Pre-Flight

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The Forgotten Few

by Ron Brighty, P.Eng.

March 21st was one of those rare occasions when the past comes vividly to life and the intervening years melt into insignificance. It was the dinner and get-together celebrating the 40th anniversary of the first flight of the *Arrow*. Despite the satisfyingly large attendance, I felt a little sad at the relatively small number of people who were able to stand upon request and identify themselves as Avro participants in the *Arrow* programme. We are a declining population. The after-dinner speeches included reference to the vast range of vocations employed in the design, production and flight of that beautiful aircraft, and the commitment of each to the development and care of their creation. In the Avro community there was an unusual spirit of family, with all its togetherness, squabbles and solidarity. Its one determination was the furtherence of the achievements of its "baby", the *Arrow*. Nothing can detract from the zeal and loyalty of those family members. But, as always, one of the family was forgotten.

A small group of people held the "baby's" hand through all its flights, and was almost as close to the aircraft as the pilot. This was the Experimental Flight Test and Experimental Flight Test Instrumentation Group. Among all of its innovations, the *Arrow* had one of the most advanced flight test instrumentation systems in the world. Yet, to my knowledge, no reference has ever been made to the fact that from the moment of take off to the end of the landing, engineers and technicians had their hands on the aircraft's pulse, monitoring radio signals during flight and analyzing recorded data after the flight.

For this purpose, the five aircraft had a vast array of electronic instrumentation, completely filling their 17x9x3 foot armament packs and fed, via five 4 inch diameter cables, from transducers in every part of the aircraft. The transducers converted parameters such as position, acceleration, pressure, temperature, rate, etc., to electrical analog signals which were routed to a central distribution point. From there, they were channeled to appropriate instrumentation systems.

The continuous trace oscillographs which recorded analog signals from the transducers, and the auto-observer panels which photographically recorded the reading on instruments, had been used regularly on CF100 flight test aircraft. However, the

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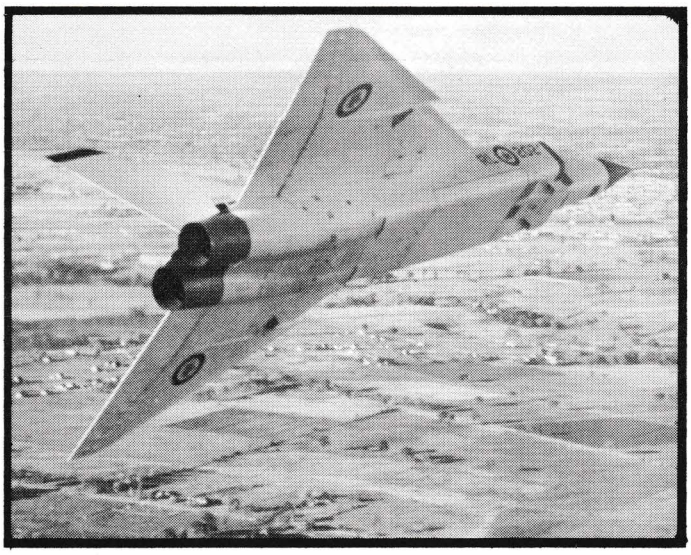

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FROM THE PRESIDENT

The summer is upon us once more and things will be heating up in some areas, while slowing down in others. If, by chance, you happen to drive by the Toronto Aerospace Museum buuilding at Downsview, you may not see too much activity on the outside. However, let me assure you, things are moving along on the inside, according to schedule. The Foundation has already brought items into the space allotted to it and the moving schedule is being finalized. The member volunteers will have a lot of cataloguing and packing to do before the final move to our new digs. AHFC has accumulated much over the years, thanks to good fortune, generous donors and faithful members. We are truly grateful to all of you.

The underwater recovery Group will be out on the lake again this summer, its members keeping their fingers crossed for good weather and a light swell. We'll keep you regularly posted through *Pre-Flight*.

Nicholas Doran
NICHOLAS DORAN

Forgotten Few, continued:

telemetry system and data tape recording system were state-of-the-art innovations. The telemetry system continuously transmitted the performance of important aircraft parameters to the ground trailer, via a stub antenna that projected beneath the aircraft, behind the instrumentation pack and just forward of the jet pipes. Tests made on CF100, No. 18185, verified that good results could be obtained when the aircraft was flying at 10,000 feet, 100 miles distant, and usable data was received when at 30,000 feet and 200 miles distant.

The system was manufactured by Bendix Corporation, and I asigned two technicians to attend a three-week technical training course at the company. It is of interest to mention that one of these echnicians rose to a very responsible position at NASA in later years. The data tape system was designed and manufactured by Consolidated Electrodynamics Corporation (CEC) of Pasadena, which I visited for a week for familiarization before assigning three technicians for a five week course at the plant.

