The Avro story

Culminating in the sad saga of the CF-105 Arrow, which brought fame and shame, success and distress, and finally Black Friday

By James C. Floyd

It is probably the understatement of a lifetime to say that I approached this assignment to "tell the story of Avro Canada from the inside" with some trepidation.

Almost 20 years after Black Friday, books and articles on the subject are still appearing at surprisingly frequent intervals. I recently read a novel based on the growth and demise of the company. It made interesting enough reading, but as I closed the paperback cover over the last page I reflected that the facts as I remembered them were far more dramatic than any novel. It would require documentation approaching that of the *Encyclopedia Britannica* to adequately convey the growth and substance of this great Canadian enterprise, which dominated the aeronautical scene in the late '40s and through the '50s.

The projects turned out at Malton were acknowledged to be technically ahead of almost anything being developed anywhere in the world. The company's jet transport, the C-102 Jetliner, was on extensive route trials on the North American continent some eight years before the first United States jet transport went into passenger service with Pan Am.

The CF-105 Arrow interceptor prototype first flew over two decades ago, and yet its performance and manoeuvrability with full internal armament has not been surpassed by any front line service aircraft in use today.

Why then, did these two magnificent aircraft end up in the scrapyards and garbage cans of our great and enterprising country?

Any attempt to answer that question in a short article is almost certainly doomed to failure, since the Avro saga was a complex interplay of technical, political and human factors, leading up to the almost unbelievable events which in a single day virtually destroyed the company and scattered a magnificent team, the pride of most Canadians and described by General Lauris Norstad, head of NORAD, as "just about the best team anywhere," over the four corners of the earth, their skills and unique potential as an incredibly capable and integrated unit lost to Canada for all time.

During the 14 years of the company's growth, the old wartime Victory Aircraft plant at Malton, near Toronto, which had done a remarkable job of building over 400 Avro Lancaster bombers during the Second World War, was transformed into a giant aircraft and jet engine complex spread over some 400 acres and having a manufacturing area of over two million square feet. At the peak, over 14,000 people were employed at Avro Aircraft (9,000) and Orenda Engines (5,000) in facilities among the most sophisticated in the world.

Tooling, computing and testing equipment were comparable with anything in the United States; complete aircraft structures could be accommodated in the huge structural and mechanical test laboratories.

Flight simulation was provided by aircraft cockpit presentations coupled to complex analogue computation systems and displays, allowing pilots to get the "feel" of a new aircraft prior to first flight. Avro also had one of the first of the enormous IBM 704 digital computer installations.

The engine test beds and instrumentation were among the most comprehensive ever established. The Orenda and Iroquois engines, designed, developed and turned out in the Orenda facility, were comparable with anything in the world.

The manufacturing divisions in both the aircraft and engine companies were set up with the newest and widest range of machine tools and some of the largest heavy-press and skin-milling machines in the aviation industry.

Many of the employees had left excellent prospects in the United Kingdom and Europe to join their Canadian colleagues in the "excitement and tremendous potential" of the Malton scene.

The build-up of this large labor force in a relatively short time, involving the screening, training and integration of the recruits into a tightly-knit team is a story in its own right. At one crucial point in the Arrow program we were hiring up to 100 new people each week in order to maintain the schedule.

It has been necessary to confine this narrative to the activities of the Aircraft Engineering Division of the company, since that was my personal responsibility. The engine side was obviously of equal importance; but that aspect of the story would have to be told by someone better qualified than myself to cover the outstanding achievements made by Orenda Engines, particularly by men like Paul Dilworth, Winnet Boyd, Earle Brownridge, Walter McLachlan, Charles Grinyer, Harry Keast and scores of other key personnel, who among other things developed and produced over 3,000 Orenda engines in the first three years of the operation of the Orenda plant.

The main activities within the aircraft facility revolved around three projects: the C-102 jet transport, the Jetliner; the CF-

100 all-weather, twin-jet fighter, the Canuck; and the CF-105 supersonic twin-jet interceptor, the Arrow.

THE JETLINER

The birth of the C-102 Avro Jetliner was almost coincidental with the birth of the company.

A. V. Roe Canada Limited, a newly-formed Canadian company wholly owned by the Hawker Siddeley Group in England, moved into the ex-Victory Aircraft plant on Dec. 1, 1945, taking over the 300 employees remaining out of the wartime work force of almost 10,000 people.

The events leading to this move had commenced in the summer of 1945, as the result of negotiatons between Sir Roy Dobson (Dobbie), Managing Director of A.

Avro CF-105 Arrow on test flight . . . later scrapped because "the day of the manned fighter is over". (National Archives)

V. Roe in England, a member company within the Hawker Siddeley Group, and C. D. Howe, the Canadian Minister of Munitions and Supply.

Dobbie had been impressed with the manner in which Victory had tackled the job of building his Lancaster bombers and he became "sold" on the idea of Hawker Siddeley participation in building up a self-sufficient aviation industry in Canada, including research, design and manufacture of Canada's own aviation products.

His enthusiasm was shared, if not generated, by Fred Smye, a brilliant young Canadian who had been wartime Director of Aircraft Production in the Canadian government. It was Smye who was responsible for getting Dobbie and Howe together to talk things over. Howe was naturally concerned about the future of the large Malton plant and Dobbie's interest was like manna from heaven.

