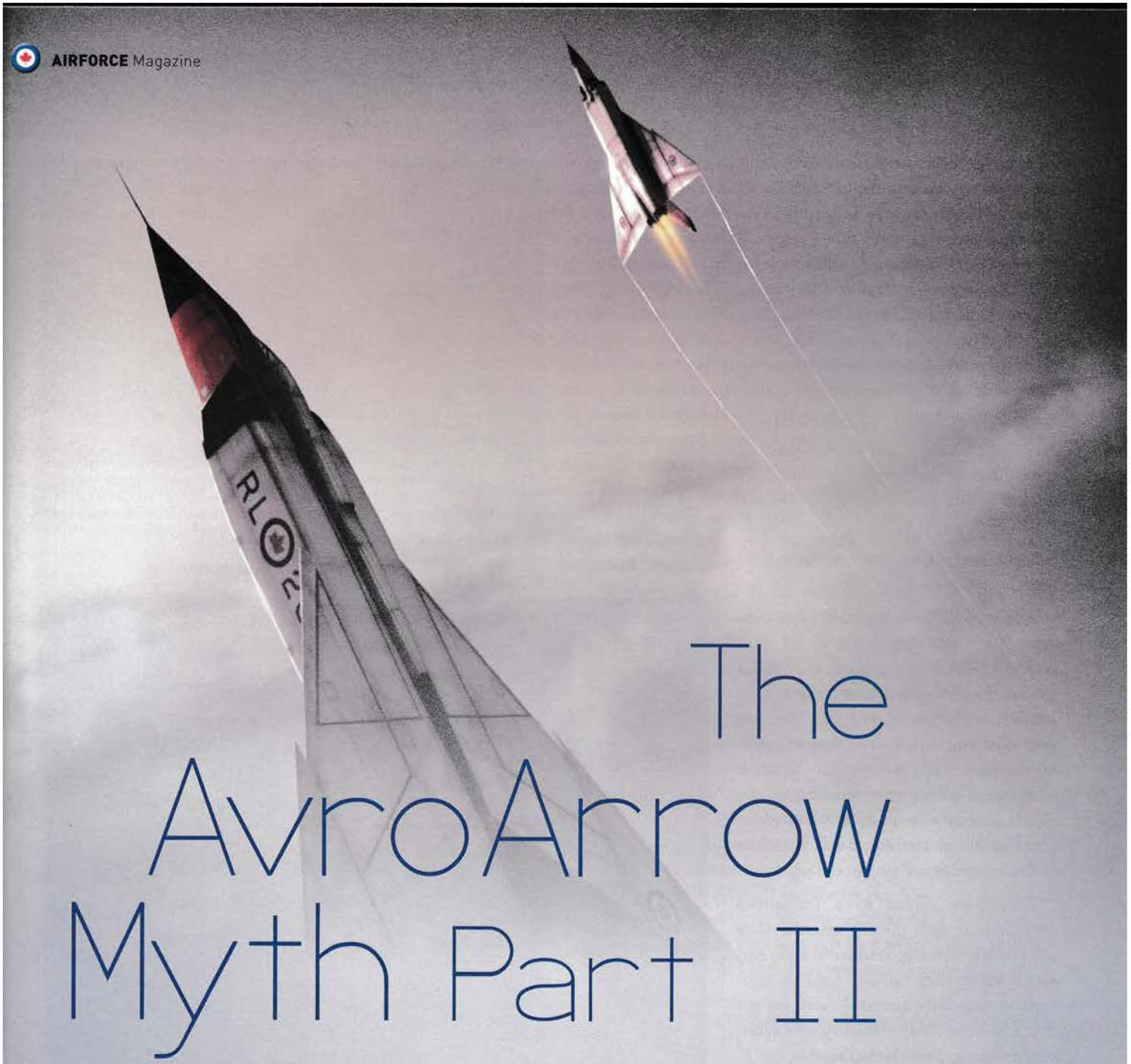

The Avro Arrow Myth Part II

by Colonel Layne Larsen, CD (Ret)

In Part I, Layne Larsen provided a chronological summary of the Avro Arrow project from inception to scrapping. Here he examines three of the widely-held myths, takes an objective look at the aircraft itself, and determines why the project was doomed to failure almost from the outset.

