Hello Fred,

I thought I should pass along two items that could be added to your records in the Avro museum. One is my 2018 correspondence from Fred Matthews, who passed away on Oct 25, 2019. I had received his contact information from Palmiro Campagna and sent him a complementary copy of my book. The second is a wedding card that my father received from his Avro colleagues when he got married (on May 1, 1954). It was signed by the "Avro Mob" and has a type-written list of all the people who contributed to the wedding gift. I am sure that many of the names are already in your employee list, but perhaps there are a few names that could be added.

I have decided to put a hold on my plans to visit Calgary until the covid situation improves. Let's hope it won't take too long.

All the best,
David

Lexington, MA, , USA
June 10, 2018

Dr. David Waechter

Kitchener, ON,
Canada

Dear David

Thank you so much for your great book on the Arrow and Ralph's career. It was a delight to read, particularly because it vividly highlighted so many memories - including some I had forgotten.

Ralph and I graduated together from Aeronautical Engineering at the UofT in 1948, but we ended up working in different areas of the Avro aircraft development programs. Ralph was directly involved with design and performance analyses, whereas I was involved in the Experimental Flight Test Engineering Operation activities.

The difference between our two areas of activity made reading your account of Ralph's work so very interesting and informative - mostly in detailed ways I had been only aware of in general terms. You are to be congratulated for all of the hard work you did to piece together Ralph's work.

During all of the flight test activities on the CF-100, Jetliner, and Arrow, there were some interesting and amusing events. I've kept random notes of some of these over the years and now I've started to gather some of them together. I've included one that might be of interest to you.

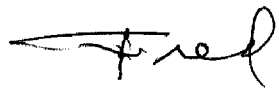
It concerns **the ice protection systems on the Jetliner and CF-100.** Avro was in the forefront for applying and testing such systems - far ahead of the US. because of the excellent icing research work done by the NAE. I was directly involved in the development and testing of the Avro aircraft icing systems from the beginning

Another subject that I'm in the middle of revising describes our **flight tests on the second CF-100 prototype, 18102, with its removable wing-tip fuel tanks for long-range ferry flights.** I was lucky that I wasn't in it when It crashed. I had been grounded with a cold.

Another subject that I'm also revising resulted from **me wondering why the observer, Bob Ostrander, who had taken my place, hadn't ejected before the crash of 18102.** This question was never posed in the formal investigation of the crash. which only dealt with the reason for the crash - pilot's loss of oxygen. I proved that Bob couldn't get out because the canopy wouldn't eject. My proof resulted in a complete re-design of the canopy and ejection system and a test program to prove that they worked.

Again, thanks for the copy of your great book about Ralph and his important role at Avro.

Best wishes:



Fred Matthews

Attachment: o Avro Aircraft Ice Protection Systems

p.s.: I was interested to see that you are in Kitchener. I was born in nearby Guelph. With Trump as president, I would move back to Guelph if my family weren't all here.

AVRO AIRCRAFT ICE PROTECTION SYSTEMS

CF-100 and Jetliner (C102) Ice Protedtion Systems. The systems on both were originally essentially the same.

- o For the airframes: the electric ice protection system built by Goodrich based on the design developed by the National Aeronautical Establishment (NEA), Ottawa
- o For the engines: alcohol injection
- o ice detectors designed by the NAE
- o NESA windscreens.

The NAE electrical boot ice protection system concepts originated during WW2 when, under the direction of John Orr, they developed electrical de-icing for the propellers of the ferry aircraft crossing the Atlantic to England and Africa.

The airframe ice protection system was an electrically-heated set of boots installed on the wing and tailplane. It consisted of a combination of anti-icing and de-icing. The anti-icing was provided by narrow, heated "parting strips" along the leading edges of the wing and tailplane to separate any ice on the top side of the airfoil from any on the bottom side. Then, after a certain accumulation of ice immediately behind the parting strips, the de-icing system applied heat to the de-icing boots to melt the underlayer of the ice accumulated on the top and bottom surfaces to let the ice blow off in the airstream. The Ice detection system controlled both the activation of the parting strips and the amount of ice allowed to accumulate before activation of the de-icing boots.

The ice detector was an airstream ram-air pressure-measuring device. When ice blocked a small air inlet in the front of it, it sent an ice-detection signal to the system controller then it immediately de-iced itself ready for any more icing. On the first detection, the anti-icing parting strips were activated and stayed on. After each 10 detections, the de-icing system was turned on for one cycle of boot heating. To minimize peak power requirements, the boots were segmented and the segments were heated individually in a cycle sequence that switched asymmetrically between port and starboard and wing and tail.

CF-100 icing protection systems Later, the CF-100 airframe ice protection system and the engine intake screens were deleted leaving only the ice detectors, NESA windscreens and engine ice protection. Apparently, the presumption was that, with engine power assured, the aircraft could survive long enough to climb out of any icing conditions.