On a visit to Canada in mid-1945 Dobbie had an "over the drinks" discussion with Jim Bain, then Chief Engineer of Trans-Canada Air Lines, about the possibility of his proposed Canadian company building a medium-range jet transport for TCA. Dobbie was keen on getting in on the ground floor to exploit the new jet engine technology developed in the latter part of the Second World War, and Jim Bain became enamored with the idea of TCA being the first airline in the world to operate a jet transport.

In November 1945, Dobbie's top technical man, Stuart Davies (Dave) arrived in Canada for discussions with Fred Smye, who by this time had become Dobbie's sole employee of the as yet unnamed and unformed company. Operating out of an office at Malton, Smye had been given the task of deciding what projects the company should undertake when it was formed.

After their initial meetings, Dave and Smye had further discussions with Bain, and Dave undertook to "look at the possibilities."

At that time I was Dave's Chief Project Engineer at the Avro factory in Yorkshire. Among other things, we had been looking at turbine transport possibilities, for both turbo-prop and pure jet engines.

On his return to the U.K., oozing with enthusiasm about the potential in Canada and the TCA project in particular, Dave sketched out a specification which he believed would fill the airline's requirement and we set about the task of producing a feasibility study on an aircraft to meet this. We produced a number of possible configurations, both turbo-prop and pure jet powered versions.

Dave favored a 36-seat, twin turbo-prop version, but Jim Bain had been to England in the meantime and Rolls-Royce had done a remarkable job of convincing him that he should go the whole hog, throw out the props and specify R-R's new jet engine, the AJ65. Despite Dave's arguments, Jim Bain made it clear to Dobbie that "his" aircraft *must* be powered by the straight jet engines.

By this time Hawker Siddeley had purchased the Malton plant and Dobbie had christened the new company A. V. Roe Canada Limited, mainly because of his personal lifetime association with A. V. Roe in England. A well-respected and capable Canadian, Walter Deisher, was installed as president, with Fred Smye as his second in command.

Edgar Atkin, then Assistant Chief Designer at Avro in England, was appointed Chief Designer, with Stan Harper as his administrative man. They were just about to leave for Canada when Dave walked into my office in Yorkshire and out of the blue asked, "How would you like to go to Canada with Atkin and continue work on the jet transport over there?" I was on my way within a few days, landing at Malton in a snowstorm in late January, 1946.

With the exception of some conversion work, the plant appeared to be virtually empty; but there was a small nucleus of excellent engineers from Victory, who had been persuaded to stay on after the close-down of the wartime programs.

In April, 1946 Mario Pesando, who had been Victory's Chief Aerodynamisist, accompanied me to TCA engineering headquarters at Winnipeg and we spent some time with the airline's engineers firming up the specification and preliminary design for the transport, earmarked as the Avro C-102. H. J. Symington, president of TCA, followed up with a letter to Deisher saying that TCA would be in the market for 30 of these aircraft, if the agreed specification was met.

We returned to Toronto and design work on the C-102 commenced immediately, the engineering team rapidly building up to approximately 100 people. Design work progressed at a very hectic pace and was well underway when, in the late spring of 1947, Dobbie cabled Smye from the U.K. to say that Rolls-Royce had encountered difficulties with the AJ65 axial flow engines and could not now supply the certified civil version until two years after we needed it. They offered the Derwent centrifugal flow engine, with half the thrust of the AJ65. This meant we would have to change the design to accommodate four engines. The Derwent fuel consumption was higher, resulting in a weight increase for comparable range and there were other problems in changing the power plants; but there were also advantages with a well-proven engine: four-engine reliability, better take-off in hot and high conditions in the event of engine failure, and other considerations.

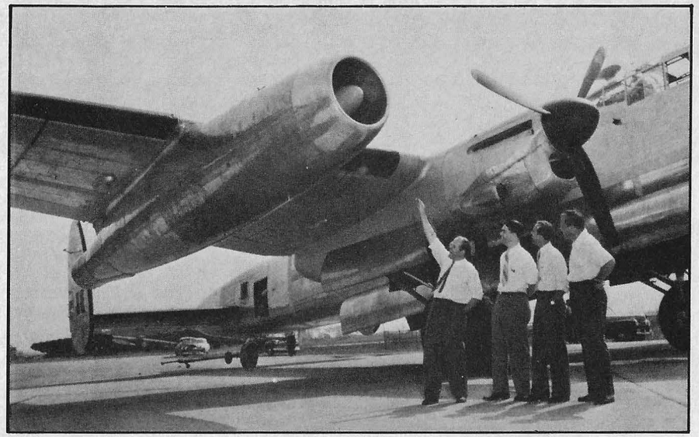
We therefore decided to push ahead with the project and modify the design so that the aircraft would still meet the TCA requirement.

In the meantime, there had been some contractual disagreement between the company, the airline and the Canadian government. The problems were mainly concerned with the establishment of the production cost of the aircraft. The company felt that it could not give a firm price until the airline made up its mind about the number of aircraft it would eventually order. On the other hand, the airline was not prepared to reach a decision on numbers until the aircraft had flown, and a firm price had been established (a situation very frequently met in the aviation business).

The outcome of this impasse was that Dobbie had returned the airline's letter of intent and TCA at this time had no contractual obligation on the project.