The signals from the various transducers were of different voltage amplitudes and waveforms, so before being passed to the recording and/or transmitting instrumentation, they had to be suitably modified by signal conditioning units to be compatible with the systems. For very slowly varying signals, where continuous recording was not necessary, a multiplexing system allowed forty different parameters to be sampled, each at 20 times per second, and recorded on one channel of the datatape or telemetry systems.

The whole test instrumentation system could be programmed to automatically calibrate itself at preset intervals, or could be calibrated at any time by a push of a button in the cockpit. The data tape system also had one channel devoted to a Range Time Generator signal that recorded an elapsed time signal, and identified the precise time that any event occured. The data tape generally ran at 10 inches per second, but could be programmed to perate at 20 or 40 inches per second. Signals received on the ground from the telemetry system during flight were recorded at 60 inches per second to preserve the high frequency content.

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Forgotten Few, continued:

The data reduction systems on the ground provided means of recording the individual aircraft signals. This could be in either analog form on continuous trace recorders or oscilloscopes, or digital form for computer or card punch system use. It is impossible to cover the full scope of all the *Arrow* experimental flight test instrumentation here. But it is safe to say that, at the time, it was about as advanced as one could get. In my *Arrow* memory file, I still have a sixteen-page summary for the whole system that I wrote for the benefit of some who were not so closely involved with it.

Maintenance of all of this complex system was the responsiblity of the 42 members of my staff, as was the design of certain power supplies and other auxiliary equipment. Every member of that staff was as close to that aircraft and as dedicated to it as I was. How close were we?

Let me give you just one incident. At around 1:00 am on a morning, I was in D2 hangar, talking to Harry Shipley while one of my staff was in the port air intake of RL201, smoothing the epoxy cement around a static pressure transducer. In a calm, matter-of-fact voice, Harry asked, "Do you want to see her fly today?", which sent me up the ladder, and my staff member home for a few hours' sleep; I lived closer to the plant than he did. I went into the air intake and finished the job before hightailing it home.

Around six hours later, I was back at the plant, standing by the side of Derry Road West with Don Whitley and one of my staff, feeling a sense of personal pride as my finger pressed the button of my old 8 mm movie camera and recorded, directly over our heads, the take-off of the first flight of the *Arrow*. A little later, standing within 30 feet of the side of the runway, I recorded the first touchdown.

Yes, we members of the Experimental Instrumentation Lab, in the old D1 hangar, were very fond of and very close to that aircraft.

Ron was the Supervisor, Experimental Flight Test Instrument Laboratory, is quite able to stand up when his name is called, and lives in a pleasant part of south-western Ontario in the town of Tottenham. For those who might want to talk over the old days and renew memories, his address is:

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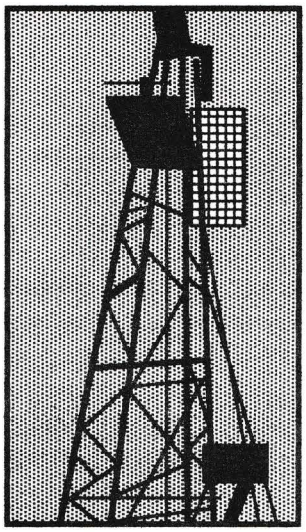
Tottenham ON L0G 1W0.

RADAR: radio detection and ranging



The next time you are asked to pull over on the 401 by one of the province's finest, you should know that the radar indicating your speed began in the fertile mind of Robert Watson-Watt, a distant kinsman of James Watt, the inventor of the steam engine. Watson-Watt began his career in engineering, but during WW I, he was sidetracked into a new field, meterology. While working on an electronic system to locate thunderstorms, he discoverred that distant airborne objects could be detected by the reflection of radio waves.

The British Air Ministry was concerned about the ominous signs of war in 1935. It asked Watson-Watt if he could adapt this system to detect aircraft. It was not long before this was accomplished and presented to the Ministry. The opposition to this radio location technique was intense. British scientists and politicians in high places did not believe it would work. But Watson-Watt persisted and continued the development of the radio system. It was tested during the flight of British PM Neville Chamberlain to and from Munich and soon was reluctantly approved.

The radio detection and ranging system (RADAR) was used during WW II very effectively, especially during the Battle of Britain in 1940 - 1941. As wave after wave of Nazi aircraft flew toward England, the British air and ground defenses had advance warning and were prepared, though outnumbered. As a result, they stopped this apparently invincible Nazi air armada. The King knighted Watson-Watt in 1942, whose invention stemmed the onslaught and saved not only England but also his native Scotland. Radar continued to be developed, perfected and adapted during the remaining war years, and was used extensively in aircraft and naval vessels. It was a major factor for some amazing successes by the Allies and undoubtedly saved many thousands of lives. The USA recognized the great contribution of Watson-Watt by honouring him with the Medal for Merit in 1946. He died, aged 80, in 1973.

So while the officer is writing out the ticket, you can fill him in about the radar unit that helped him assess, through detection and ranging, your relative position and speed. But don't expect his appreciation.

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