Pre-Flight

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My Fond Memories of Bruce Warren, CF-100 Test Pilot

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Conclusion

After the accident, I had a nagging feeling about what had happened. If Bruce was unconscious, why hadn't Bob bailed out? Because here was no evidence that the canope had been jettisiioned. There was an aircraft canopy in the hangar that had just been taken off one of a flying aircraft because it had a minor crack in the glazing. Although it was not fit for normal use, it was just thing for conducting an in-flight pressure distribution test. Overnight, we drilled a series of holes in the canopy, ran hoses from them to a set of jury-rigged sensitive pressure guages in the back cockpit where they could be read by a flight observer.

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President's Message

Well, we are finally into Spring (March 20th), after what seems to be a very long and cold winter.

Negotiations by the Board at the Canadian Air and Space Museum are ongoing.

I hope this situation for a new home can be resolve soon. Toronto with its rich Aerospace History requires a permanent home so the achievements made by the Aerospace Companies in the Toronto and District can be passed on to the young people in the Greater Toronto Area.

Frank Harvey

Conclusion:
Bruce Warren, CF-100 Test Pilot

The ejection seat was unarmed because the array of gauges obstructed its use. Results of the flight test matched the wind tunnel test very closely except we had not put enough test points in an area crucial to determining if the canopy would jettison or not. So, we drilled more holes in that area and repeated the test. Results showed close agreement with the tunnel tests, and as a result, all aircraft were grounded for canopy modifications.

Canopy Jettison Flight Tests: After canopy modifications were made, ground tests were conducted prior to Flight Tests. For the flight tests, Jan Zurakowski and I went up to Camp Borden to arrange for conducting the jettison tests over their airfield. Jan flew tests on a Mk. 3 and a Mk. 4 aircraft, with the Jetliner acting as a photographic platform for the tests. Later, seat ejection tests, and observer windscreen tests were also conducted. The sacrifice of Bruce and Bob was the beginning of this sequence of developments and tests all adding to the safety of canopy jettison and seat ejection for subsequent aircrews.

Memories
of the
AVRO CANADA C-102 JETLINER
North America's First Jet Transport

The Avro Jetliner was the first jet transport to fly in North America [1], [2], and the second in the world, beaten by the de Haviland Comet DH106 by two weeks. The Jetliner first flew on 10th August, 1949, some eight years before the first American commercial jet transport, the Boeing 707-120, flew on 20th December, 1957 [3] and sixteen years before its first United States (U.S.) counterpart, the McDonnell Douglas DC-9, first entered airline service. The prototype, CF-EJD-X, was highly successful in all of its many testlights and demonstrations. However, despite intended orders from National Airlines, the USAF, and Howard Hughes, and interest from others, the prototype, the Mark 2 Jetliner which was under construction, and future configuration developments were all forced to be shelved because of Korean War politics on both sides of the U.S.-Canadian border.

Jetliner ... *cont'd*

My introduction to the Jetliner In the Summer of 1947, after having completed my third year of Aeronautical engineering doing stress work on the Jetliner which at that point had 2 Avon engines. It was there that I first became aware of Jim Floyd, the Jetliner designer. I was assigned to do a stress analysis on the center section of the wing and fuselage (which picked up all the wing, undercarriage, and engine loads) using a new stress-analysis technique - it was so new that nobody else really knew anything about what I was doing. This was in the days before computers. I did all the massive calculations on a Frieden mechanical calculator, and did the load flow-charts using multi-colored pencils. I just finished the analysis before going back to school. When I handed in my thick report to the Chief Structures Engineer, he looked at it and said that it was a good report - too bad we have just had to change the design to replace the two Avons with four Derwents because Britain won't release any Avons for commercial use! All that summer's work 'gone up in a puff of smoke' - c'est la guerre.