We returned to TCA with the modified design in October, 1947, and TCA issued a report on its reaction in February, 1948, from which it became obvious that TCA management had had second thoughts about going out on a limb as the first airline to operate a straight jet transport.

TCA engineers informed us that due mainly to the disappointingly slow development of Instrument Landing Systems at Canadian airports, their fuel allowances would have to be drastically increased. They also broke the news that they had had second thoughts on many



Above: Lancaster was flying test bed for Orenda engine. (National Archives) Below: Howard Hughes with the Jetliner, which he considered for his Trans World Airlines. (Don Rogers)

other requirements as set out in the previously agreed specification. That must have been the understatement of 1948!

The C-102 had been designed to the TCA requirement agreed in 1946, which called for a 36-seat aircraft with a cruising speed of 425 miles per hour, a "still-air" range of 1,200 miles, an average distance between stops of 250 miles, with 500 miles as the longest leg requirement. Allowances were specified as 45 minutes' stacking and flight time to a 120-mile alternate airport. Headwind was to be taken as 20 mph average, with 40 mph maximum.

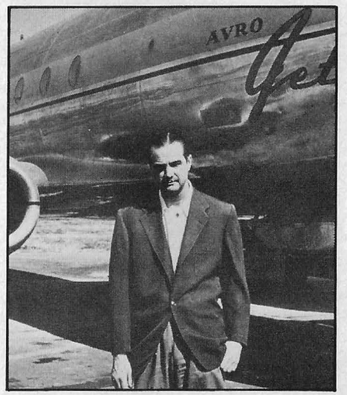
The new requirements called for a desired cruising speed of 500 mph, a still-air range of 2,000 miles, distance between stops of 954 miles with 40-passenger payload, against a 50 mph headwind. Stacking was now to be up to two hours on some routes, etc., etc.

As an indication of the severity of the new allowances, on the New York/Toronto run, the fuel needed for the actual flight of 364 miles was 9,400 lbs., but the *reserve* fuel to meet all of the new TCA requirements was 20,400 lbs., making for a total fuel load of almost 30,000 lbs. on this short flight. It should be mentioned that these levels of allowances were never eventually used on any civil jet aircraft operated by TCA, or anyone else; even on trans-Atlantic services.

(It might also be mentioned that while TCA credited the Derwent-engined Jetliner with only 300 miles range with 36 passengers using the new fuel reserves, a much more detailed analysis carried out jointly by Trans World Airlines and Avro engineers at Kansas City in April, 1952, on precisely the same Derwent-powered aircraft but using accepted TWA fuel allowances, resulted in a 40-passenger range of 940 miles. A version with Rolls Royce Nene engines was shown to have a 40-passenger range of 1,500 miles at higher gross weight, again with full TWA fuel allowances.)

It was therefore obvious to us that TCA had decided to "back-off" being first with a jet transport and were now in fact in full reverse.

I do not wish to imply by the foregoing that any blame for the ultimate abandonment of the project should be placed on TCA.



The airline was in a very difficult position. Not only had the ILS installations not materialized as we all thought they would back in 1946 and Jim Bain's pet engine flown out the window, but TCA had no previous experience of working closely with the manufacturer of a radically new type of aircraft.

This requires a very special and sympathetic relationship between the airline and the manufacturer. As a prime example, American Airlines worked so closely with Douglas on the incredibly successful DC-3 that it is still in debate as to whether Bill Littlewood, American's Vice-President Engineering, or the plane's creator, Donald Douglas, really masterminded the development of that aircraft.

We were never able to build up that kind of relationship with TCA, for one reason or another.

Whatever the reason, from the engineering point of view, TCA participation in the Jetliner project ceased completely more than 10 months before the aircraft had its first flight. Unfortunately, participation did not cease politically and under some pressure from both the government and the company, TCA was constantly asked to comment on the progress of flight testing and development. I personally feel this was a ridiculous imposition on an airline which had already expressed its disinterest in the project, and it resulted in the inevitable defensive criticisms which such a situation is sure to generate.

From my point of view, I knew that we had a really first class aircraft, with an excellent potential, and I felt that if TCA now had no interest in the Jetliner we should leave the poor sods alone and look to the more experienced and flexible airlines in the United States as potential customers.

Encouraging noises had already been getting to us indicating that a number of U.S. and European airlines were showing some interest in the high speed advantages of a jet transport and despite the TCA bale-out the decision was made to continue with at least the first prototypes and press ahead with an extensive development and testing program as quickly as possible.

The first prototype, CF-EJD-X, by this time christened the Jetliner, first flew Aug. 10, 1949, just 25 months after the design of the Derwent-engined version was started and just 13 days after the de Havilland Comet, the world's first jet transport, took to the air.

The weather was not ideal for the flight, with a temperature of 103°F in the shade and a strong crosswind.

The success of that first flight of a jet transport in North America can best be summed up by the euphoric remarks of the three crew members: Jimmy Orrel, Avro U.K. Chief Test Pilot, who had come over from England to fly the aircraft, said, "It was a piece of cake"; Don Rogers, Avro Canada Chief Test Pilot, "It handled like a feather, you wouldn't believe how well she behaved"; and from Bill Baker, the flight engineer, "I was amazed; everything was so sweet, so perfect."

All was not so perfect on the second flight when the aircraft had to make an emergency belly-landing because the main gear would not extend. But there was little damage and the aircraft was flying again within three weeks, having at least proved that a belly-landing would not be a catastrophe. This was the only mishap to the aircraft in over 500 hours of test flying.