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Myth No. 1:

Prime Minister John Diefenbaker killed the Arrow.

Although Diefenbaker has been considered the "villain of the piece" for five decades, he really only made the formal announcement of the Cabinet decision (over which its members had agonized for five months) which itself was based upon a recommendation from the Service Chiefs. Diefenbaker could probably have kept the project alive, at least until the initial contract was finished, but to what end? The RCAF did not want the aircraft and had already determined that of the 37 contracted aircraft, only 20-25 would eventually be suitable for operational service, but that *they couldn't realistically afford to operate them*! (That is, logistic costs outweighed the military value of the asset.)

Myth No. 2:

Diefenbaker ordered everything destroyed to prevent the project ever being resurrected.

The real architect of this decision was the chief of the air staff (CAS), Air Marshal Hugh Campbell, *not* the PM. While this was long suspected, it was not proven fully until 1990 when declassification of some DND documents uncovered the relevant correspondence. Under standard procedures in place at the time, when a contract was cancelled, the Department of Defence Production (DDP) would:

• Determine whether any of the project's assets could be used by any other government department, and if so, negotiate their transfer, and;

• Transfer to Crown Assets Disposal Corporation (CADC) all the assets for which there were no takers so they could arrange for their disposal at whatever benefit could be obtained for the Crown. Used vehicles, office equipment, etc, were often sold by tender "as is." Items which had no potential civilian use were usually sold, also by tender, for their scrap value.

This process would normally take at least six months. In the case of the Arrow, everything was reduced to scrap in barely four months. Only two other agencies, the National Aeronautical Establishment (NAE) and the Royal Aeronautical Establishment (RAE) were offered assets. For various reasons, NAE passed on the airframes but did take one Iroquois engine. RAE took neither. The request of the then National Aeronautical Collection for an airframe and engine was ignored, as were preservation suggestions from civilian groups. In a memo to DDP, G/C Ray Foottit, signing for the CAS, specifically directed that everything was to be cut up *before* being sold for scrap unless a better price could be obtained by not doing so. However, *in no case* were major components or the engines, with the exception of the nose of RL206 that was to go to the Institute of Aviation Medicine (IAM) in Toronto, to be sold as entities. Scrapping of the engines was held up for a time, pending resolution of foreign interest (in 1957 Curtiss-Wright had signed an option to produce and market the engine in the U.S.), but the engines too were eventually (Nov 1960) passed to CADC for disposal.

Myth No. 3:

The Arrow was so far ahead of its time that if we had bought them, we would still be flying them; we would also not have needed to buy the CF-101 Voodo, the CF-116 Freedom Fighter (CF-5), the CF-104 Starfighter and the CF-188 Hornet (F/A-18).

In researching this article I skimmed several websites that made claims for the Arrow bordering on science fiction. For example: it was "...capable of 'super-cruising' at over 85,000 feet." That is, accelerating to supersonic speed and cruising there *without* the use of afterburner. Its actual service ceiling was 56,000 ft, but its combat ceiling would be only around 16,000 m, or about 52,000 ft – far short of the 85,000 claimed.

One site attributed cancellation to an American plot to eliminate competition to their aircraft industry; another to animosity between Diefenbaker and Avro executive, Crawford Gordon. A couple talked about the "one that got away," i.e. the Arrow that was secretly removed, hidden away, and won't be publicly revealed until all the participants are dead. The first two are near and dear to conspiracy theorists; the last one can be easily debunked through photographic evidence that shows the five Mk Is progressively being reduced to scrap (the only other completed aircraft, RL206, had the nose cut off for the Institute of Aviation Medicine).