After rerturning to the University of Toronto and completing my aeronautical degree in the Spring of 1948, I returned to Avro's Technical Office working on both the Jetliner and the CF-100.. Then, after the Jetliner's first flight, I joined the newly-formed Flight Test Engineeering group. Over the next few years, I spent a lot of time with the Jetliner, but my most vivid memory is that of my first flight. We were flying just north of Kingston, Ontario, at between 30,000 and 35,000 feet. Although I had been a pilot of the Royal Canadian Air Force a few years earlier, most of my flying had been below 10,00 feet. Now, here we were at over 30,000 feet - about 4 miles higher. The view was spectacular, with the Lake Ontario far below, and with beautiful, huge thunderheads to the South of the Lake.

What impressed me the most, however, was the overwhelming feeling I had of being so very much alone. (I later had the same feeling on my first flight in the prototype CF-100 when we were even higher). At this altitude, there were no other aircraft in sight. They were all far, far below flying at half (or less) of our altitude and speed. That feeling of being alone was a direct measure of how far ahead of the competition we were. Moreover, this situation didn't change much throughout the life of the Jetliner, and it would be years before there were any other commercial aircraft up there with us. It has always amazed me that the politicians and others never seemed to grasp or appreciate the full significance of this tremendous lead and never vigorously nurtured and exploited the astounding opportunities that Jim Floyd and his Jetliner team had created.

First flight. The first flight of the Jetliner took place on the 10th August, 1949. The crew consisted of pilot Jimmy Orrell, the chief test pilot for AVRO in the United Kingdom; co-pilot Don Rogers, chief test pilot of AVRO Canada; and flight engineer Bill Baker, of AVRO Canada. The flight was a stunning success and, as Bill Baker said [2]: Awesome!

Second flight. Six days later, on its second flight, the Jetliner was put through a series of stall tests that involved buffeting and vibration. As a result, uplocks on the main undercarriage shifted so that the main gear would not release in spite of the strenuous efforts of Bill Baker to use the dual emergency release mechanisms - so strenuous that he broke a couple of ribs. Orrell landed the aircraft on the grass beside. a runway with the nose wheel down but the main gear locked up. It stopped just short of the airfield's boundary fence in a cloud of dust. The aircraft suffered only minor damage in its three-point landing - nose gear and the rear of the 2 engine nacelles. After minor repairs to the aft fuselage and the nacelles, and minor modifications to the main gear system, it was flying again in five weeks.

New York City. The Jetliner's flight program was a mixture of test flights and demonstration flights. An early demonstration flight was from Toronto to New York City's Idlewild airport. This was the first flight of a commercial jet transport in the U.S., and it carried the first jet airmail in North America. However, before the New York Port Authority would let the Jetliner land, I had to make and send them a color movie of a mechanic holding a long pole with a bundle of rags on the end and showing him dipping the rags into a can of aviation gasoline then extending the pole and rags into the jet stream of the idling jet engines. This was to show that the hot jet gases would not ignite gasoline that might be on the tarmac. Even with this demonstration, they made the aircraft park in the field away from the tarmac.The flight attracted the attention of many newspapers including the New York Times which featured the photo of the Jetliner over New York on its first page.

Many newspapers questioned why Canada had a commercial jet transport flying and the U.S. did not.

*The **conclusion** of this article will be in our next issue. Fred Matthews gives us a sense of what it was to be there, to sense the enthusiasm of participating in the development of the Jetliner, a huge step ahead of the rest of the world in the development of sommercial jet flight . And why it was stopped cold.*

Jetliner ... *cont'd.*

I worked on the Jetliner as a structures stress analyst during its design, first during the summer while I was an aeronautical engineering student at the University of Toronto, and then again after graduation. After its first flight, I joined the newly-formed Engineering Flight Test Section as a flight test engineer.

Because the Jetliner was licensed as an experimental aircraft, we wore parachutes. For stability and control tests, two 300 Imperial gallon water ballast tanks were installed in the fuselage, one forward and one aft. By shifting water from one to the other we could control the aircraft center of gravity during flight without having to land to shift lead ballast.

