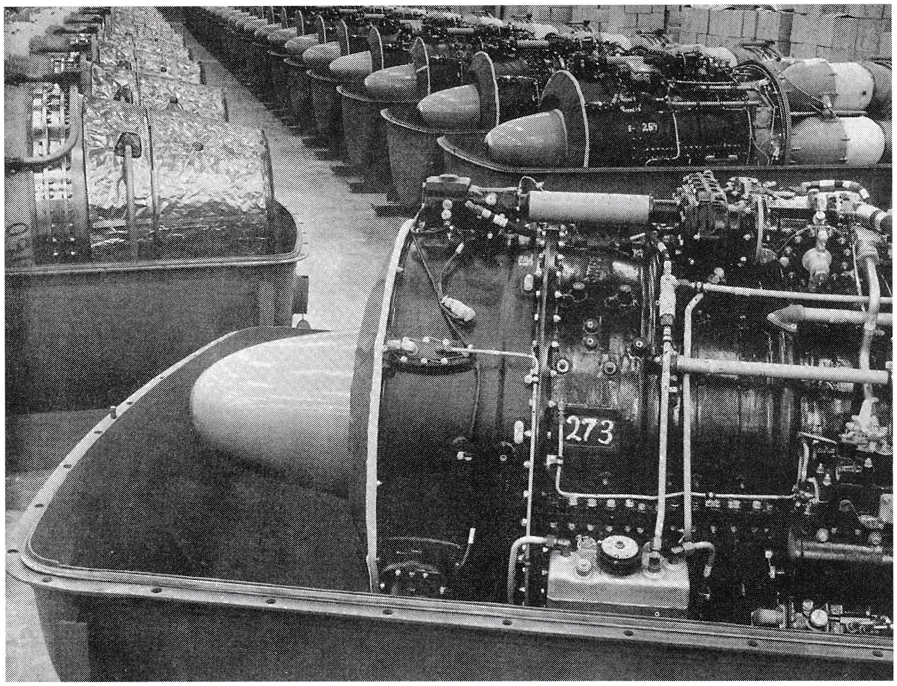
When the Orenda plant officially opened in September 1952, only 30 Orendas had been built. By February 1955, the company had passed the 2,000 mark.

One of the major challenges facing Orenda was the personnel to produce the engines. In January 1952, direct production workers numbered less than 200. Within a year, that number shot up by 500 percent. The assembly shop requirements were filled by automotive mechanics and aircraft mechanics trained by the RCAF during World War II.

The machine shop, with so much equipment of the latest design and some machines, like the Bullard Man-au-Trols which were relatively unknown in Canada, presented a greater challenge. To meet this challenge, an extensive operator training program was undertaken in the plant.

Intake of parts and materials increased from around $500,000 a month in April 1952 to more than $6,000,000 a year later, an increase of 1200 percent.

Setting up the supply network to meet demand provided the Procurement Department with a gigantic task because few Canadian manufacturers were able to supply parts and materials of type and in quantities required. With capital assistance from the government and the cooperation of manufacturers in Canada, the U.S. and Britain, sources of supply were eventually established. A total of more than sixty major subcontractors had to be organized. Many of these built new plants in Canada or expanded existing facilities to provide the necessary parts or materials.



Row upon row of Orendas ready to go out the door of the new production plant

The manufacture of jet engines involves steady design modification for increased performance. This constant development of an engine while in production is essential and perpetual change is the order of the day. As Walter McLachlan, who headed up Orenda Engines, said, "You skinny the engine down and run it until it breaks somewhere, fix that part, run it until it breaks somewhere else, fix it, run it again."

In the first three years of the Orenda production program, over 4,000 design changes were introduced into production engines, each change bringing its own individual problems of supply and incorporation.

With the Orenda, in spite of the challenges of establishing a new industry, peak production was reached within seven years, including the introduction of two new models.

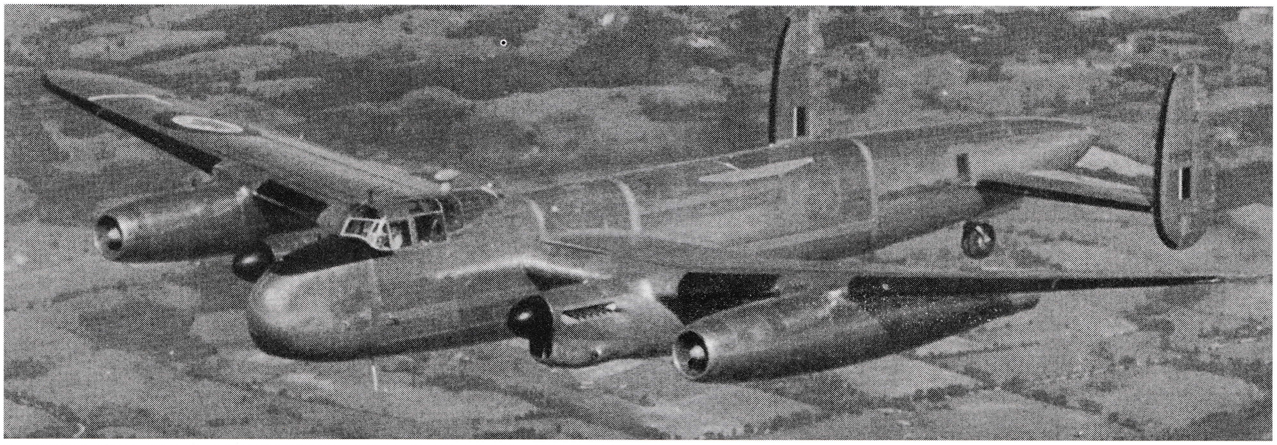
A.V. Roe Canada and the Canadian economy

A.V. Roe Canada Limited played a major part in fueling the economy of this country, both financially and through employment in the industry. For example, in the development of the CF-100 and the Orenda engine, the company worked with many subcontractors and suppliers. Of the production procurement funds received from the Department of Defence Production for component parts, 55 percent was passed along to other Canadian companies. About 50 percent of that went to subcontractors; the other half went to suppliers of finished parts, equipment and raw materials.

In 1946, in the postwar aircraft industry slump, the industry's working strength was less than 1,000 people. Only six years later, Avro employed 15,000 workers. The company's subcontractors employed another 15,000 people.

Orenda and the 747

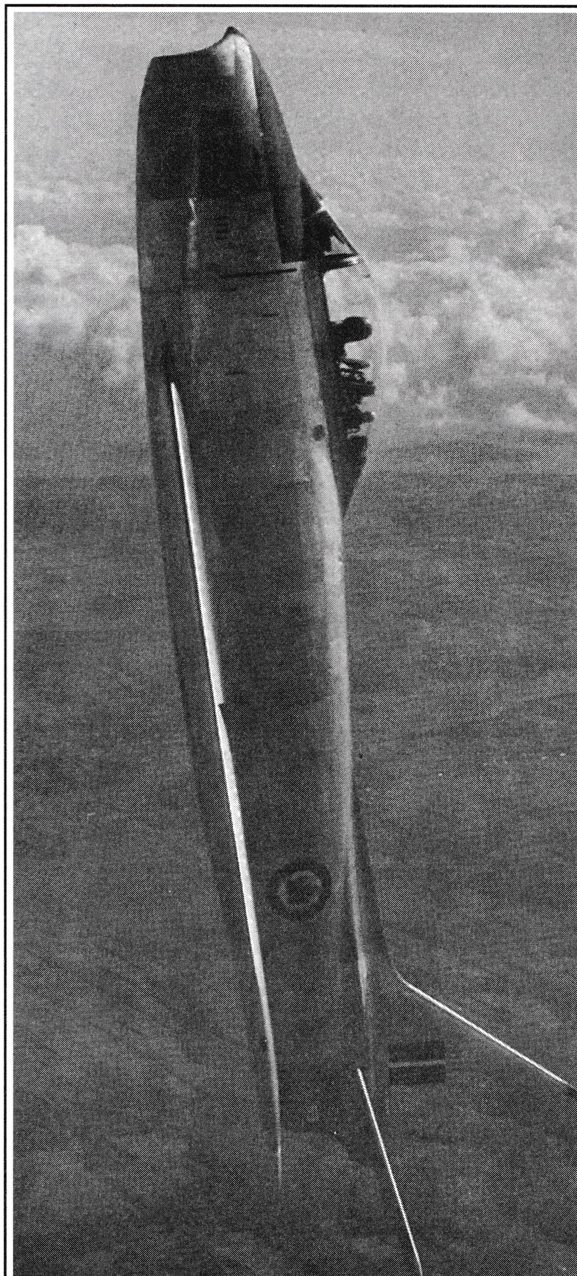
On February 9, 1969, the Boeing 747 made its maiden flight. Accompanying the jumbo jet was a Canadair Sabre 5, powered by an Orenda 10, Serial No. 1603. Engine No. 1603 was sold to the RCAF in April 1954 and saw service in Canada and with No.1 Air Division in Europe before being purchased by Boeing. A spare engine, No. 1208, built in September 1953, was overhauled by Orenda and was installed in the Sabre 5 at Boeing. It too accompanied the 747 in its months of flight trials.



The Orenda was first flight-tested in this converted Lancaster using two conventional piston engines inboard, two Orendas outboard.

Orenda-powered Sabre speed records

May 18, 1953	Pilot Jacqueline Cochran, flight consultant, Canadair Ltd. 100 km closed course, Muroc, California, 652 mph. World record.
May 23, 1953	Pilot Jacqueline Cochran. 500 km course, Muroc, California. 590.952 mph. World record.
June 3, 1953	Pilot Jacqueline Cochran. 15 km course, Muroc, California. 670 mph. World record.
April 11, 1954	Pilot S/L Robert Christie, RCAF. Vancouver to Ottawa, 2,315 miles. 3 hours, 46 minutes. 575 mph.
June 12, 1954	Pilot S/L Robert Christie. Round-trip Ottawa - Montreal - Ottawa. 184 miles in 15 minutes, 4.1 seconds. Average speed 732.5 mph.



Flying an Orenda-powered Sabre, Jacqueline Cochrane broke world records.