While the Arrow did incorporate a number of leading edge technologies in its design, these did not translate into "ahead of its time" performance. As can be seen in Table 1, the comparison of the Arrow and its contemporaries indicates that it was not leading the pack, but firmly ensconced in the middle.

Based on our history with the Sea King, CT-133 (T-Bird) and Tutor, it is indeed conceivable that had we bought the Arrow we might still have been flying it into the 21st century. However, as will be become clear shortly, that is rather unlikely. In addition, acquisition of the Arrow would not have obviated the other purchases, except perhaps for the CF-101 Voodoo. This was acquired as the CF-100 follow-on at such advantageous terms from the U.S. that it fell into the category of "...an offer too good to refuse."

The Arrow was designed as a medium-range, point-defence interceptor – the same role the Voodoo filled. The CF-104 was acquired to fulfill a change in our NATO role – one which the Arrow was completely incapable of performing. The CF-116 (CF-5) was acquired as a cheap, lightweight tactical fighter to support the land forces – again a role for which the Arrow was completely unsuited. Had the Arrow followed an evolutionary upgrade

Aircraft	First Flight	Max Mach	R of A (km)	IOC	Service Ceiling (feet)
Convair F-102	Oct 1953	1.25	1,080	Apr 1956	50,000
Convair F-106	Dec 1956	2.3	1,170	Oct 1959	57,000
McDonnell F-101	Sep 1954	1.85	1,240	Mar 1957	55,000
McDonnell F-4	May 1958	2.25	960	Sep 1962	62,000
Lockheed F-104	Mar 1954	2.0	870	Jan 1958	50,000
Mikoyan MiG 21	1957	2.1	550	1959	51,000
Dassault Mirage	Dec 1956	2.2	630	Oct 1959	59,000
SAAB Draken	Oct 1955	2.0	560	Mar 1960	66,000
Fairey F.D.2	Oct 1954	2.0	640	N/A	N/A
English Electric Lightning	Apr 1957	2.1	670	1961	66,000
AVRO Canada Arrow	Mar 1958	2.3	660	June 1963 (estimate)	56,000

Table 1:

Comparison of key dates and performance factors of the Arrow and its contemporaries.
R of A – radius of action from base including five minutes combat in engagement zone.
IOC – initial operational capability (stand-up of the first operational unit.]
Service Ceiling – altitude at which rate-of-climb has decreased to 100 feet per minute.

program with new airframes, we might still have had some in service (Mk V, Mk VI?) in the early 1980s when the CF-18 was acquired. The original Mk II airframes, which were maintenance nightmares anyway, would have long since life expired.

How good was the Arrow?

As shown in Table 1, there was nothing in the way of performance to distinguish the Arrow from its contemporaries; however, it was still in very good company. The U.S. Air Force's F-106 Delta Dart served as NORAD's front-line interceptor until replaced by the F-15 Eagle. Similar claims can be made for the F-4, MiG-21 (USSR), Draken (Sweden) and Mirage III (France), all of which served their countries, and many export customers, with distinction for two, and even three, decades.

It is possible that with further development, the Arrow might have broken out of the pack and moved into the lead – and might not. At the time of its cancellation it was still a completely unproven design and years away from becoming an effective military weapons system. The RCAF had calculated that it would require 1,700 flight hours (and that was exceedingly optimistic giving the complexity of its systems) to clear the aircraft for operational service. At the time of cancellation, the five prototypes had accumulated a total of *less than 80 hours* (and two accidents, albeit minor) in the *11 months* since RL201 took to the air. This was also a major source of friction between Avro and the RCAF, when the latter discovered that the F-106 program was achieving figures as high as 1,000 hours per month!

Another significant problem was that Avro had designed many of the mechanical components as though they were for a "one-of-a-kind" research aircraft rather than to meet military operational availability and maintainability requirements.