In conjunction with the flight testing and route analysis program we now mounted an intensive marketing campaign, led by Avro's energetic head of Sales and Service, Joe Morley, and his equally energetic assistant, Murray Willer. They also brought in one of the most competent aviation people in America, Dixon Speas, who left a key position in American Airlines because, as he put it, "I'm really sold on that aircraft."

The flight program went unbelievably well. Airline flight times were halved by the Jetliner on intercity flights all over the U.S. and Canada; many U.S. airline executives were carried on these flights and without exception were enthusiastic about the aircraft.

The success of this phase was due in no small measure to the superb demonstration flying and technical ability of Don Rogers, Avro's Chief Test Pilot,

C-102 Jetliner after second flight. Aircraft was belly landed at Malton when the main gear failed to extend. (National Archives)

and Mike Cooper-Slipper, his co-pilot on most flights.

On one flight from Toronto to New York, with Don Rogers as Captain, we carried the first air mail in the world to be carried by jet, as well as a number of VIP passengers. On arrival in New York we were whisked downtown, flanked by a siren-blasting escort of New York City police, straight through the city to meet the mayor.

The next day the New York press had pictures of the Jetliner flying over the city, with the following caption: "This should give our nation a good healthful kick in its placidity. The fact that our massive but under-populated good neighbor to the north has a mechanical product that licks anything of ours is just what the doctor ordered for our over-developed ego. The Canadian plane's feat accelerates a process already begun in this nation—a realization that Uncle Sam has no monopoly on genius."

American Aviation magazine, in the January 1964 issue, recalled how G. T. Baker, the tough president of National Airlines, reacted to his engineer's report on their analysis of and flight in the Jetliner: "I send two of my most conservative people up to Canada for a couple of days to look at the C-102 Jetliner and they come back stark raving mad with enthusiasm for it."

Evaluation studies of the aircraft carried out jointly by the individual airlines and Avro showed that the aircraft was suitable for over 70% of National Airline's routes, 60% of United's, 50% of Swissair's and 60% of KLM's European services. Also, thanks to the untiring and dedicated efforts of Dixon Speas, the United States Air Force had expressed considerable interest in a military training version. The future of the Jetliner was looking very good.

In the meantime the Korean War had broken out and the United States had become heavily involved. It was not known where the conflict might end and all military production in North America had been stepped up. Avro Canada had designed, developed and flown the fighter aircraft, the CF-100 (about which more later) and a rapid production build-up was under way on that aircraft.

Just when the marketing efforts on the Jetliner finally seemed to be paying off—Dixon Speas had returned from a visit to National Airlines with a letter of intent to purchase four aircraft and an option on a further six; there was also the encouraging report that after thoroughly evaluating the aircraft on assessment trials at Wright Field where it had been flown by military pilots and some generals, the USAF had allocated funds for 20 Avro Jetliners to be used as navigation trainers—C. D. Howe instructed the company to close down the Jetliner program and concentrate all effort on the CF-100 because of the Korean situation.

From that point on the aircraft led a chequered existence. It was used as a camera platform on the CF-100 rocket firing program—it was the only aircraft large enough to carry the gear and still keep up with the CF-100. The final chapter was played out at Culver City, Calif., with CF-EJD-X used as a "toy" by the late Howard Hughes. He was interested in manufacturing the aircraft under licence at Convair and using it on TWA routes, but the U.S. government would not agree to Convair devoting effort and space to a new civil project in view of the Korean crisis.

The Jetliner was finally broken up for scrap. With the exception of a portion of the front fuselage and cockpit now reposing in a storage area at the National Aeronautical Collection at Ottawa, the only remaining substantial evidence of this great aircraft is in the personal basement museum of my old friend Bob Johnson, the man who was in charge of building the Jetliner in the plant at Avro. He has thousands of photographs, tapes and physical relics of CF-EJD-X.

Although the Jetliner never went into passenger service, there is no doubt that the lessons learned by the interested airlines, the airport authorities and the licensing authorities during the route flying over the North American continent served to pave the way for the eventual entry of the American jet transports into airline service a decade later.

Ironically, Dan Beard, American Airlines' Chief Engineering Test Pilot, recognized as one of the best assessors of new aircraft and the pilot who had been responsible for the flight development of the DC-3 earlier, said to Joe Morley, Dixon Speas and myself after a series of test flights in the Jetliner in the U.S., "You've got a bloody good aircraft there. I reckon it could be the DC-3 of the jet age." Cancellation came only weeks later.

I leave the epitaph on the Jetliner to the well-researched and conservative analysis of Dr. J. J. Brown, Professor of Entrepreneural History at McGill, in his book "Ideas in Exile" published in 1967. I quote:

"The Avro Jetliner—An Abandoned Masterwork:

"Even after 18 years (now 28) when one would think that the flush of rage and frustration would be eased by time, it is difficult to write about the Jetliner episode without passion. The Jetliner is without a doubt the major fiasco in the whole sweep of the history of Canadian technology. The decision to abandon the aircraft cost us billions of dollars in export earnings as well as incalculable world prestige. Yet there is no book on the subject that tells the real story, out of which we can gain invaluable lessons for our conduct in the future."