Orenda and Sabre a powerful match against "iron"

"Canadian warriors have tested it, slashing practice swaths through the European heavens, and say it has met those tests...They are prepared, if need be, to match it against iron—the iron from which metaphorical curtains are fashioned." (Jet Age, Summer 1954)

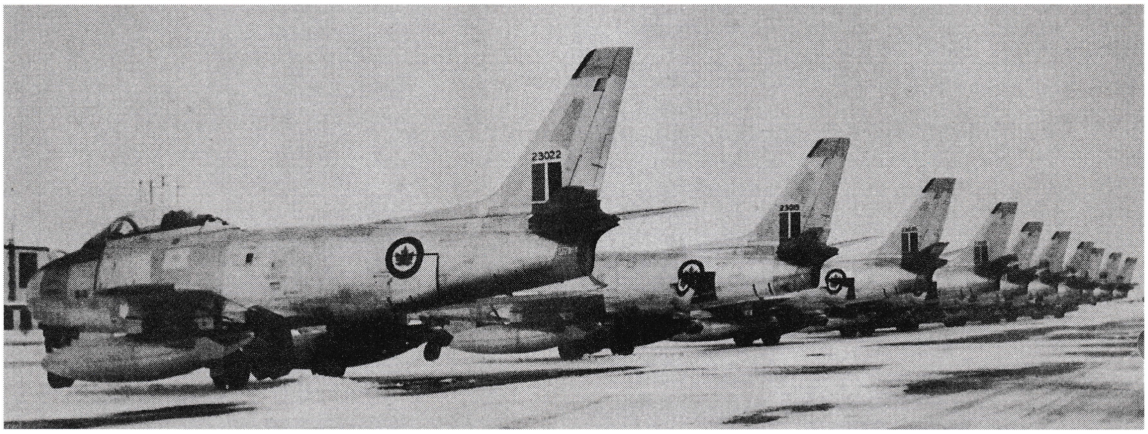
The Sabre above is the F-86 Sabre jet interceptor. Its cutting edge was the Orenda engine, which gave it faster takeoff, higher ceiling, greater speed—advantages that made the Mark 5 Sabre the most effective operational fighter plane in Europe in 1952.

The Mark 5 Sabre was in service at the time with the R.C.A.F's 1 Air Division, Canada's chief contribution to NATO's defence forces. This division was aligned with crack fighting units of the U.S. Air Force and France's Armée de l'Air to form the 4th Allied Tactical Air Force, a powerful segment of the Allied Air Forces Central Europe. Headquartered at Metz, France, the division controlled four wings of three squadrons each. Each squadron comprised 20-odd aircraft and divisional personnel exceeded 4,000.

Sabres were located at North Luffenham, England; Grostenquin, France; Baden-Soellingen and Zweibrucken, Germany.

The Sabre 5 provided an interim solution to the challenge presented by Soviet air strength derived from Russia's apparently plentiful MIG15s.

The equivalent of "10,000 or 12,000 screaming horses" travelled from a railway siding at Malton in summer 1954, as Orenda engines, housed in metal containers made their way from Malton to Montreal to be installed in Canadair's Sabre 5 sweptwing fighters. From Montreal, some 200 young pilots delivered the Orenda-equipped Sabres in convoys to the NATO bases in Europe via the Arctic perimeter, or what was called the "Northern Bridge" by Prime Minister Mackenzie King in 1941.The itinerary took the convoys from St. Hubert to Goose Bay, to Greenland, then to Iceland and finally to their destination. The Canadians were not alone in their task. Pilots from Britain and the U.S. flew the fighter convoys to bring Canadian production to Europe.



More than 700 Orenda-powered Sabres posed like these before pouring into the "aerial pipeline" to Europe. Although each aircraft was prepared with the latest survival and emergency equipment, not a single plane was lost in the crossings.

Operation Prairie Pacific: Canadians see their planes in action

At Winnipeg Airport on August 13, 1953, 25,000 people watched as five CF-100 interceptors powered by Orenda turbojets, five F-86 Sabres and five T-33 Silver Star trainers took off on an 80,000 mile operation that would take them to cities, towns, villages and hamlets from Toronto to Victoria. Operation Prairie Pacific was a 5-week tour of the Western and Central provinces, designed to increase awareness of the RCAF and provide a mobility exercise for the Air Force. Incidentally it provided a showcase for the all-Canadian aircraft and their all-Canadian engines.

One and a quarter million people in major cities saw the cavalcade of jets in their 50-minute displays of aerobatics and flypasts. Thousands more in towns, villages, hamlets and farming communities watched the jets in their flypasts over the rural areas.

One achievement of Operation Prairie Pacific was that of the accompanying ground crews, who kept the aircraft serviceable throughout the tour. Operation Prairie Pacific proved that RCAF jets can receive expert attention in emergencies far from home base.

Even in 1953, individual air shows were not uncommon. Neither were cross-country nor inter-continental jet flights. But never before had any air force attempted a cross-country, mobile display of jet fighters, interceptors and trainers, all with the "Made in Canada" label, of the scale and scope of Operation Prairie Pacific.

The Iroquois

In March 1953, the RCAF issued a requirement for a supersonic all-weather interceptor aircraft to replace the CF-100.

Avro responded with a design study of a series of delta-wing aircraft of varying sizes and weights. The Liberal government, represented by Minister of National Defence Brooke Claxton, proposed that the government invest nearly $27 million in the development of the aircraft, spread over a period of five years. Engines for this plane would be the most suitable ones found in either the United States or Britain. Avro was awarded a design and development contract in March 1954 and the design of the plane, designated the CF-105, began the following May.

In 1953 also, a decision was made to begin the design of an engine to power the CF-100 replacement. In the beginning, the project, known as PS (Project Study) 13 had no military sponsorship; it was a private venture of A.V. Roe Canada. This engine posed many challenges in aerodynamic, thermodynamic and mechanical design, as well as in manufacturing technology.

The US Air Force (USAF) became interested in the PS-13, now called the Iroquois, for some of their aircraft, including the B-52 bomber. The Arrow itself also interested them, provided it was fitted with the Iroquois.

In Canada, an RCAF study on available engines concluded that the Iroquois was more advanced in design and concept than any engine being developed in Britain or the United States. "In fact," said the report, "the PS-13 is the only engine likely to be available on time to give the CF-105 its required performance."

Much discussion at high government levels about supporting development of the engine followed, with praise for the technical competence of the design team from then Minister of National Defence Ralph Campney. He believed that by developing this engine, Canada would remain in the forefront of jet engine technology.

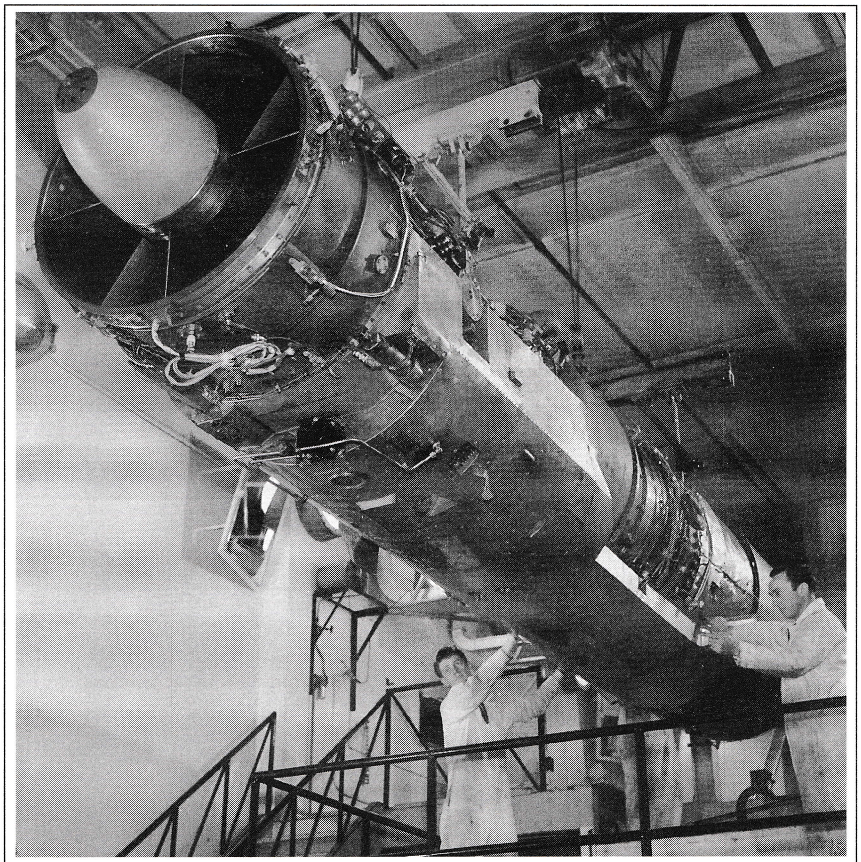
The PS-13 was about 19 feet long and 4 feet wide. It was rated at 19500 lbs dry thrust and at up to 26000 lbs with afterburner, a total of 52000 lbs from both engines. On November 1, 1957, dry thrust runs of over 20000 lbs were demonstrated. More titanium was used in construction of the engine than any other at that time, and Orenda pioneered methods for machining and welding this material. Through advances made also in lubrication design, the engine consumed only ten times more oil than a 200-hp automobile engine of the day.

By November 1957, the Iroquois had completed 3200 hours of development running, including a 100-hour endurance test and a 20000 lb static run. On November 13, it was flight-tested on a B47 bomber on loan from the USAF.

Meanwhile development continued on the Arrow. On March 25, 1958, fitted with J-75 engines, the first Arrow took off, with test pilot Jan Zurakowski at the controls. The flight lasted 35 minutes, achieving a speed of 250 knots and a maximum altitude of 11,000 feet. After another flight and minor adjustments, the Arrow was flown supersonically on April 3, 1958. In the 65-minute flight, the plane achieved a speed of Mach 1.1 at an altitude of 40,000 feet.

By the end of 1958, fourteen development Iroquois engines had been built, 6700 hours of test running had been completed, 22 of them on the B-47 flying test bed. A further 96 engines were on order.

On February 20, 1959, a day known as Black Friday, the Arrow and Iroquois programs were cancelled by the government. Only five Arrows, fitted with J-75 engines, had flown. The first Arrow to be powered by Iroquois engines was ready for taxi trials when the project was cancelled. The aircraft and the engine were deemed to be of no further value and were ordered destroyed. The dream of a great industry and a great country leading the world in aerospace development was over.



From an Orenda Engines Limited Press Release, prior to February 20, 1959 (exact date unknown)

1909 to 1959 50th Year of Flight

Aircraft Engines Then and Now

Canada's latest jet aircraft engine produces 10 times more power than the country's first jet engine of just over a decade ago, and is hardly to be compared with the engine used in the first official British Commonwealth flight 50 years ago at Baddeck, N.S.

Powering the Silver Dart on that first flight on February 23, 1909, was a 35-horsepower, eight-cylinder, vee-shape, water-cooled piston engine.

Today, the equivalent of over 60,000 horsepower is available in the Orenda Iroquois turbojet engine, two of which provide the power for the Avro Arrow interceptor. One Iroquois weights 4650 lbs, more than the combined weight of the Silver Dart, its engine, pilot and fuel.

Actually, jet power is measured in pounds of thrust developed. The Iroquois develops over 20,000 lbs of thrust. This compares with 2600 lbs of thrust in Canada's first jet engine, The Chinook, which first ran in 1948.

Both jets were designed and developed in Canada by Orenda Engines Limited of Malton, Ontario. The Silver Dart's engine was the product of Glenn Curtiss, an early designer-builder of planes and engines who achieved considerable prominence in the U.S. aircraft industry.

The development of the jet engine industry in Canada is seen in brief descriptions of engines produced by Orenda, the only company designing jets in Canada.