CF-100 icing flight tests were carried out on the 5th CF-100, 18105 - the third Mk. 2 aircraft. On its initial test flight, it was determined that the engine-driven generators weren't powerful enough to support the electrical de-icing system. Therefore, the generators were replaced by higher-power alternators. No

drawings for such an installation had been made, so the chief electrical systems designer, Jim Clemenson, drew the necessary circuits on the side of the aircraft using marker pens. A draftsman stood by to copy it all for official drawings. Jim's grandfather in Scotland was 105. He attributed his longevity to his daily routine of taking the top off a coconut, drinking the juice, filling the coconut with scotch, sealing the top back on with wax, and putting it on a long shelf in the pantry. There were 364 similar coconuts on the shelves - one for each day of the year. Then he would go to the far end of the line and take the oldest coconut and open it and drink the scotch.

After one of the early icing system check flights, I wrote a sharp report to Orenda Engines. They had done work on the engine de-icing system before the flight and had left in a plug that totally blocked the flow of de-icing alcohol - oops. Fortunately we found this out before getting into any serious icing tests.

During the icing trials at Uplands, we shared a hangar with an RAF aircraft and ground crew. The aircraft had been on cold weather testing in Alberta and was being flown to Halifax for shipment back to England. When it arrived at Uplands it landed dead stick. The engine had suddenly quit as it approached the airport. This had also happened at Winnipeg on the way to Ottawa. While we were wrapping up for the day and getting ready to leave for supper, their ground crew had unbuttoned the engine and were in the process of removing some sort of assembly when all of a sudden there was a loud *boing* sound followed by all eyes looking up toward the ceiling and tracking some object all across the hangar. As we left, they were all on their hands and knees looking for the object, whatever it was.

For the CF-100, there was an alternative ice protection system under development by a well known heating and ventilating equipment manufacturer (I forget who it was). It consisted of gas pipes nestled in the leading edges of the wing and tail assembly, Inside the pipe, gases were lit to heat the pipe and thus heat the airfoil leading edges. When a test on a test rig ended with the pipe bent and actually touching the skin and damaging it, I wrote a blunt memo to the project office noting that such occurrence in a CF-100 could end in disaster particularly because the integral wing fuel tanks were known to leak on occasion. As a result, the project was cancelled in favor of the electrical system. I didn't know it at the time, but the proponent of the gas system was the Chief Engineer, the late Bob Lindley. I think he was annoyed at me for blowing the whistle.

USAF Icing Research Symposium After the successful tests on both the Jetliner and the CF-100, I was sent, with Floyd's assistant and a project engineer, to the USAF's annual Icing Research Symposium held atop Mt. Washington. They had a jet engine icing test facility in a barn-like building just below the summit. For engine testing, they just opened the front doors and the

back doors and let the icy wind blow through. The altitude and local weather in the winter were ideal for testing.

The Symposium was held in the ski chalet (lost in a fire some years later) located at the base of the mountain road leading to the test facility and the weather facility just above it. When we checked in to the chalet, they assigned us to beds in one of the several dormitory areas. Each area held about 20 beds.

The guests at the Symposium included some very high-level executives from the various jet engine companies, particularly those companies whose engines had been under test.

After we checked in, we were still in the lobby when a very well dressed gentleman with lots of fancy luggage checked in. He was obviously one of the engine company executives. When he was told where he was to sleep, he objected, saying: *Wasn't that the room number you just gave those people?* The clerk said: *Yes! And 16 more before them!* The man blustered and finally said: *How am I supposed to get all of this luggage up there?* The clerk replied: *Carry it! How else do you think it'll get there?*

The engine test facility was just below the weather observatory. You got to the facility and weather observatory over a narrow gravel road that wound up along the side of the mountain. Although it was spring and trees were starting to bud, once you got to the tree line, it was still deep snow. In summer you can drive your car up the road to the top. However, the only way to get there the rest of the year is by authorized tracked vehicles. For a tour of the test and weather facilities, six of us were driven up in a Weasel. After we passed the tree line, we approached a part of the road which barely skirts the edge of a steep 800 ft. deep ravine. Because the snow had drifted, the road wasn't flat, it was sloped toward the ravine. The driver stopped the Weasel and said: *You guys had better get out for the next couple of hundred yards and walk.* You never saw 6 guys get out a vehicle so fast. Somewhere, I have a photo I took of the group of us outside the vehicle showing the very limited visibility in the blowing snow. When we got to the weather facility, the wind was so strong and the ground was so icy and slippery that we had to hang on to ropes strung between the buildings to get from one to another.

When the Symposium staff found out that we were from Avro and had finished flight testing the de-icing systems in the Jetliner and the CF-100, they asked me to give a presentation. I didn't have any briefing material with me so I gave a chalk talk. It was in distinct contrast to the other presentations in that I was talking about actual flight tests in icing conditions, whereas the other talks were either about the engine tunnel tests or were theoretical papers on flows over airfoils to determine just how far back from the leading edge you had to provide

icing protection. That contrast was a good indication of just how far ahead of the competition we were.