CF-100 CANUCK

Commercial success is inevitably measured in terms of profitability and numbers built, and on that basis the CF-100 can perhaps best be described as the only successful aircraft to come out of Avro Canada. Approximately 700 CF-100 aircraft were built at Malton through the many versions of that versatile aircraft; most of them delivered to the Royal Canadian Air Force although the Belgian Air Force also purchased a number of the later mark of the CF-100 as front-line night fighters.

Because the CF-100 was produced and used in quantity, and was therefore familiar to most Canadians, there is obviously less requirement for detailed documentation about it; but the impact of the CF-100 production program and the corresponding Orenda Engine build-up on the growth of the aviation industry must be emphasized in any article on Avro.

The CF-100 was the 1946 brainchild of Edgar Atkin, then Chief Engineer, and John Frost, a brilliant young designer from de Havilland in England who had worked on the DH Vampire and 108 Flying Wing project. Frost joined the company in mid-1946 and at that time Atkin formalized the engineering team by appointing Frost as Chief Design Engineer, Military Projects, in charge of the CF-100 and myself as Chief Design Engineer, Transports, in charge of the C-102.

The role of the CF-100 was to provide the RCAF with a truly all-weather day and night fighter with long range and very high speed at high altitude. It was equipped with sophisticated radar and weaponry and had to be able to operate from minimum service runway facilities. It may not be appreciated three decades later what a "tall order" this was at that time when successful jet fighters could still be counted on the fingers of one hand. The aircraft carried about the same fuel load as a Second World War bomber and the

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armament in the later marks was equal in fire power to that of a naval cruiser.

The first few aircraft were powered by British engines and the first prototype flew in January, 1950. The aircraft was designed to take the Avro Canada Orenda engines and the first Orenda-powered CF-100 took to the air on June 20, 1951. This was the first truly 100% Canadian aircraft and engine combination ever designed, developed and produced in Canada. Full production commenced in the winter of 1952-53, by which time the total Canadian involvement in Avro projects was considerable.

A new President of Avro Canada, Crawford Gordon, had joined the company in 1951 and had accelerated the build-up of the aircraft and engine facilities. By 1952 a new engine production plant had been opened at Malton and extension of facilities on the aircraft side was under way, with tooling and production of the CF-100 now virtually filling the plant. By the summer of 1952 it was estimated that more than 30,000 Canadians were involved in the Malton programs, in 400 different sub-contracting companies.

Engineering and production personnel had also been built up and by the end of 1954 the company was being re-organized, with the aviation divisions now consisting of two distinct companies, Avro Aircraft Limited and Orenda Engines Limited.

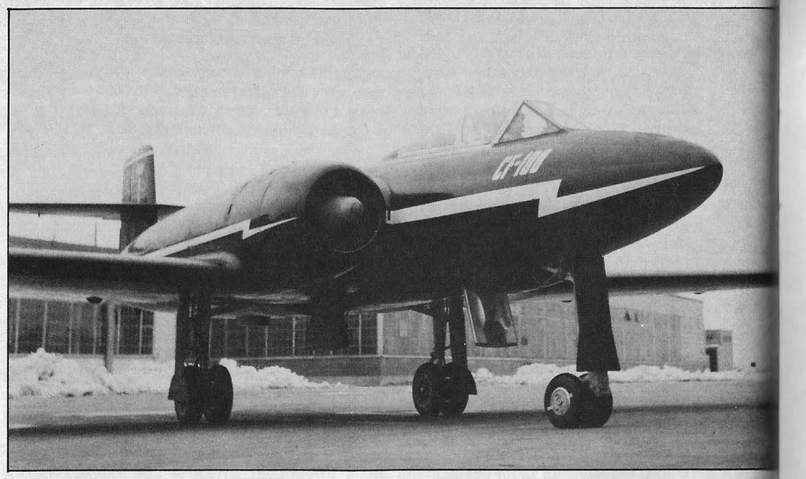
As in all forefront-of-technology projects we had problems as well as success. Cracks had appeared in the preproduction CF-100s at the junction of the main wing and the nacelles. It was obvious that this was a major structural defect requiring re-work of all the pre-production aircraft. These were withdrawn into the Experimental Department of the plant for modification.

We set up a special "blitz-group" in engineering which was given the sole task of addressing itself to the problem and coming up with the best and quickest cure.

The solution, a pin-joint at the intersection of the wing and engine nacelle "banjo-fitting" was evolved by a quiet but brilliant Polish engineer, Waslow Czerwinski. His scheme was simple and easily retrofitted and was quickly incorporated in the pre-production batch of aircraft which were re-delivered to a relieved RCAF.

Except for the constant "weight-reduction campaigns" and other normal development "pains," this was the only really major problem in the long production line life of the CF-100. Its rapid solution was a good demonstration that the capable engineering team we had welded together could rise to any emergency with ability and speed.

The first squadron of CF-100 aircraft was formed in the summer of 1953 and the last of these great aircraft was produced in 1958. In addition to its important role in the defence of Canada in squadrons which formed an integral part of the North American air defence system under NORAD, the CF-100 also saw service with Canada's NATO Air Division, as well as the Belgian Air Force.