The Chinook marked Canada's entry into the field of engine design and development. First ran March 17, 1948 at 2600 lbs thrust, was later developed to over 3000 lbs thrust. A few were built as a forerunner to the Orenda series.

The Orenda. First ran February 10, 1949, at 6075 lbs thrust. First production models were rated at 5800 lbs thrust, eventually developed to 7275 lbs, at the same time showing a weight decrease from 2685 lbs to 2430 lbs after six years. Production ceased in June, 1958. A total of 3,794 engines were built in six different models. The Orenda series of engines power the Canadian-designed CF-100 interceptor and Canadian-built Sabre. In addition to service with the Royal Canadian Air Force, these aircraft are also front-line planes with Belgian, West German, South African and Colombian air forces.

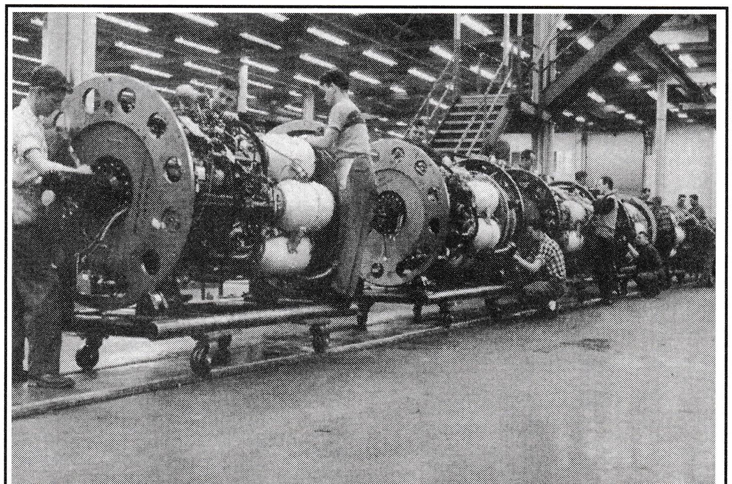
The Iroquois. First ran December 15, 1954. Designed for speeds faster than sound, it was the most powerful production engine known in the western world at the time it entered production. Two Iroquois power the Avro Arrow interceptor, each engine capable of delivering over 20,000 lbs of thrust.

Orenda Engines Limited is the only company in Canada doing design and development work in the gas turbine aero engine field. Until January 2, 1955, the company operated as the Gas Turbine Division of A.V. Roe Canada Limited, and today is a wholly-owned subsidiary of that company. Located at Malton, Ontario, northwest of Toronto, Orenda employs a total of some 5,000 persons. Among them is found virtually every engineering,production and technical skill existing.

Orenda's engineering department includes design and development offices, an experimental manufacturing shop, engine test houses, a high altitude tunnel, a variety of test "rigs," laboratories and a flight test establishment. The laboratories are fully equipped for metallurgical, mechanical, fuel systems, instrument and aerodynamics investigations.

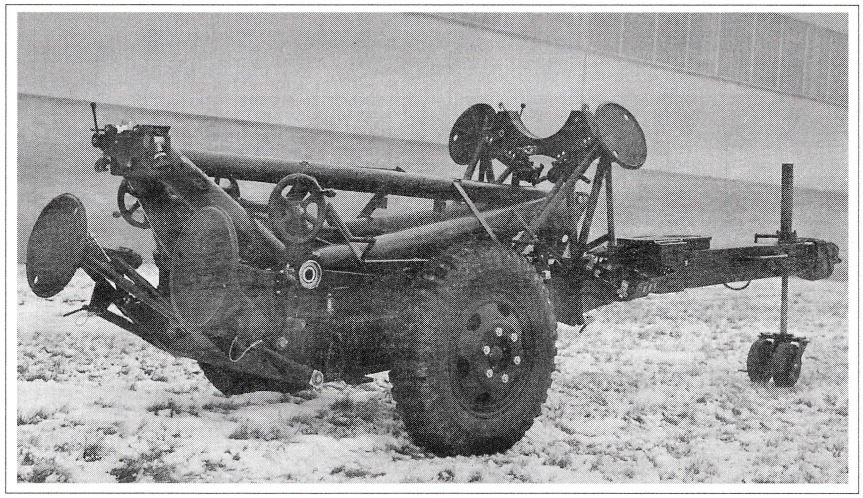
Orenda's modern production plant was designed for flexibility and sudden expansion in case of national emergency. Covering over 800,000 square feet of manufacturing and warehouse space, it was planned to allow rapid change from one engine model to another or the manufacture of two or more models concurrently. The plant has one of the finest machine shops and tool rooms on the North American continent.

Orenda Industrial Limited, a wholly-owned subsidiary of Orenda Engines Limited, was established in May, 1958, to handle activities other than gas turbine which Orenda might undertake. Initially, the company is handling the sale and servicing of a broad range of British electrical and diesel products in Canada and the United States. To handle the U.S. business, Orenda Industrial Inc., of New York, a subsidiary of Orenda Industrial Limited, was announced simultaneously.



Orenda 14s roll down the final assembly line at Malton.

Lance Missile Lightweight Launcher



The Lance missile was an Army battlefield surface-to-surface missile that could be moved into position, aimed and fired by only six people. Designed to replace the Honest John, and possibly Little John rockets, it complemented tube artillery and extended the division commander's capability for conventional or nuclear supporting fire. Lance was the first Army missile to use prepackaged, storable liquid propellants. It also used a simplified, inertial guidance system and control concept.

In 1963 Hawker Siddeley Canada was selected as subcontractor for design and manufacture of the lightweight launcher. A team of Orenda engineers went to LTV Aerospace's Missiles and Space Division in Michigan, to develop the complex specifications for the first launcher that did not weigh more than the missile it launched and was air-droppable by parachute, complete with missile.

Delivery of the first engineering model launcher was made in June 1964. Following a rigorous test program both at Malton and at various U.S. Army Proving Grounds, a missile design change was made. The changes resulted in a substantial re-design of the launcher.

The first of a number of tactical prototype launchers was delivered in February 1966. Further test programs including mechanical, environmental, field and firing tests were carried out. After continued development of the launchers, Orenda was awarded a contract for the first Production Buy. In January 1967, the whole Launcher operation was moved to the original High Altitude Test Facility at Malton. New production equipment and machinery were installed and manufacture began in the following May. The contract was completed some two years later.

Famous names in Orenda's history

ALLIOTT VERDON ROE

Alliott Verdon Roe was born in Manchester in 1877. During a sea voyage as a marine engineer, he became fascinated by the flight of birds, especially the effortless gliding ability of the gull and the albatross. He was determined to achieve this feat by mechanical means and spent all his spare time making and studying flying models.

He built his first aircraft in 1906, a fragile biplane, powered by a 24 hp Antoinette engine, which he named the Roe 1. He tried out his invention at the Brooklands race track, and in June 1908, he made a few short flights, becoming the first man to fly a British designed and built aircraft in England.

In 1909, he completed and flew a triplane, powered by a 9 hp JAP motorcycle engine. This craft was mounted on four small wheels, the front pair steerable. Lightness and rigidity were combined with the use of thin, curved sheet metal and hollow rivets. The machine's patented control was the first system to combine longitudinal and lateral control in a single lever by tilting or warping a large front elevator.

In 1909, his small tractor triplane flown at Lea Marshes in East London proved his theory that the Wright brothers of the United States were on the wrong track with their front elevator type of craft. His plane was controlled through the variation of angle of main and tail planes.

Also in 1909, he and his brother Humphrey set up a manufacturing firm in Manchester. His innovative ideas and his instinct for design and proportion for flying machines brought continuing success, and with it the first order from the British army for a dozen biplanes in 1912. The first cabin biplane, bult in 1912, won the British Duration Record the same year with 7 1/2 hours of non-stop flying.

In the following year Roe designed and built the '504' model, which in improved form was used in the Royal Flying Corps throughout World War I. In the 1920s and 1930s, hundreds of these sturdy little biplanes were built, and the Avro 504K became the standard primary trainer in the RAF.

Alliott Verdon Roe left the firm in 1928. A year later he was knighted for his pioneer work in aviation. He died at his home in Hampshire in 1958, having witnessed the entire span of aviation from the Wright Brothers to the Concorde.

Industrial gas turbines around the world

Early in 1959, the Engineering and Sales Departments began to study the possibility of entering the industrial turbine business, using the design of the Orenda engine as a base. It became apparent from conversations with potential customers in the petroleum and natural gas industries that heavy frame type industrial turbines were preferred to the aero derivative type. However, the aero derivatives could be acceptable to the electrical utilities for peak load generation.

The major difference in operation between a jet gas turbine and an industrial gas turbine is the way the hot exhaust gas is used. Like its aircraft-powering "cousin," the industrial gas turbine is used to generate power; however, the power is on or below ground.

OT-2

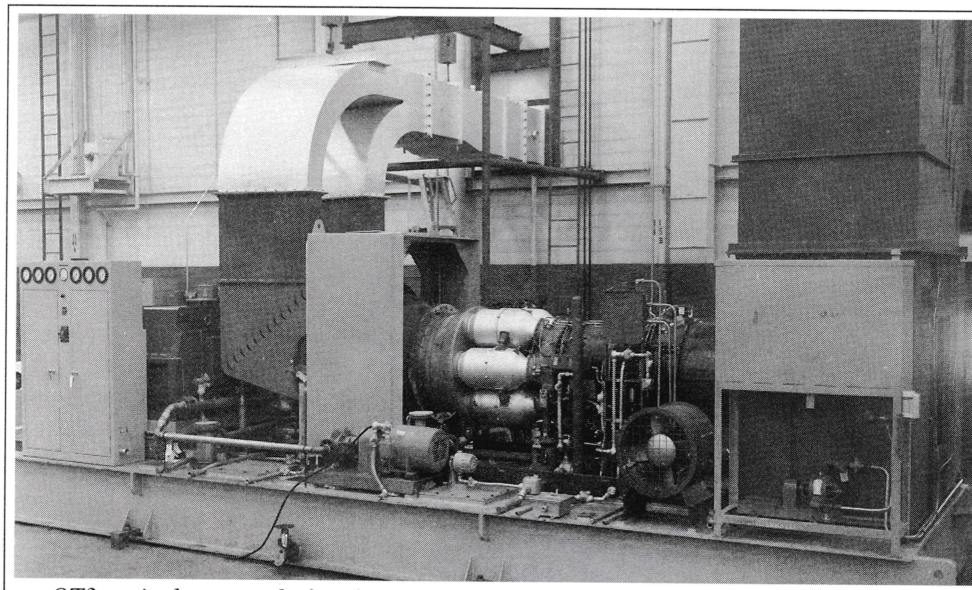
A conceptual design of a heavy frame turbine, using the aerodynamics of the Orenda 11 and 14, complete with a single-stage, free-power turbine was produced in 1960. This turbine, called the OT-2, is approximately 18 feet long, 9 feet wide and weighs 25 tons. The 28-foot-long base on which the engine is mounted adds another 17 tons and includes provision for mounting a compressor or electric generator and accessories. The OT-2 Series of industrial gas turbines had three versions: The OT-F-270 (Simple Cycle, 8250 hp); OT-F-270R (Regenerative Cycle, 7800 hp); and the OT-F-2100 (Simple Cycle, 13,800 hp)

OT-3

The OT-3 consisted of the power turbine of the OT-2 driven by the exhaust gases of an Orenda jet engine modified for burning diesel fuel or natural gas instead of jet aircraft fuel. At the time, both machines were rated at about 7400 hp,uprated since then by increasing firing temperature and speed.