Also attending the Symposium were two key people from the NAE Icing Research Lab. They drove us back to Montreal so we could catch a train to Toronto.

Grumman An indication of the magnitude of the jet engine icing problem is the loss of a complete flight of Grumman Navy jets in an icing encounter. After my presentation at the Icing Symposium, Grumman apparently contacted Avro and asked that I visit them on Long Island. I never heard any details of the request but I was never sent.

Fred Matthews

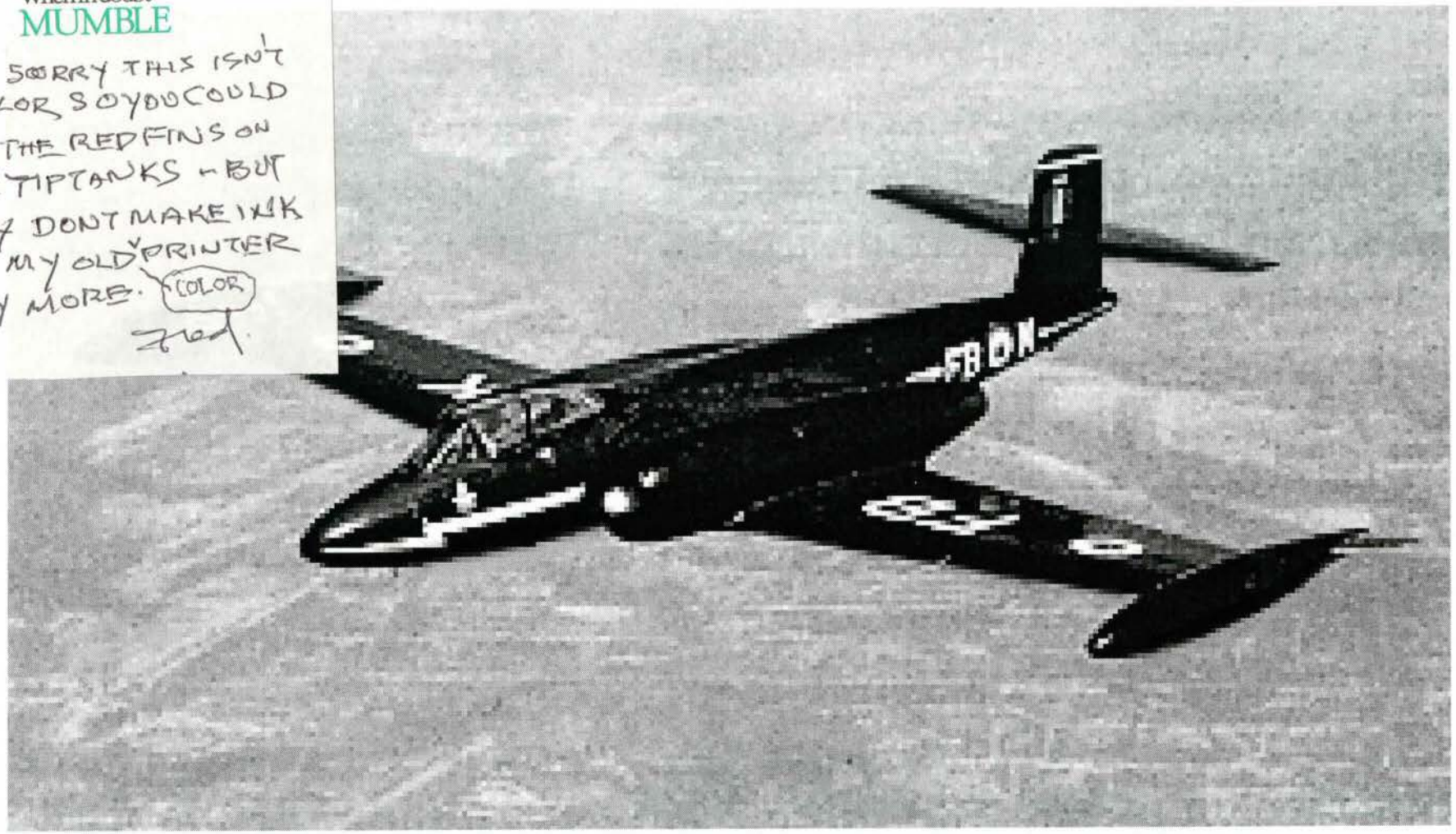
Lexington, MA, USA
Aug. 31, 2009
Revised June 10, 2018

When in charge
PONDER
When in trouble
DELEGATE
When in doubt
MUMBLE

IM SORRY THIS ISN'T IN COLOR SO YOU COULD SEE THE RED FINS ON THE TIPTANKS - BUT THEY DONT MAKE INK FOR MY OLD PRINTER ANY MORE. (COLOR)

Fred

Post-it note attached by Fred Matthews



CF-100 Mk 1 18102 (FBK) with prototype long-range ferry tip-tanks with red fins.
White patches on the starboard tip-taniks are strain gauges. (I was in it when the photo was taken - Fred Matthews)