CF-100 Mk. 1, of which more than 700 were built for the air forces of Canada and Belgium. (M. Cooper-Slipper)

CF-105 ARROW

So much has been written in the past about the CF-105 Arrow that one hesitates to add yet another chapter to the seemingly never ending re-assessment and re-statement of the impact of the development and ultimate fate of the Arrow. It would, however, not be possible to "tell the story of Avro" without some reference to this "super-project" which brought fame and shame, success and distress, and finally oblivion to the company; dealing a tremendous blow to Canadian prestige throughout the world.

In the autumn of 1952 the RCAF decided that, in view of the apparent increase in the threat, some consideration should be given to the ultimate replacement of the CF-100 (even before that aircraft had entered squadron service) and Air Marshal Roy Slemon, Chief of the Air Staff, sent an evaluation team of senior RCAF officers, led by Wing Commander Ray Foottit, to all the countries of the western alliance to ascertain the availability of a suitable aircraft to fill the need, since it was realized that development of a supersonic aircraft to meet the RCAF's specific requirements would be an extremely costly undertaking for Canada alone. None of the foreign designs being developed or projected met the full needs of the Canadian defence and in May of 1953 the Air Staff issued a specification, Air 7-3, for the project. This was followed, in July 1953, by a ministerial directive from the Department of Defence Production to Avro authorizing the company to carry out a design study for an aircraft to meet this requirement.

Meanwhile, Atkin and Avro's Chief Technician, Jim Chamberlin had during the previous two-year period been investigating a number of configurations for a CF-100 replacement and the RCAF had shown some interest in a delta-wing design, the performance of which had been reflected in their own specification. Atkin had since left the company to join an American firm and I was appointed Chief Engineer in January, 1952. It therefore fell to Chamberlin and myself to decide what we would submit as the optimum design to meet the specification.

As the analysis of the various possible configurations progressed it became increasingly clear that it would be very difficult to meet the RCAF specification based on current technology, since in its desire to meet Canada's obligations as the "first line of defence of North America" in a nuclear war, the Air Staff had asked for the moon. They required a two-place, twin-engined aircraft with all-weather reliability, long range, short take-off and landing, an internal weapons compartment as large as the bomb bay of the B-29, and a supersonic manoeuvrability of 2 g at Mach 1.5 at 50,000 feet without any loss in speed or altitude—a requirement which has been met by few, if any, service aircraft even to this day. In addition, it was to be guided by the most sophisticated automatic flight and fire control system ever envisaged. It was small wonder that Foottit's team had failed to find any such aircraft on the drawing boards anywhere in the world.

Chamberlin, a great bear of a man with a brain to match, was without doubt the best technical man I have ever had the privilege to be associated with. We finally came up with a design which would meet this demanding specification; a tailless delta, an inevitable compromise between aerodynamic, structural and aerolastic efficiency, with a very thin wing.

The Air Staff carried out a very comprehensive evaluation of the proposal before giving the go-ahead to commence the design and development of the CF-105 project in the spring of 1954.

At an advanced stage in the initial design we ran into Rolls-Royce trouble again on the engines, as we had on the Jetliner. The RB.106 engine around which the CF-105 had been designed was cancelled. We quickly switched to the Curtiss-Wright J67, only to have the US government pull out support on that engine. The only suitable engine left was the Pratt and Whitney J75, so we had to completely re-design the fuselage to take these engines since the power plants were integrated into the fuselage structure.

In view of the embarrassing frequency with which foreign engines had fallen by the wayside, a decision was made to fit the sixth and subsequent aircraft, to be designed the Mark II, with a new-technology engine being developed by Orenda, which also appeared to be of a size which would have excellent export potential.

This engine represented the ultimate in performance and fuel usage at that time and gave the Mark II CF-105 even better performance than the specification.

Because of the tremendous urgency of the program, it was decided to eliminate the building of prototype aircraft and virtually go straight into production with "hard tooling" on the first aircraft. Only those who have been associated with the design of a new aircraft will even begin to appreciate the tremendous pressures put onto Engineering by the combination of these decisions.

Here we were dealing with an aircraft more complex in every way than any previous service project and there were few reports or tests to substantiate the design features. We also had a brand new engine to develop at the same time (a combination avoided if at all possible by every aircraft designer since Icarus) and we were to issue full production drawings from scratch, from which permanent hard tools were made, well prior to even the basic testing program being completed.

Because of this decision, we had to mount one of the most comprehensive series of wind tunnel, structural, equipment and systems testing programs ever undertaken. The full record of these tests alone would fill a book. The company invested a fortune in the latest and most efficient machine tools from all parts of the world to mill the wing skins, form the structural panels and press the thousand and one items required on the aircraft.

They also brought in a new production chief from the U.S., Harvey Smith, who had previous experience of the "into-production-from-scratch method" at Kaiser. He drove all of us in engineering stark mad with his 7:30 a.m. "parts count" every day and his almost fanatical resistance to any changes in even the smallest part, but we knew that his attention to detail and his total dedication to the job was the only way that aircraft could be produced on schedule. He really was a most remarkable man.

The organization in Avro Aircraft was once more formalized under Fred Smye as President. Harvey became vice-president, Manufacturing, I became vice-president, Engineering, and Bob Lindley, another most unusual and capable man, who had been with me in the earlier days at Avro in Manchester, was made Chief Engineer in charge of the Arrow development, backed up by a very experienced and mature team.

It would be difficult to describe in detail the tremendous effort that went into the development of this aircraft. The best accolade one could give to the company and the CF-105 team is to say that by some miracle and the total dedication of those saddled with the responsibility of making the aircraft and the program work, it did!