OT-5

The OT-5 is a heavy frame single shaft engine, using about one-quarter scale aerodynamics from the Orenda 11 and producing 1650 hp. The first industrial engine installed was an OT-5 driving an electrical generator, one of 18 installed in Pinetree Radar Stations in Western Canada. Installations are still in use for emergency electrical generation, gas compressor and refrigeration compressor drives.



OT3 on its base, ready for shipment and installation

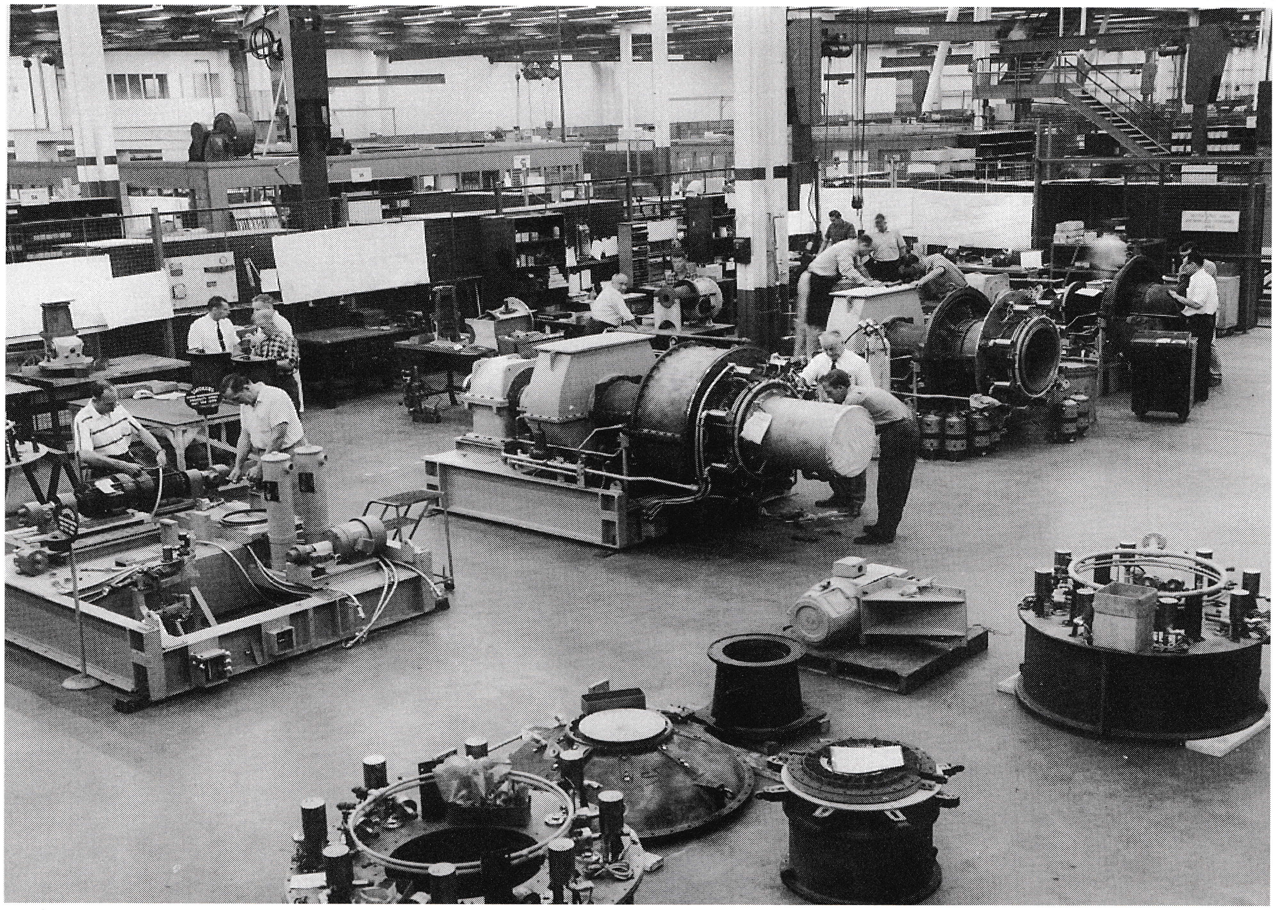
In 1961, Orenda took its first order for industrial gas turbine engines. In the following ten years, Orenda built and sold 125 engines, representing 680,000 hp.

The National Research Council in Ottawa took delivery of the first OT-3 power turbine in Spring 1962, for use as a wind tunnel fan drive. The turbine was driven by the exhaust gas from a remotely mounted Orenda jet engine.

Some of Orenda's early industrial gas turbine customers included: the Royal Canadian Air Force, the U.S. Army, TransCanada Pipelines, Northern Illinois Gas, Great Lakes Gas Transmission Co. , Alberta Gas Trunk Lines, Creole Petroleum (Venezuela), Productos-de-Vidrio, S.A. (Venezuela), Olin Chemical Co. (Kentucky), Ontario Hydro, British Gas,and Louisiana Power and Light Company.

The first OT-F-270R, was delivered to TransCanada Pipelines in 1963 for installation at Orient Bay near Fort William (now Thunder Bay). Five more OT-F-270s were delivered to TCPL, two OT-F-270Rs to Alberta Gas Trunk Lines, and six OT-F-270Rs to Great Lakes Gas Transmission Co. in Michigan. The latter represented the first mainline compressor station order from the United States. The engines powered a 36" diameter pipeline for natural gas, extending from the Manitoba border to Ontario through the U.S.

Reflecting customer requirements for engines with larger horsepower, and to broaden the product line, the OT-F-2 design was modified to add 2 stages to the existing 10-stage compressor and to add a second power turbine stage. These changes uprated the engine to 10,650 hp with only a slight increase in size. The five TransCanada Pipeline OT-F-270s were converted to the new configuration, called OT-F-2100, and a further three were delivered to Alberta Gas Trunk Lines.



OT5s being assembled on the shop floor

By September 1969, total running time on all the OT-F-270R and OT-F-21200 engines had neared the 300,000 hour mark with one OT-F-270R up to 40,000 hours.

In 1969 Orenda was selected as the supplier of gas turbine generating sets for DisneyWorld, near Orlando, Florida. The equipment, delivered in May 1970, consisted of two OT-F-3 packaged generating sets, each set rated at 5500 kW. The sets generated directly a portion of the electrical load at DisneyWorld and the exhaust gases were utilized in waste heat water heaters to supply hot water for air conditioning and heating loads.

One of Orenda's leading customers for industrial gas turbine engines has been Ontario Hydro. The auxiliary equipment at Hydro's very large thermal generating stations—pumps for boilers, fans for furnace blowers, etc.—required large quantities of power. The gas turbine engine met the need for standby power for these auxiliaries. Orenda supplied 19 OT-F-3 Generating Sets, which were installed at Lakeview, R.L. Hearn, Nanticoke, Lambton and Clark Keith thermal stations, and the Pickering nuclear-powered station.

Another major customer has been the worldwide Esso-Standard Oil organization. As of November 1969, they had a total of 13 OT-C-5 industrial gas turbine units in service or on order. Five of those units were purchased by Imperial Oil for installation in Canada. The other eight, all OT-F-3 units, were installed in Venezuela by Creole Petroleum Corporation for driving oil or water pumps.

Around March 1, 1970, the 53 Orenda OT-5 Series Industrial Turbines in service passed the one million hour mark for total running time. This is the equivalent of 114 years of continuous running for one engine. The million hours is spread over the 53 engines, under many different kinds of service and in different climates.

In Fall 1970, the sale of an OT-F-390 gas turbine compressor package to Alberta Gas Trunk Line was announced. This improved version of the OT-F-370 looked the same as the 370 and had identical dimensions and common systems. However, it produced 20 percent more power and had an improved heat rate. It was rated at 9,280 hp, achieved with modest modifications to the hot end components.

Production of the industrial gas turbine ceased in the late 1970s. However, units are still in operation worldwide: Britain, Dubai, Canada, the U.S., Mexico, Venezuela, New Zealand, China. To date in 1996, over 9,000,000 operating hours have been accumulated by Orenda's industrial gas turbines.

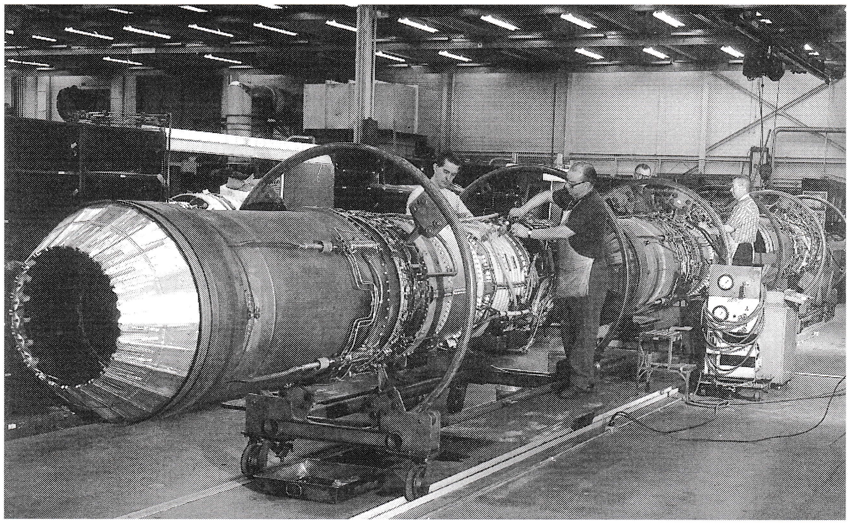
Engines under licence

J79-OEL-7

After the cancellation of the Arrow and the Iroquois, Canadian design and development of military aircraft and engines came to an end. The Lockheed F-104 fighter aircraft was chosen as the successor to the Sabre by mid-1959 and Orenda was contracted to build the General Electric J79-OEL-7 engines for those planes. The drawings and specifications arrived from GE in late October 1959 and the first engine finished its acceptance testing in late January 1961.

Orenda was able to utilize most of the Canadian companies that had manufactured accessories and parts for the Orenda and Iroquois programs, giving the J79 a high Canadian content.

Production of the J79 continued until the mid-1960s; 478 engines were delivered. Some of these engines are still in service with the Turkish Air Force and some in Germany, 35 years after the first engine was delivered.



J79-OEL-7 being checked out in assembly.