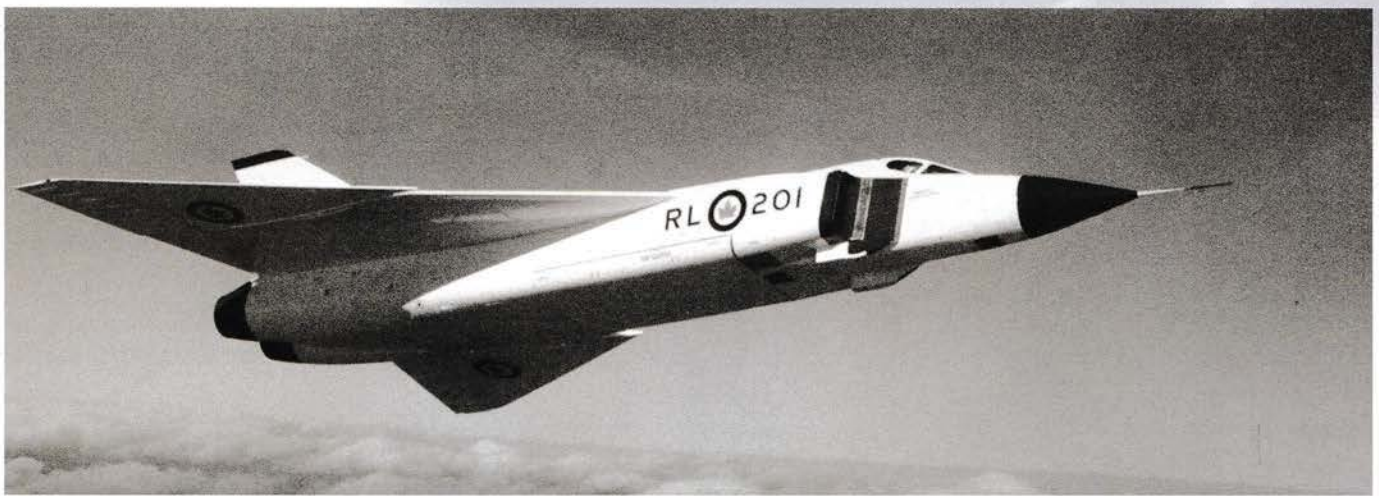
For example:

• Access to the control surface actuators could only be obtained by removal of control boxes that were held on by 400 close-tolerance, torqued fasteners for the ailerons, 372 for the rudder and 500 for the elevators.

• These parts were not interchangeable, but rather custom fitted to an individual airframe. A replacement would have to be clamped in place. For fastener holes that did line up the fasteners could be re-installed. For those that did not line up, the holes had to be drilled oversize, tapped, and have oversize fasteners installed. It was estimated that removal and replacement of any one of these control boxes would require about 70 man-hours, but the specified inspection interval was *only 50 hours*.

These are only examples of maintainability/interchangeability problems, and as early as July 1956, the RCAF had informed Avro that these problems were entirely unacceptable. Avro's solution was to increase the inspection intervals rather than to make the components interchangeable. It was these and other maintenance-related problems that were in part responsible for the glacially slow pace of the test flying.