The first CF-105 aircraft was rolled out on Oct. 4, 1957, and was promptly christened the Avro Arrow. It first flew on March 25, 1958, with Jan Zurakowski, one of the most capable pilots in the western world, at the controls. The first flight was so successful that we framed the "snag list," containing Jan's criticism of the "operation of two electrical switches." It must have been the shortest snag sheet of any first flight on any aircraft.

The aircraft was flown supersonically on the third test flight, while climbing and still accelerating at 50,000 feet. On the seventh flight it had reached a speed in excess of 1,000 mph and in subsequent flights was flown throughout the speed range up to 1,350 mph.

The second, third, fourth and fifth aircraft flew in relatively quick succession and all seemed set for the most successful aircraft program ever. By this time most of Canada appeared to be involved in the progress at Malton. The labor force of Avro Aircraft and Orenda Engines had grown to over 14,000 and Avro President John Plant, the retired senior Air-Vice Marshal and highly competent engineer who had joined Avro Aircraft as General Manager in 1957, announced in mid-1958 that some 650 Canadian firms were involved in supplying the 38,000 parts for the aircraft in addition to Avro and Orenda.

The government research establishments were also heavily involved in the testing program; and in the agonizing reappraisals that went on ceaselessly throughout the program.

It all seemed too good to be true—And was!

The Arrow weapon system was a complex combination of aircraft, weaponry and ground control. Avro could control the aircraft, but the responsibility and the final say in the overall weapon system rested squarely on the Air Staff.

Avro management made no secret of the fact it was most disturbed at the RCAF insistence on specifying the ultimate in fire control systems, the RCA Astra 1, and a new missile—neither of which were at the time even in the design stages—rather than an existing and proven system such as the Hughes M.G. 3 system with existing Falcon missiles, later to be replaced with the Hughes MX1179 advanced system. From Avro's point of view this added a further risk to the already gigantic task of developing a new aircraft and engine at the same time.

The company was apprehensive that development costs of all these items would ultimately be accounted against the aircraft program. This apprehension proved later to be only too correct, since at the time of the cancellation the airframe development costs were overshadowed by the anticipated costs of the avionics and armament.

The estimated costs of all of the weapon system components were already causing some anxious soul-searching when Canada elected a new Conservative Prime Minister, John Diefenbaker, in 1957. Diefenbaker made it clear shortly after assuming office that all his advisers were indicating that the days of the manned fighter were coming to a close and that

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missiles would quickly take their place in the defence role.

On Sept. 24, 1958, he took his first action on that advice, placing an order for the US BOEMA IM-99 Bomarc anti-aircraft missile and announcing that the Arrow program would be reviewed on March 31, 1959. He was not to wait that long. On Feb. 20, 1959, ironically the Golden Anniversary year of powered flight in Canada, he announced in Parliament that he had cancelled the whole Arrow program.

Just before noon on that morning, Fred Smye received a telephone call from DDP to the effect that Diefenbaker had instructed them to advise the company that: (a) the Arrow and Iroquois engine contracts were immediately cancelled and the companies must cease all work on the projects; and (b) that no further costs must be incurred and no alternative work would be available to the companies.

During that "Black Friday" company management explored every possible alternative and every aspect of this brutal announcement; finally, at 4 p.m., it was decided there was no other course open but to announce the immediate layoff of all the work force in the plants until "something could be sorted out."

It never really was. Although a nucleus of around 17% of the work-force was recalled on the Monday when seniority and other aspects had been sorted out with the unions, within a few weeks there was virtually nothing left of that great company.

Inquests into the events of Black Friday, and subsequent attempts to recapture the broken threads and build up the facility again, are legion; the smoke has still not entirely cleared from the scene.

Blame for the cancellation of the Arrow has, almost without exception, been laid squarely on Diefenbaker; but he was in some ways only the Pontius Pilate in the crucifixion of both the Arrow and the company. At a time when the British government had issued a White Paper prophesying the diminishing role of the manned fighter and the United States was considering cancellation of its requirement for a "super interceptor", the "prairie lawyer" who appeared to know so little, and understand less, about the aviation business or the defence needs of Canada, could perhaps be forgiven, for bowing to the clamor from some quarters that this costly program be terminated. His Minister of National Defence, a grand and brave old man who didn't appear to know one end of an aircraft from the other, was hoodwinked into believing that Bomarc would be the answer to all Canada's defence problems and that the manned fighter was obsolete.

The fact that these predictions and the advice proved later to be absolutely false cannot be laid entirely at Diefenbaker's door. How false they turned out to be is emphasized by the fact that many new breeds of manned interceptor aircraft have been used in service in a number of countries since that fateful decision was made some 20 years ago, and newer aircraft with performance approaching that of the Arrow are still emerging.

Even in the short term, the decision proved to be entirely wrong. Having already spent the taxpayers' money on the most expensive part of the Arrow program, that of designing, developing and test-flying the first batch of aircraft and engines, instead of purchasing the follow-on aircraft at a reasonable price, this solid investment was literally thrown away; two years later, when it was obvious that the RCAF would indeed have to have another manned aircraft, the government had to purchase from the United States one of the aircraft which Foottit's evaluation team had initially rejected as inadequate for the RCAF requirement—at around the same price that would have been paid for the Arrow production aircraft!