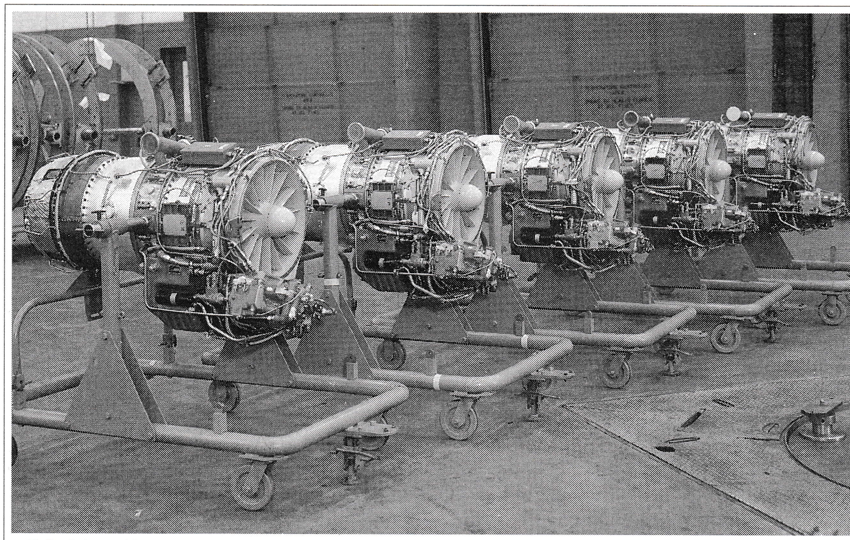
J85-CAN-15

The J85-CAN-15 was manufactured under licence from General Electric to service the R.C.A.F.'s CF-5 strike surveillance produced by Canadair under Licence to Northrop. In production in 1967, this afterburning engine developed approximately 4,000 lb. thrust with the same physical dimensions as the J85-CAN-40 (except for the afterburner) which produces about 2,900 lb. thrust.

The axial-flow turbojet engine, about 18" in diameter, 45" long, with a 58" afterburning tailpipe had a very high performance-to-weight ratio. It swallowed air at a rate of some 1.25 tons per minute and burned 6 gallons of fuel per minute to produce 2,900 lb. of continuous thrust at the jet nozzle. When maximum power was required, extra fuel burned in the tailpipe, increasing fuel consumption to 20 gallons per minute and thrust to 4300 lb. To get that thrust, the engine performed at 16500 rpm.

On May 4, 1968, the first Canadair-built CF-5 supersonic tactical fighter, powered by two J85-CAN-15 engines flew at Edwards Air Force Base, California. The plane flew for 61 minutes and went supersonic twice. The engines each delivered 4300 lb. sea level static thrust.

A total of 609 J85-CAN-15s were built until May 1974, when the program was discontinued. Orenda still provides repair and overhaul services for the engines still in use.



J85-CAN-40. One engine powers the 'Tutor' 2-seat jet trainer

J85-CAN-40

Orenda manufactured the General Electric J85-CAN-40 for the Canadair CL-41 Tutor trainer aircraft, under contract to the Canadian Government. The RCAF accepted the first engine officially in September 1963. By October 1965, Orenda had produced a further 230 J85-CAN-40s.

The J85-CAN-40 is perhaps best known today as the engine that powers the Tutors used by the Canadian Air Force in the aerial displays of the Snowbirds..

Orenda still provides repair and overhaul, spare parts manufacture and engineering product support services for this engine.

Famous names in Orenda's history

H.G. Hawker

Harry Hawker, born in 1889, left school in Melbourne, Australia at the age of 12 to become an apprentice mechanic. By the age of 15 he was test-driving cars for his employer. When he was 16, he saw one of the first airplanes to be displayed in Australia. That event set his career path in aviation.

In 1911, he was employed as a mechanic with Thomas Sopwith in England. Sopwith was operating a flying school at the Brooklands race track, near London. Hawker, displaying a natural talent for flying, earned his pilot's certificate by 1912.

He soon was representing the Sopwith company at the many flying exhibitions and air races then becoming so popular with the public. In doing so he broke many of the existing records for height, speed and endurance.

In August 1914, England entered World War I, and the young aircraft industry had to produce planes by the hundreds. Hawker's job was testing new and untried models of aircraft, especially the Sopwith Camel, which became famous at the Western Front. Hawker's mechanical aptitudes earned him a place with the small group of men responsible for new aircraft designs.

At the end of the war, the London Daily Mail offered a prize worth about $50,000 for the first non-stop crossing of the Atlantic Ocean. The Sopwith company decided to enter, and in just six weeks designed and built a special aircraft, the Atlantic, powered by a single Rolls-Royce Eagle engine.

The competitors had to crate and ship their aircraft to Newfoundland, considered the best starting point to take advantage of westerly winds over the ocean. Hawker and his navigator, Kenneth Mackenzie-Grieve, uncrated and assembled their machine in record time and took off well ahead of the other contestants. At first, it was smooth flying, but in mid-ocean their engine began to overheat and they were forced to 'ditch.' They were reported missing, and after five days, were presumed dead. King George V sent a telegram of sympathy to the pilot's wife, Muriel. The telegram was premature! Hawker and his navigator had been lucky enough to ditch near a Danish steamer, which had picked them from the water. The steamer had no radio, however, and the news could not be passed on until the ship reached Scotland. By the time he had returned safely to London, Harry Hawker was a celebrity.

When the aircraft industry went into its post-war slump, the Sopwith Aircraft Company was forced to sell off its assets. The company was later reformed under the name H.G. Hawker Engineering Limited, to honour the man who had contributed so much. Hawker continued to fly, and had entered another air race, the Aerial Derby of 1921. In a test flight before the race, his plane crashed and he was killed. He was only 32 years of age.

H.G. Hawker Engineering continued to design military aircraft, many of them with names beginning with the letter 'H.' The Hurricane was vital to victory in the Battle of Britain. The Hunter, a graceful jet fighter, saw service in 10 Air Forces around the world.

In 1935, the Hawker Aircraft Company had joined Armstrong Whitworth, Gloster Aircraft and A.V. Roe as one of the founding members of the Hawker Siddeley Group.

J.D. Siddeley

John Davenport Siddeley was one of the founders of the British automobile industry. In his early adult years, in the 1890s, the first motorcars were being produced, mainly in France, Germany and the USA.

'Motoring' or 'touring' was catching on as a great sport among the upper classes. Many small carriage-making firms were turning out their own version of the 'horseless carriage,' using the newly invented and still unreliable gasoline engine. Companies exchanged engines, chassis parts and personnel, and promising design ideas were soon copied by others.

John Siddeley founded the Siddeley Autocar Company in Coventry, England, in 1902, and for two years produced cars based on a Peugeot design, with a vertical-standing engine and a side chain drive. He also produced a restyled version of one of the Wolseley Motor Company cars.

In 1905, he joined Wolseley as General Manager. The former general manager, Herbert Austin, had been in conflict with his directors by stubbornly insisting on horizontal engine designs and resigned to form his own company. With Siddeley now in charge and using his own designs, cars produced in 1905 and 1906 were known as Wolseley-Siddeleys, or just Siddeleys.

In 1909, Siddeley joined the Deasy Motor Car Company, also of Coventry, a company that had been importing and modifying the Martini car from Switzerland. After some radical design changes and improvements, the company operated as the Siddeley-Deasy Motor Manufacturing Co. from 1912 to 1919.

In 1919, Siddeley-Deasy amalgamated with Armstrong-Whitworth, an engineering firm that had been producing cars of their own design in Newcastle since 1906. With John Siddeley as chairman and managing director, Armstrong Siddeley Motors produced a series of elegant and luxurious cars. Production was modest, about 1000 cars a year, intended for upper class customers. (A sporty 1934 coupe was advertised as suitable "for the daughters of gentlemen.")

John Siddeley received a knighthood in 1934. Armstrong Siddeley Motors joined the Hawker Siddeley Group in 1935.

After World War II, a new line of cars was marketed, with the names of famous aircraft such as Hurricane, Lancaster and Typhoon. One famous car produced in the 1950s, the Star Sapphire, was favourable compared with the Rolls-Royce. The company ceased production in 1960.

John Siddeley died in 1953, but his name lived on in the world of engineering for many years.

New plant changes Malton's landscape forever

"Look what's happened to David Tomlinson's old cow pasture. Today, the 72-year old farmer, born on this land like his father and grandfather before him, quietly tends his remaining single acre and sometimes leans upon the fence to gaze at the spreading pile of brick and concrete that has burst upon the rural Malton landscape in little over a year. It is understandable that Tomlinson's eyes reflect a little wonder. They, and those of his generation, have seen an almost complete cycle of strange, wonderful sights. Electric power has replaced his oil lamps and lessened and eased his hours of toil; his telephone connects him with the world; his radio brings him instantaneous news of it; TV aerials thrust into the country sky all around him; his kitchen cupboards stock once-rare, now-commonplace foolds from distant corners of the earth. And sometimes, as he watches the great airliners thunder low overhead down the glide path to nearby Malton airport, he remembers that once he measured travel and speed by the fast-stepping pace of his chestnut mare; that now even those airliners are slow compared to jet travel. And to have the home of the Jet Age in Canada just over the fence, is something to think about." (Avro Canada Jet Age, Autumn 1952)

That home of the Jet Age was the "splendid" Orenda plant at 3160 Derry Road, that officially opened on September 29, 1952, twelve months after the federal government of the day made a decision to produce engines in a new plant. Because of the uncertain international situation at the time, Avro Canada had been given twelve months to build the plant and schedule the entire project in all its detail stages. Complete manufacturing facilities and the equipment required for production had to be selected, procured and delivered in that short period of time.

The building was planned to provide flexibility, allowing for the rapid change from one engine model to another, or the manufacture of two or more models at the same time. As Earle K. Brownridge, Orenda's Vice-President Manufacturing, said, "We never minded setting up a system today and changing it tomorrow...We wanted to be able to put changes on an engine going out the door, if necessary, and sometimes we do." Everything was newly built, for nothing but jet engines, and everything was built superlatively well.

Remarkably, the work on the 750,000 sq.ft. plant was completed on schedule, despite a three-month interruption caused by outside strikes. Well into construction the originally planned manufacturing output doubled and the construction had to provide for this without any change in the target dates.

As well as planning for manufacturing and all that those operations entailed, including test cells so quiet they cannot be heard from a few yards away, auxiliary utilities had to be considered.

To accommodate the traffic of cars and freight in and out of the plant, new highways were needed and existing ones had to be modified.

The plans for the plant included provision for future expansion to twice the initial size of the main manufacturing building, and a proportionate extension of the secondary utilities. The main manufacturing building included a self-contained service unit of 50,000 square feet housing all the required auxiliary utilities. The plant itself was designed as a single storey floor area except for "very modern" washrooms which were elevated to save main floor space for the installation of manufacturing equipment. Daylight was eliminated to prevent heat losses; 13 miles of fluorescent lighting replaced the daylight and gave uniformity of lighting.Headroom throughout the plant was 22 feet. The steel structure was capable of taking a capacity of 3-ton cranes. The floors were of 12" double reinforced, dust-proof concrete. In the shop and the office, the internal partitions were mainly of steel frame with wire mesh or sheet metal panels that could be easily moved to accommodate layout changes.