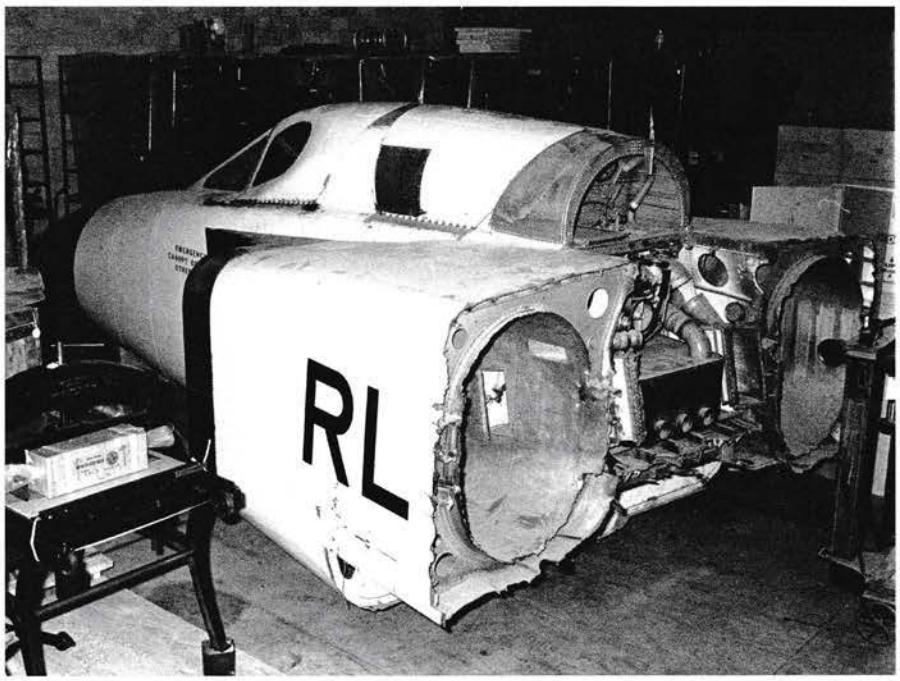
It is not enough merely to place the interceptor in the vicinity of its target: once there, it has to find and destroy it. The RCAF had been banking on RCA's ASTRA/Sparrow system, and when it was cancelled in late 1958, Avro was left



scrambling to fit the Hughes MA-1/Falcon system used in the F-106 into RL206 which was itself several months away from flying. (A trial installation of the Iroquois engine revealed that it did not quite fit; although not a major problem, this could require several months to resolve and could also delay delivery of RL207 and subsequent prototypes.)

What was clearly ahead of the pack was the Iroquois engine:

- Its thrust-to weight ratio was considerably higher than its contemporaries;
- Its oxygen-injection relight system was a first;
- First variable stator blades on a twin-shaft engine;
- First use of a transonic first compressor stage;
- First "hot streak" afterburner ignition system;
- First fully variable afterburner rather than the standard ON/OFF system;
- First bleed-bypass system for both intake and exhaust;
- First by-pass engine design, albeit a very low bypass ratio; and
- Combination of the above two points with an ejector nozzle that used the bypass air to create thrust at the exhaust nozzle while also improving intake flow. Most contemporary engines merely used a straight pipe.



The sad remains of the scrapped Avro Arrow now rest at the Canada Aviation and Space Museum in Ottawa.

This engine, which had completed thousands of hours of test running, was clearly superior to its contemporaries, and interest in acquisition or licensed production had been expressed by several foreign companies. Had the engines been exempted from the destruction order, and sales abroad more actively pursued, it is possible that something truly valuable might have been salvaged from the program.

A Project Doomed to Failure

There is no single factor to which one can point and say "This is the critical one," rather, there are several that combined synergistically to doom the project almost from the outset. Had any one of these not been present, the program might well have had a different outcome.

The RCAF had embraced the CF-100 project with confidence and enthusiasm; however, this waned when the aircraft continued to suffer from a litany of problems – such as falling out of the sky with embarrassing frequency – even after entering service (some claim this is the source of the aircraft's nickname "Clunk"). Although Avro eventually cured most of the problems, many senior members of the RCAF lost confidence in the company and had doubts about its ability to cope with the much more complex Arrow. This soured relationship was certainly not helped by the company's cavalier attitude towards RCAF concerns over operational maintainability and interchangeability, growth in aircraft weight and a corresponding decrease in performance, and failure to keep the program office fully abreast of ongoing events. Almost from the beginning, the project lacked the "we" attitude that fosters co-operation among the parties concerned. Instead, there was an "us and them" approach with constant "nasty-grams" flying between the participants.