Later on, I also did flight test work on the Avro Canada CF-100 long-range all-weather fighter for the Royal Canadian Air Force (RCAF) and Belgians, and was in charge of Experimental Flight Test Engineering Operations on the Arrow CF-105 supersonic interceptor. After the collapse of AVRO in 1959, I joined NASA's Project Mercury and was named one of the first three Flight Directors. Following this, I was project engineer for RCA, working on such programs as adding the first comand-and-control computer-display system to SAC's Airborne Command Post aircraft. Of all of this, my work on the Jetliner was by far the most interesting and satisfying. To me, the Jetliner was like one's first romance - you never forget her.

Origin of the Jetliner. Canadian production of aircraft in World War II was at a higher output per capita than any other of the democratic nations. This included AvroAnsons, Curtiss Helldivers, Supermarine Stranraer flying-boats, Consolidated Catalinas and Cansos, Westland Lysanders, Hawker Hurricanes, Handley Page Hampdens, Bristol Bolingbrokes, North American Harvards, Fleet Finches, de Haviland Tiger Moths, Noorduyn Norsemen, de Haviland Mosquitoes, and AVRO Lancasters. In 1943, research began on jet engines. By 1945, preliminary design concepts for an axial f3 flow engine were developed resulting in the first Canadian jet engine design, the Chinook, which first ran on the 17th March 1948. One of the major Canadian wartime production plants was the Victory Aircraft Company, a Crown Corporation, at Malton Airport (now Pearson International Airport) just outside Toronto. It had produced Lancasters and other aircraft during the war and became idle at the end of the war. In England, the legendary, four-engine Avro Lancaster night bomber had been developed from the failed, two-engine Manchester. A major contributor to the Lancaster's development was James C. Floyd [1], [2]. Toward the end of the war, he was project engineer for post-war design concepts.

Meanwhile, Sir Roy Dobson, head of AVRO in England, had been impressed with Canada's work on the Lancaster and believed that there would be post-war opportunities for Canadian aircraft design and construction. At the same time, Trans-Canada Airlines (T.C.A., now Air Canada) became interested in the next generation of what is now called a regional airliner. Sir Roy seized upon this interest and, on 1st December 1945, on a rent-to-own basis from the Canadian Government, bought the Victory Aircraft plant and established A.V. Roe Canada Ltd. A few months later, Jim Floyd was sent there to be the design engineer for a jet transport project tailored to meet T.C.A.'s requirements. The project was soon given the designation C-102, and was later given the name The Avro Canada Jetliner.

Coincident with the development of the Jetliner, the CF-100 all-weather jet fighter and the Orenda engine were under development at Malton.

The Jetliner prototype configuration originally, was to have two, axial-flow, Rolls Royce AJ65 Avon engines, but, because of major development problems, the Avon was behind schedule and was only available for military applications. So in their place, four, highly-reliable, centrifugal-flow, Rolls Royce Derwent 5 engines were substituted in the prototype in a dual-pod arrangement. The cruising altitude and speed of the Jetliner were about twice that of contemporary transports.

As a result, a major concern in the design was cabin pressurization.

The Jetliner maintained sea-level pressure up to 21,250 ft. then 2,000 ft. cabin pressure at 25,000 ft. and 4,000 ft. cabin pressure at 30,000 ft. This capability required twice the differential pressure of previous airliners and was a major factor in designing the fuselage. Of particular concern were the windows which were round to avoid the structural problems of rectangular ones [1].

In designing the windows, AVRO profitted from research at Cornell Laboratories where vented double-pane windows, now the standard, were shown to mitigate decompression if a window blew out. A graphic film demonstrated the concept and showed a dummy seated next to a single pane window when it had a blowout - the dummy was extruded through the window. With their vented, double-pane window installed, the Cornell project engineer sat in the seat when the outer pressurized window had a blowout -he was enveloped in a rush of air but maintained his seating.

The Comet 1 was later to experience catastrophic explosive decompression because of window structural fatigue.