Auxiliary utilities

❒ Electrical power transformer substation of 7500 KVA capacity

❒ Steam generating plant of 60,000 lbs/hr output

❒ Airconditioning system of approximately 1200 tons of refrigeration. Precise air conditioning was critical because parts that go into a jet engine have to be made so accurately.

❒ Supply and distribution of 1,000,000 gallons per day of domestic treated and untreated water

❒ Compressed air supply system of approximately 2000 cubic feet per minute output

❒ Sprinkler and hydrant water supply and distribution system, with a reservoir capacity of approximately 1/2 million gallons

❒ Storm water and sewage draining system with a modern disposal plant

❒ Separate chemical waste disposal

❒ Modern fire alarm system

❒ Vertical flow engine test house installation with the most up-to-date silencers in the air intake and exhaust system, with 300,000 gallon capacity fuel tank farm, and appropriate fuel unloading and supply installations

❒ Industrial liquefied gas station to supply the tool room and production heat treat departments with gas to the various types of furnaces of approximately 3000 gallons per week evaporation capacity

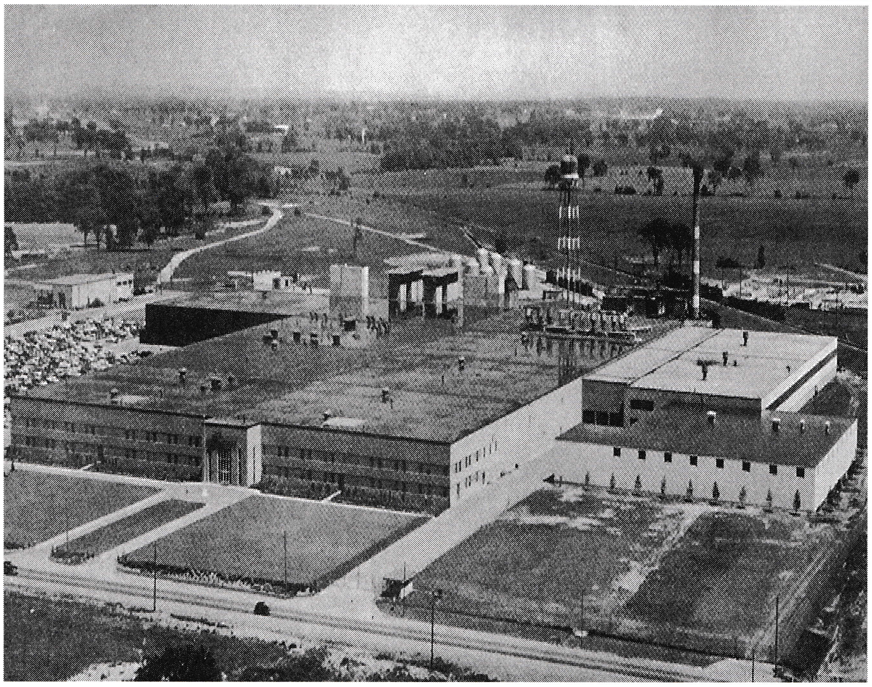
❒ Very modern cafeteria, able to serve 1000 people at one sitting

❒ Incinerator with waste disposal capacity of approximately 5 tons per day

❒ Material handling facilities, including large central and individual battery charging stations

❒ Internal road system, operational yards and grounds

❒ Paved parking lot for 2,000 to 2,500 cars.



Orenda, and Derry Road, in 1952

Manufacturing equipment inventory 1963

42 Broaching machines, both horizontal and vertical, up to 20 ton capacity
8 Balancing machines
108 Buffers and polishers
84 Cutter grinders
55 Radial drills, of 3' to 7' range
81 Miscellaneous single- and multi-spindle drills
242 Grinding machines, including surface, cylindrical, internal, universal, cams, optical and contour
14 Gear Shapers, Hobbers
14 Horizontal Boring Mills
22 Jig Borers, Jig Grinders
78 Vertical and Turret Lathes, mainly Bullard Man-au-Trols and King Tracers from 30" to 72" swing
20 Tracer and Copying Lathes, up to 60" swing, to produce internal and external contours
25 Turret Lathes of various sizes up to 36" swing
8 Instrument Lathes
26 Engine Lathes, from 8" to 48" swing, maximum bed length of 13' to 14'
36 Vertical Mills
139 Horizontal Mills
41 Special Mills
132 Miscellaneous standard machines: electrical discharge, duplicating, hand saws and other cutoff equipment; face and centre lapping machines
7 Presses, 300-600 ton triple action and pressbrake to 14' capacity
7 Shears, up to 14' capacity
29 Sheet Metal machines
5 Shapers and Slotters from 7" to 36" stroke
6 Tapping machines
17 Tube equipment, for cutting, binding, swaging tubes up to 2-1/2" diameter
54 Welding equipment, including spot and seam welders, Automatic Circumferential welders, hand welding equipment

Modernization

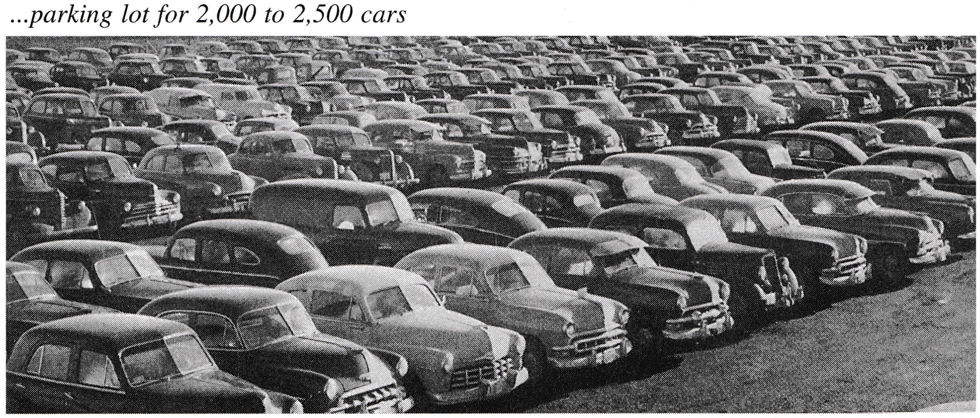
The plant served its purpose superbly for a few years. By 1968, however, rapidly changing technology and design in the turbojet field required new manufacturing methods. The bulk of machine tools and other equipment was becoming or was considered obsolete and could not meet the changing demands of manufacture.

The growing computer industry contributed "automatic control" to the machine tool industry. New machine tools with numerical control were obtained from vendors in Canada, Great Britain, the U.S., France, Germany, Switzerland, Japan and other countries. The machines included the Canadian-designed and built Shanfield Numerical Control Rotary Table Special Slot Milling Machine, a Sciaky Automatic Fusion Welding Machine with 24 channel numerical control and a Lucas Numerical Control Horizontal Jig Bore.

A Sundstrand OM2 was one of newer and more modern machines introduced on the shop floor in 1968. This machine operated from predetermined instructions fed into the OmniMill via punched computer tape. At the touch of a button, the machine operated with consistent accuracy to ± 0.0005 inch on milling, drilling and tapping operations.

(Continued next page)

...parking lot for 2,000 to 2,500 cars



Computer-Aided Manufacturing System (CAD/CAM)

Although the machinery on the shop floor was increasingly sophisticated, the programming to process parts on NC machines was entirely manual until 1968. In that year, process planning became computer-assisted through use of a programming language called APT.

In the 1970s through to mid-1988, Orenda utilized a time-sharing service provided by GE for production of Numerical Control tapes for NC machine tools. During those years, the shop floor became more technologically advanced. To provide greater capability and support to Component Manufacturing, early in 1988 the company installed three Auto-trol CAD/CAM advanced graphics work stations. The CAD/CAM system enabled the company to develop tool designs, generate detailed process planning and inspection method sheets. The system also facilitated estimates, which could be prepared on the system by carrying out detailed planning on components and by extracting "like parts" from the system for modification. Another six stations were installed in early 1989.

Today, the process planners use sophisticated technology to facilitate parts manufacture. Sixteen Hewlett Packard workstations are networked to each other for ease of communication, and they are all connected to Orenda's local area network to enable data transfer to AMES in Ottawa. The Auto-trol software Series 7000 produces 3D designs and does all the NC part programming for all the automated NC machines, as well as tool design. The Series 5000 software produces the processes needed to move the part through all stages of its manufacture from forging to shipping.

Modernization *(continued)*

By 1968 the main production facility had undercover shipping and receiving docks with provision for accommodating trucks and railway cars. Pipe distribution gas systems for propane, argon, nitrogen, hydrogen and natural gas serviced the facility.

A number of test facilities allowed production run-up or development of both aeronautical and industrial engines. Test facilities are equipped with control instrumentation, acoustic silencers and a range of fuels to meet various customer requirements. Two test cells were converted about 1968 to accommodate J85-CAN-15 engine testing.

Diesel generating equipment provided emergency lighting throughout the plant and power for such essential equipment as the fire protection system water pump, certain safety controls and special continuously operated test equipment.

At 6:00 a.m. on October 24, 1968, Orenda joined the battle for a cleaner Ontario, when the power house began burning natural gas under the steam boilers. After 17 years of burning coal with the resultant smoke and pollution, Orenda had a cleaner breathing chimney.

The boilers in the power house at the rear of the main plant were converted for operation on either gas or oil. When they were operated with coal, waste products of combustion from 8000 tons of coal per year were emitted into the atmosphere. Conversion cost the company $65,000. Special facilities controlled effluents to prevent polluting the Mimico Creek.

Owners Orenda's known

In its early life, Orenda was the Gas Turbine Division of A.V. Roe Canada, owned by the Hawker Siddeley Group of Great Britain. In 1955, the Gas Turbine Division became Orenda Engines Ltd., still part of the A.V. Roe organization. Four years later, Orenda Engines join three other A.V. Roe companies to form Avro Aeronautical.

In 1962, deHavilland Canada bought Avro's Malton plant and Avro closed its doors. Orenda became a division of Hawker Siddeley Canada.

Orenda Limited was formed from the Orenda Division in 1966, when Hawker Siddeley sold 40 percent of its shares to United Aircraft. It bought back those shares in 1973, regaining 100 percent ownership.

In 1990, Orenda purchased Middleton Aerospace Corporation, Massachusetts, and its Windsor Aerospace Division in Windsor, Ontario.

Hawker Siddeley, worldwide, was taken over in 1991 by BTR (British Tire & Rubber). BTR sold Hawker Siddeley Canada into the public market three years later. In that same year, 1994, the Orenda Division of Hawker Siddeley Canada purchased A.R.Technologies in British Columbia.

A year later, Hawker Siddeley Canada announced that it was selling off its component companies. After a six-month period of uncertainty, Orenda was purchased by Fleet Aerospace, becoming a sister company of Fleet Industries of Fort Erie. Orenda's full name is now Orenda Aerospace Corporation.