Hindsight is of course always easy to come by, but it should be said that the company produced numerous reports predicting exactly what could happen if the Arrow was cancelled. The ironic part of this fiasco was that the RCAF, which had laid down such an uncompromising requirement for the most advanced and sophisticated aircraft ever, inevitably resulting in a weapon system which was bound to be expensive under any condition, was conspicuous by its absence when "D-Day" came and the service stood back without a single official comment and "let it all happen."

While Diefenbaker cannot alone be held responsible for the cancellation, he can and should be indicted for the vicious and sadistic way in which he carried out the execution. To the staff of Avro Canada and the thousands at other Canadian firms who had put everything they had into those aircraft to make them "the best in the world", Diefenbaker's order to immediately "destroy them" was obscene and unforgivable.

I would like to have concluded on a note of profound wisdom, with a catalogue of the lessons to be learned from the Avro story; but the real tragedy of Avro is that the contributions it made to Canada's prestige and capabilities virtually disintegrated in the explosion of Black Friday.

For instance, the engineering team on the Arrow was scattered all over the western world, some into very important and "frontier technology" jobs. A group of ex-Avro engineers, including Jim Chamberlin, ran part of the Gemini space project under Bob Gilruth at NASA. John Hodges, the Gemini flight director was previously in flight test at Avro.

Bob Lindley, Avro's capable and dynamic Chief Engineer, went to McDonnell to run part of their space program; Carl Lindow and Frank Brame, two key Avro engineers, went to Boeing; Alan Buley, the Project Manager of Arrow II is now Managing Director of Fokker International in Holland. John Morris, Arrow Chief of Performance, is now in charge of the DC-10 at McDonnell Douglas.

Some stayed in Canada and are still making a substantial contribution to Canadian technology. Peter Martin, Project Engineer on the Arrow 1, was responsible for the design of the Twin Otter at de Havilland. Mario Pesando, who was originally Chief Aerodynamiscist at Victory Aircraft and later Chief of Flight Test at Avro, is now Technical Director of DAF Indal at Toronto, designing unique systems for bringing helicopters safely down on ships in all weather.

Some of the engineering team went over to the UK with me to set up an Advanced Projects Group at Hawker Siddeley where we did the original feasibility studies on the UK supersonic transport, which later became Concorde, in conjunction with BAC.

John Frost, the designer of the successful CF-100 was last heard of in Vancouver, designing advanced water craft. Guest Hake, who had been a key engineer on both the Jetliner and the Arrow, and Stan Harper, who had also contributed greatly to all the Avro projects, both went to Atomic Energy Canada Limited.

Some decided they had had enough: Jan Zurakowski, described by many as "just about the world's best test pilot," retired from the aviation scene altogether and moved north to run a vacation lodge.

The list of names of people of all divisions of the Avro Canada companies who contributed to the reputation which the company enjoyed world wide would more than fill the space alloted to this article; I mention these few merely to show the quality of the expertise represented by all employees of the company.

Fate did not deal so kindly with Avro Canada's top executives.

Crawford Gordon, the most forthright and capable President of Avro Canada and a great guy in any language, died a few years after Black Friday still a young man. One cannot help speculating as to the extent to which the traumatic events, culminating in that dreadful experience of having to announce the collapse of all the company's hopes to the 14,000 people at Malton, played their part in his untimely death.

The man who was really the "father" of Avro Canada, however, was Fred Smye, since he was involved in the part of the decision to set up the facility at Malton, was involved in all the decision-making throughout the life of Avro, and was in fact the longest standing member of the company.

The tremendous pressures involved in running a growing company were on his broad shoulders for the whole of the 14 years the company was in existence. Totally dedicated to establishing Avro Canada as a major aeronautical asset to Canada, he worked long hours and expected no less from those reporting to him. Yet even in the most difficult periods, when tempers were understandably "thin", I never once heard him raise his voice in unjustifiable anger.

He was and still is a great friend and inspiration to all of those who worked closely with him. I deeply appreciated his help in jogging my inadequate memory on proof-reading the draft of this article. Ironically, he now sits many thousands of miles from his homeland, writing a book on the "dark days". Perhaps we will all learn some lessons from that if and when it breaks; in the meantime, his great talent and sincerity are lost to Canada.

So what really went wrong? Was it simply that under great pressure the decision-makers lacked the guts to stand firm? Was the mistake in putting too much trust in the politicians? Was it lack of communication between the company and the voting public? Or simply that the company and its projects were too far ahead of their time to be understood and supported? Perhaps a little of all of these.

For those of us who were privileged to have participated in the trials, tribulations and the glory of Avro, it is sufficient to know that: "We were there!"

Theodore Roosevelt might best be quoted for a fitting last word on the subject:

"It is not the critic who counts, not the man who points out how the strong man stumbled or where the doer of deeds could have done them better.

"The credit belongs to the man who is actually in the arena, whose face is marred by dust and sweat and blood; who strives valiantly; who errs and comes up short again; who knows the great enthusiasms, the great devotions, and spends himself in a worthy cause; who at best knows in the end the triumphs of high achievement, and who at the worst, if he fails, at least fails while daring greatly, so that his place shall never be with those cold and timid souls who know neither defeat nor victory."

One thing is sure. Canada will never see the like of that great team again; . . . and yet!