The RCAF tried to manage the project out of Air Materiel Command HQ in Ottawa, rather than establishing a functional program office in Avro's Malton plant. The RCAF officers who were in Malton were part of the flight test team, and the senior ranking member was only a squadron leader. Today, a program of this magnitude would have an on-site manager of at least brigadier-general rank supported by a staff of 100-plus personnel.

A fighter/interceptor aircraft has four major sub-systems: airframe, propulsion, target acquisition/fire control and weapons. Conventional wisdom holds that if one of these sub-systems is a completely new design, then the other three should be either proven in-service systems, or evolutionary improved ("tweaked") versions thereof.

Since the airframe was a completely new design embodying many leading-edge technologies, then this concept says the other three systems should be, or be based upon, proven designs. Instead, Avro and the RCAF initially agreed on all four sub-systems being of completely new design – a recipe for disaster.

When the Canadian-designed *Velvet Glove* missile project was cancelled, Avro favoured an off-the-shelf purchase of the Hughes MA-1/Falcon system. As noted earlier, the RCAF and DDP, eager to put Canada into the age of advanced electronics and missilery, decided to go with RCA's ASTRA/Sparrow and forced Avro to accept this, despite warnings from company senior management that the uncertainty of this development project threatened the success of the whole Arrow program. This prophecy eventually proved correct.

Avro, the RCAF and collaterally involved government departments let the program get out of hand. They all realized that with a program this large and complex, there were bound to be many uncertainties; however, they lacked appreciation for the potential magnitude of the problems. Avro was not too concerned; after all, it was operating on a cost-plus contract. It was the constantly moving targets, both cost and delivery milestones, with no end in sight, that made the chiefs of staff and the Cabinet very nervous.

Most very senior officers of the RCAF (i.e. air commodores and above) grew up with relatively simple piston-engine aircraft whose fire-control system was a gyro gunsight and the "Mk I eyeball." Their practical experience with turbine-powered aircraft, if any, was likely limited to a familiarization flight in a T-33. In addition, very few of them had a university degree, and even fewer of these were in technical disciplines. Thus, they lacked the essential background to understand the complexity of the Arrow and its systems, and this led directly to some of the problems described above.

There was a deep division among senior officers in the RCAF on the interceptor-versus-missile question. The missile proponents believed that the manned bomber, if not yet obsolete, could be dealt with as effectively, but much more cheaply, with missiles. They ignored the fact that, unlike the multiple mission capability of the manned interceptor, once you expend your missiles, you are defenceless against subsequent attacks.

NORAD doctrine held that the manned bomber was going to be around for the foreseeable future and that manned interceptors were the front line of defence. These would be supplemented by missiles to protect high-value targets against bombers that got past the interceptors. (The American brass did not really care which option Canada chose as long as most of the potential combat [and the air bursts of the Genie nuclear air-to-air rocket] occurred north of the 49th parallel).

This divisiveness within the top echelons of the RCAF meant that internal support for the Arrow was never as strong and unified as it should have been if the project was to have a reasonable chance of success.

In Feb 1955, the contract for 40 developmental aircraft had been costed at $261M. Four years later, when the Cabinet was discussing cancellation, $400M had already been spent, yet only five Mk Is and one Mk II (less engines) had been delivered, the flight testing was only five percent complete and the engines and target acquisition/fire control system had yet to be installed for testing. With a potential billion dollar expenditure looming to deliver the contracted 37 aircraft, and which would, in the end, not yield any useful operational capability, no wonder the Cabinet felt that the $50M cancellation penalty was a bargain! ➤

Ed note: Retired Col Layne Larsen lives in Kingston, Ont. In our previous issue, we erroneously reported that he was a retired RCAF and CF pilot. He was in fact a radio officer who later cross-trained to air navigator. He is a noted aviation artist and is the editor of Aerial Views, *the newsletter of the Canadian Aviation Artists Association. He is a member of the Air Force Association of Canada.)*