Famous names in Orenda's history

Sir Roy Hardy Dobson

One of the leading figures in world aviation, whose Lancaster bomber played a decisive role in World War II, Roy Dobson in 1945 founded A.V.Roe Canada Limited.

Under his direction, the Company made aviation history. It was the first in North America, by five years, to put a jet transport into the air, missing by only a few days the honour of being the first in the world to do so. It produced the first all-Canadian fighter aircraft powered by the first all-Canadian gas turbine aero engine. It developed engineering and research facilities that allowed the preparation for production, in the late 1950s, of an advanced supersonic fighter aircraft and engine, the ill-fated Arrow.

Sir Roy retired in 1967 from the Chairmanship of the Hawker Siddeley Group of Great Britain. He died on July 7, 1968.

Information needs and the Data Centre

The use of modern technology has helped Orenda maintain its leading position throughout its history. Information Systems in particular has kept up with the times to provide the information needed when it is needed.

In 1966, the computer facility was in a small office located directly behind the old switchboard room, in the northwest corner of the main plant. The room was divided into quarters, storage, office, keypunch and computer room. The IBM 1620 in use at the time to meet engineering and scientific needs required all input in punch card format. The data was coded onto specially designed forms completed by the user. The keypunch operators keyed this information into cards which were then verified and sorted.

This method of input did not change until the mid-1970s. Then keypunch operators transferred the data on the coded form to magnetic tape instead of a punched card.

To allow for expansion to accounting and business applications, a Honeywell 1200 computer was acquired in the late 1960s. This consisted of five tape drives, card reader, card sorter, printer, and console.

The increasing demand for more applications soon required this system to be upgraded . In early 1967, renovation work began on the east side of the cafeteria to accommodate the "Systems and Information" department and the new Honeywell 4200 computer in a modern computer complex. At the time of its installation in May 1970, the model 4200 was the largest and most sophisticated computer in Canada.

Nine offices, a systems and programming area, a keypunch area, a general office area, and a conference room accommodated all the operators and programmers. One room was dedicated solely to the computer and peripheral equipment. The computer room itself was 32' x 57'; a subfloor was installed to bury electrical wiring and computer cables, and to allow air to circulate around the computer, which was highly sensitive to temperature and humidity. Except for four air conditioning units (6'x3' each) strategically placed on its outer walls, the room was completely filled with banks of tape drives, CPU units, card readers, card sorters, printer and console. Punched cards were still used on this computer but the recently introduced magnetic tape became the most useable source of input and storage of data. Storage space for these tapes became critical. Tapes and tape racks were purchased frequently, and off-site storage rooms were acquired in the main Orenda plant and office areas.

The Data Centre in 1970. At the left, the bank of five tape drives and a printer; in the centre, the card reader, console and second printer. Not seen, the second bank of tape drives lining the right side of the room.

By 1979, the Honeywell was becoming obsolete. Because it was one of only two in North America, repair and maintenance could not be guaranteed. A DEC 2020 was acquired from Digital. Although the DEC occupied only half of the computer room, its memory capabilities were far superior. The system consisted of two magnetic tape drives, four disc drives, one printer and one console.

The DEC served Orenda's needs until the late 1980s, when demand for information exceeded its capability. A HP (Hewlett Packard) Series 70, with storage for 400,000,000 bytes of information was installed in late 1989, giving users on-line interactive access to data. The HP consisted of seven disc drives, one tape drive and one Digital Audio Tape (DAT) drive, a mainframe printer and a console. Although physically the HP was about the same size as the DEC, its functionality and memory capacity was much larger. Storage of information was done overnight and data was written onto a cassette-size tape utilizing the DAT drive. The back-up procedure was automatic; in the past,an operator had to replace the magnetic tape when it reached its capacity.

Late in 1993, the HP was upgraded to a Series 957. The new computer is the size of a large filing cabinet. Within this "filing cabinet" is one DAT drive and four disk drives, providing 8 GB of memory. A console terminal and a mainframe printer complement the computer system.

With a shrinking hardware system, the Data Centre was no longer suitable and the computer facility was relocated to the old Conference Room 'C'. The computer room is the same size as the first one back in 1966, but the capabilities of the computer have expanded immensely. Some 1200 business applications programs run on the system; 100 on-line users connect with it and print on any one of 23 printers strategically placed throughout the company.

Famous names in Orenda's history

Sir Thomas Sopwith

Sir Thomas Sopwith, whose name probably is best known in association with the Sopwith Camel, was head of the Hawker Siddeley Group of Britain when A.V.Roe Canada was flying to the forefront in Canadian aviation.

Sir Thomas became interested in flying in 1906. He bought his first plane, a 40 hp monoplane, shortly after racing his car at Brookland, England, which was also being used as an airfield. Four years later he obtained his pilot's certificate and took up his first passenger in a new biplane.

He soon started building biplanes, based on an order from the British War Office for twelve, and during World War I produced many successful aircraft: "Prep" triplane, the Camel, Snipe, Dolphin, Salamander. These aircraft were major contributors to Britain's eventual air supremacy through the war years.

After the war, Sir Thomas teamed with Harry Hawker to form H.G. Hawker Engineering Co. to develop such military aircraft as the Fury, the Hart and the Nimrod.

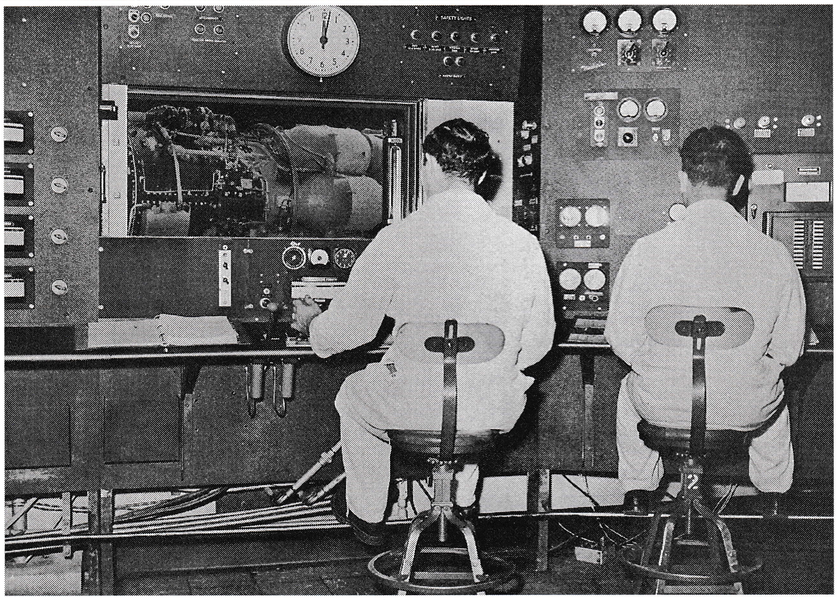
In 1935, Hawker Engineering bought the Armstrong Siddeley group and established the Hawker Siddeley Group. A year later the company started work on the famous Hurricane, a monoplane fighter that played a major role in Britain's success in the Battle of Britain.

The Hawker Siddeley Group produced 40,000 aircraft during World War II. In 1941, the company developed the first British jet aircraft, the Meteor, the only Allied jet used operationally during the war.

Sir Thomas Sopwith Laboratory

The Sir Thomas Sopwith Laboratory, near the new Orenda plant, was a research facility where scientists and technicians conducted experimental work that would advance the aircraft industry in Canada. For example, the various labs conducted:

- **Metallurgical** research, including experimental work on new metals, high temperature creep, fatigue, corrosion, surface finishes and heat treatment.
- **Mechanical** research, which studied the behaviour of all the mechanical components of engines under extremes of temperature and pressure. Test rigs were set up for bearings, seals, gears, starting equipment, anti-icing systems, lubrication pumps and overspeed tests.
- **Fuel** system research, which studied the behaviour of engine fuel and control systems.
- **Vibration** research, examining vibration and balance problems arising during engine development, especially compressor and turbine blading.
- **Instrument** research, focusing on the development of special instrumentation for other labs, engine test houses and test aircraft. Special probes for aerodynamic and mechanical investigations were maintained, repaired and calibrated. Special techniques were developed for which no commercially available instrumentation existed.



An Orenda engine on test in an early test cell

F404 Test Cell

After many months of preparation, the new test cell for the GE F404 engine was completed in early August 1985. The first F404 engine check was run at 3:30 on August 6.

The test cell was formerly used for J79 engines. To meet the requirements of the F404, the test cell and adjoining control room were totally rebuilt, representing a major capital outlay by the company.

The F404 required an entirely different installation from that of the J79. The new engine was suspended from a massive overhead structure with all supply and instrumentation lines connected from above. The control console embodied the latest advances in technology. Engine test running was largely under computer control, with much less manual input from the operator. Temperature, pressure and other readings from the engine fed out on an automatic printer. A remote-controlled TV camera provided close-up views of the side of the engine not visible from the observation windows.

Orenda and Customer Service

Throughout its history, Orenda has provided after-market customer service second to none, in the field as well as in the plant.

The Field Engineering Department, now called the Military Support Department (MSD), was composed of field representatives assigned to RCAF Command Headquarters and Operational Units (both overseas and in Canada) and personnel at Orenda who provided analytical and documentation support. The RCAF contracted Orenda to provide "on-the-spot" technical support to ensure that engines operated at maximum efficiency with a minimum of unserviceable time.

The Field Engineering personnel were the links between the field representatives and the in-house Orenda engineers. They analyzed reported problems and directed their recommendations to the design engineers at Orenda for action or referral to the prime design authority (for example, General Electric for the J-79 and J-85 engines). The department analyzed proposed design changes for impact on the engines in service and translated the changes into modifications bulletins, procedures, and inspection limits, for action in Repair and Overhaul, or at the operational level. Technical items affecting engine publications were passed on to the Graphics Department to be included in the RCAF engineering manuals which were constantly updated for the Canadian Armed Forces.

Over time, the Field Engineering Department has supported a wide variety of engines, including the Orenda 2, 8, 9, 10, 11 and 14 Series, the J79-OEL-7, the J85-CAN-40 and the J85-CAN-15 produced under licence to GE and the F404-GE-400. Field engineering representatives have worked in West Germany, Venezuela, and the Netherlands, as well as at various Canadian Forces bases across Canada. Mobile Repair Parties made up of designated experts from the plant were sent to assist at bases in Canada or abroad where the required expertise was not available locally. Provision of these services was reduced because of military spending cutbacks.

The department maintains a logbook of all engines manufactured or overhauled by Orenda, along with the relevant technical publications. This record becomes invaluable when engines are transferred to new owners.

Today, MSD continues to provide short-term engineering and investigative services on site. Representatives have been sent to various Canadian Forces bases and Turkey, for example, to investigate operational problems and other problems and to implement solutions.

Orenda service analysts write and continually update engineering manuals for the Canadian Forces for each engine model supported by Orenda. These manuals are specially tailored to each customer's requirements and their maintenance capabilities. This service confirms Orenda's reputation as a superior customer service provider.

Orenda and the PC

Before Summer 1994, many Orenda employees use standalone personal computers with a DOS operating system.

The need for standardized software, shared computer resources such as printers and, most importantly, the need to share information made a Local Area Network (LAN) a requirement for day-to-day operations. A network was installed in early summer 1994 and Orenda's computer age affected many more employees.

At first, the LAN was a single file server for which 50 users were licenced. Since it was first installed, the Orenda network has undergone a dramatic increase in power and capability. For example:

- The primary server has been "mirrored." Two main servers duplicate exactly what each other is doing. If one server experiences a hardware failure, for example, the other continues processing.
- Storage space for user data has increased more than 700 times on one server, twice that on both servers. User licences have increased from the original 50 to 350.
- Six more servers have been added to the network for additional capabilities. These allow Orenda users to transmit faxes from the network, dial into the network from home, access up to eight CDs on the LAN, and most recently, connect to the Internet, send e-mail and "surf the net, anywhere in the world.

A.R. Technologies in Richmond, B.C. and Orenda's A.M.E.S. group in Ottawa are linked to the Orenda network to create a Wide Area Network (WAN). The network is connected to the internal CAD/CAM system and HP3000 business computer for improved information and data sharing on these different hardware platforms.

Orenda has a "Home" Page on the Internet (www:/Orenda.com), and an internal "home" page on a newly installed "intranet" is under development. The intranet will enable users to share information as it is developed. The intranet may include new orders received, job postings, telephone extension numbers and any other communications useful to those on the network.

All of this has happened in two years! Looking into the future, videoconferencing may be added to the network. An interface between the company's telephone system and the network will enable employees to "see" one another as they speak.

The benefits gained from the installation of Orenda's network have been well worth the effort and cost. Constant improvements and enhancements to the network will continue to enhance communications with Orenda's employees and valued customers.

Orenda in the 1990s...

Orenda is an established leader in power and propulsion technologies. It provides a wide range of products and services, including: gas turbine engine repair and overhaul; component manufacturing for OEMs of the world's leading turbine engines; high technology reciprocating power plants; industrial power packages; and advanced materials and energy systems.

Repair and Overhaul (R&O)

Throughout its history, Orenda's engineers have been developing innovative, cost-saving repair procedures to support, repair and overhaul gas turbine engines and fleets around the world.

Applying advanced technology and processes, Orenda is able to economically repair more than 50 percent of the components in conventional gas turbine engines, both aero and industrial. When these components are returned to customers, their quality and performance are equalCand sometimes superiorCto those of the original factory components.

Since 1955, the Canadian Armed Forces have relied upon Orenda's repair and overhaul capabilities to support the operation of six different aircraft types, including the J-85 and F-404, and all of their variations. The U.S. Navy chose Orenda to repair and overhaul F-404 jet engine exhaust frames for its fleet of F/A-18 fighters.

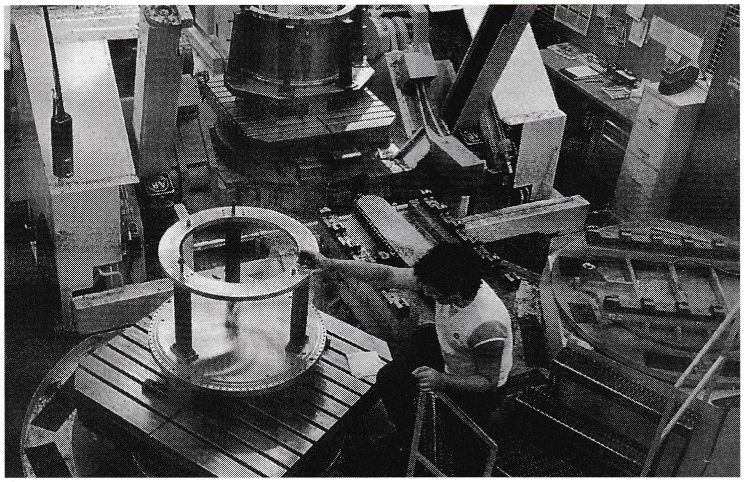
Despite military spending cutbacks, the future looks bright for R&O, as its representatives seek new opportunities to apply the unit's specialized skills and comprehensive facilities throughout the world.

Component Manufacturing

Orenda's Component Manufacturing business unit produces compressor discs, nozzles, turbine wheels, drive shafts, torque rings, combustion liners and casings for the world's leading aerospace and industrial engine builders, General Electric, AlliedSignal, Rolls Royce, Pratt & Whitney.

These are complex components. Conventional or advanced materials are worked on computer numerically controlled (CNC) machines to produce components as large as 10 feet in diameter. Manufacturing activity is organized into "flowline cells" to reduce cycle times and improve quality.

Over the past ten years, Orenda has supplied more than 200,000 individual components to OEMs as well as to civil, military and industrial end-users.



A J-79 casing for GE Aircraft Engines

Advanced Materials & Energy Systems (AMES)

Orenda's Advanced Materials and Energy Systems (AMES) business unit is a team of highly-trained engineering specialists, dedicated to developing unique and practical solutions to the challenges of engine component life usage monitoring, repair and redesign.

Much of the unique work performed by AMES engineers has been in conjunction with the National Research Council of Canada (NRCC). The development of advanced techniques for such tasks as structural analysis of aircraft engine parts and life usage monitoring systems for the Canadian Forces has been a focus over the years. The wealth of knowledge developed through its work in the military sector has enabled the unit to offer its unique services to various customers in the civil aviation industry who need technical expertise in such tasks as determining the structural integrity of parts.

Research conducted at AMES has enabled Orenda to offer remanufacturing services for customers. Applying proprietary coating processes, laser surface treatments and joining/brazing techniques with better bonding properties to parts that were designed in the 50s, 60s and 70s, remanufacturing is often a preferable option to buying new parts.

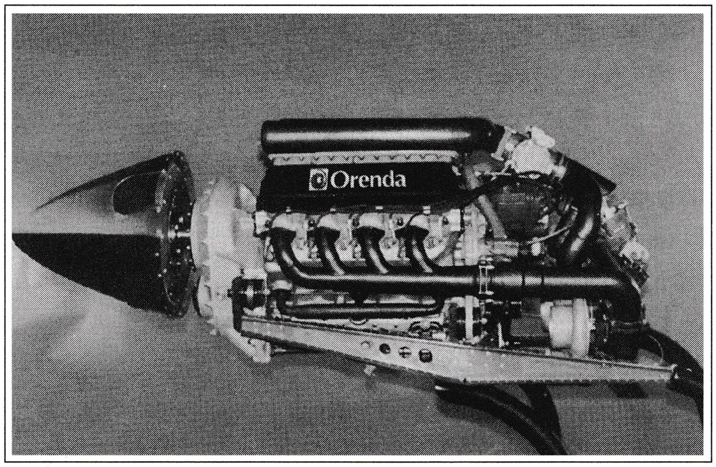
A current study is the viability of firing gas turbines with fuel derived from wood waste, as an alternative to traditional fossil fuels. This project is aligned with work being done with Mashproekt, Ukraine, on its GT2500 industrial turbine engine. After being modified by Orenda, this engine's combustor will easily accept alternative fuels, which are ordinarily difficult to burn in conventional, commercial systems. When the study is completed by the end of 1996, Orenda will market the GT2500, with its modified-combustor, fuel supply unit and generator, as a standardized, proprietary package. It will be ideal for producing electricity at pulp and paper mills, or at isolated villages in developing nations, where conventional fuels are not readily available.

These projects are among many research studies being conducted by AMES engineers, carrying on the tradition of innovative techniques and products established early in Orenda's history.

Reciprocating Engine: "Back to the future"

Early in Orenda's history, someone remarked that the world had entered the jet age; the piston engine was a thing of the past. The past is now part of Orenda's future. One of the potential growth businesses for Orenda is not in the gas turbine business but rather, in the reciprocating engine field.

This new business was uncovered in 1994 when the company was looking for strategic growth opportunities and recognized a significant void in the powerplant market. There were reciprocating engines capable of producing up to 400 horsepower available at an approximate cost of $200-250 per horsepower. Above 400 horsepower, the only turboprop engines were available at an average cost of over $400 per horsepower.



This price structure had several effects in the aviation market. First, a large number of aircraft were underpowered because, to keep total cost down, they used reciprocating engines even when additional power was needed. Second, an equally large number of aircraft are now too expensive to own and operate because they did incorporate the turboprop engine. Third, older aircraft which used out-of-production radial engines need a replacement engine because spare parts are difficult to obtain.

These issues convinced Orenda that there was a significant market for a powerplant in the 500-750 horsepower range if it could be produced at a price comparable to existing reciprocating engines. Orenda purchased the assets from such an engine program, that had been developed in the 1980's, that fit these criteria. The program had been dormant since that time because of funding issues.

Orenda has assembled a development team and has been refining that design for the last two years. Two significant Transport Canada milestones have been completed and final engine Type Approval is expected late this year. In conjunction with the engine activity, programs have been launched to install the engine in the Beechcraft King Air and the deHavilland Beaver. Both aircraft are expected to fly this year.

Interest in the engine program has been tremendous. Almost every aviation publication has written at least one story on the program and Orenda has received over 1000 written inquiries for additional information. That interest has come from a wide variety sources, pilots owners and operators of corporate aircraft, charter aircraft, and utility aircraft. Based on the overwhelming response as well as market studies it is estimated that there are over 35,000 aircraft that can benefit from the use of the Orenda series engines.

Such a niche market does not seem to exist anywhere in the turbine engine market. If it did, development of a new turbine engine would cost close to a billion dollars, well beyond Orenda's capabilities. Consequently, Orenda plans to grow the business by providing new reciprocating engines, utilizing the technology developed during 50 years of turbine engine accomplishments.

Affiliated companies

In its continuing efforts to provide customers with state-of-the-art products and services, Orenda is joined by two smaller companies, A.R. Technologies and Middleton Aerospace.

A. R. Technologies

A. R. Technologies became part of the Orenda group in 1994. At the time, Orenda needed a facility with the capability to tackle the most challenging component repairs, especially on smaller engine components.

At its modern, well-equipped facilities in Richmond, British Columbia, the company specializes in complex repairs of small, advanced components. Its capabilities include hydrogen, plasma spray, a wide range of welding and brazing techniques, non-destructive testing and air flow calibration, to accomplish even the most complex repairs.

Middleton Aerospace

Middleton Aerospace, located just outside Boston, Massachusetts, was purchased by Orenda in 1990, when Hawker Siddeley was looking for growth opportunities.

Middleton manufactures critical, prototype and production rotating and non-rotating parts for major engine builders in the United States, as well as for a number of the world's armed forces. Like Orenda, the company uses the latest CAD/CAM technology. Its well equipped facility includes conventional as well as numerically controlled machines, which can turn, mill and grind parts as large as 60 inches in diameter. The company is ISO9002 certified.

AVRO
CANADA

ORENDA

ORENDA

HAWKER
SIDDELEY
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Orenda

Changes to the Corporate Identity through 50 years

Orenda

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