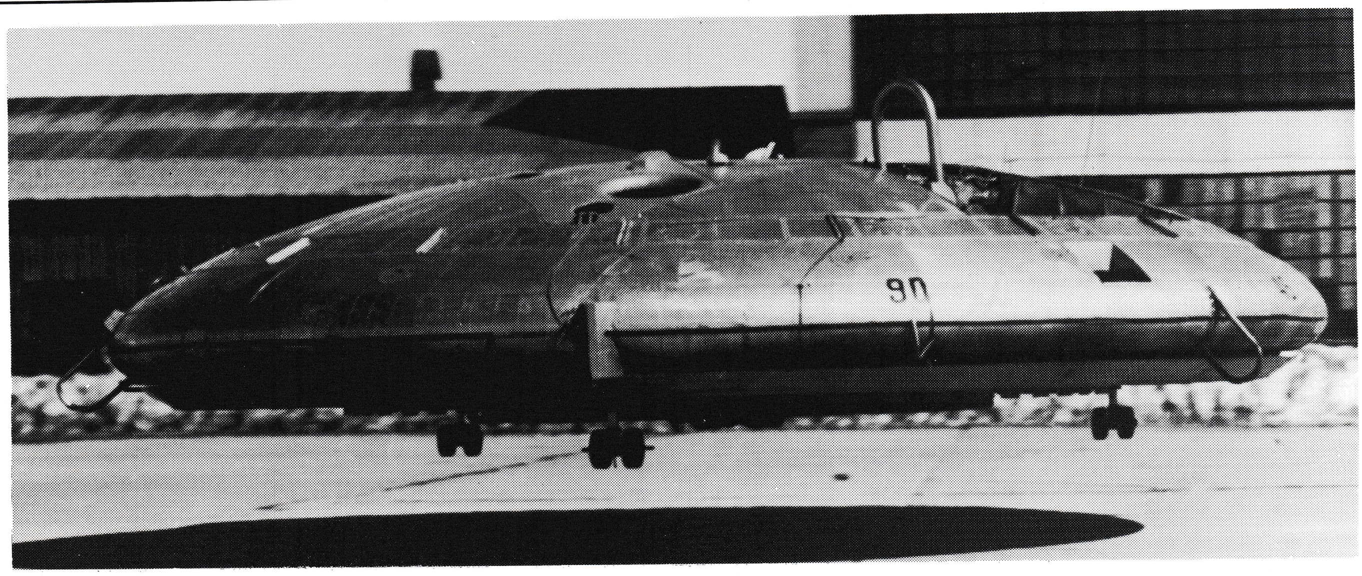
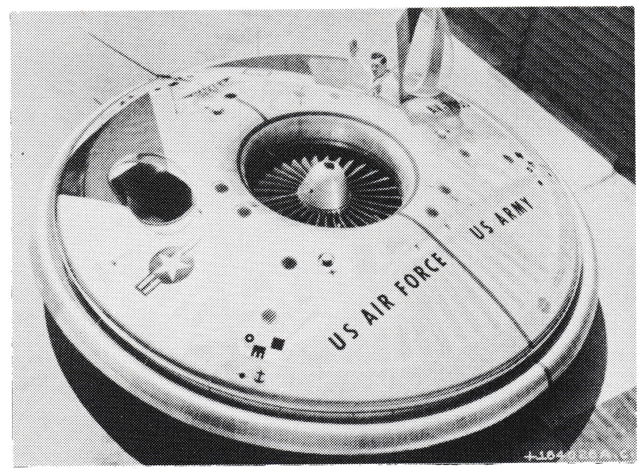




the VZ-9V AVROCAR "Flying Saucer"

Alan C. Dares

Even Today, the General Public is Unaware of the Existence of this Canadian-Designed and -Built Special Purpose Vehicle

On a calm day, 5 December 1959, a high-pitched whirring sound filled the air in a small town in Southern Ontario. Here on the tarmac of the old Malton airport, history was being made. This was the era of the flying saucer - the first of a possible full line of high performance, high altitude aircraft based on an inverted saucer platform. Canada, due to its highly developed jet engine technology and aircraft manufacturing, was chosen to conduct the experimentation, development and testing of this new concept. Generally speaking, it involved vertical take-off and landing, ground-effect flight, and circular wing aerodynamics.

The project had always been elusive and secretive in nature and even today, the general public is unaware of the existence of this Canadian-designed and built special purpose vehicle. The following article is an attempt to shed some more light on the background of the saucer, designated the Avro VZ-9V Avrocar.

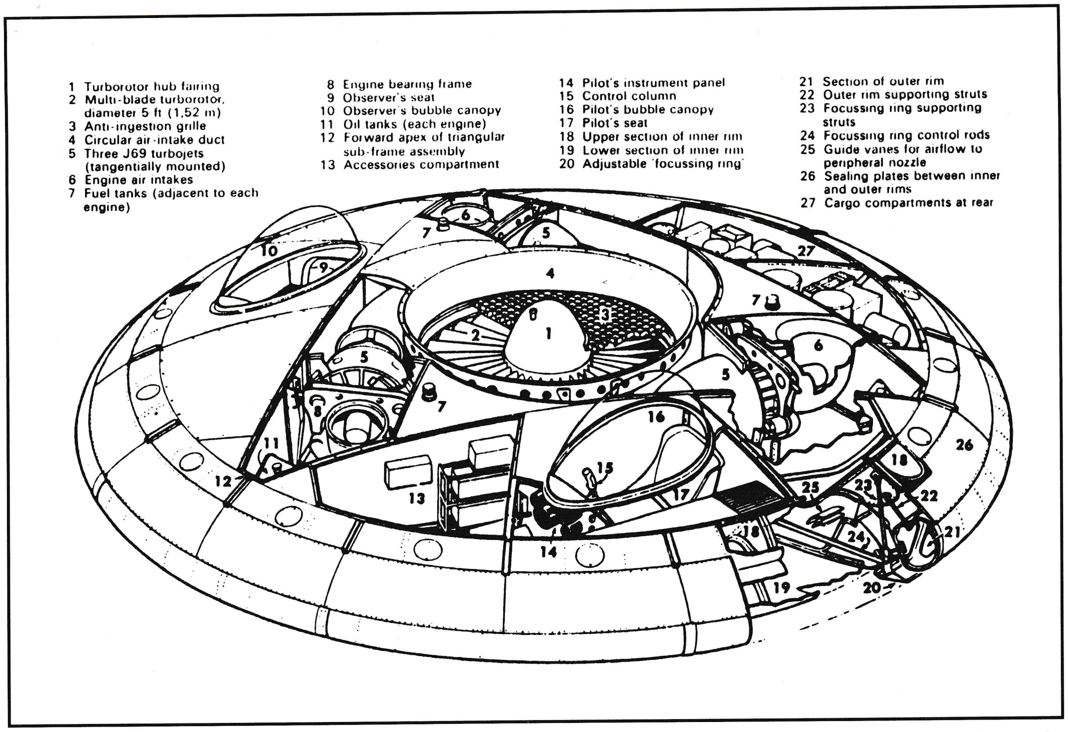
Interest seems to be quite high in North America and Europe in space activities, shuttles, UFO's, flying saucers, VTOL aircraft, and the bizarre events associated with the Bermuda Triangle and the Maryland Vortex. It may come as a surprise to many that the town of Malton, in the outskirts of Toronto, could produce such a highly sophisticated product in the 1950's.

Beginning in 1951, with feasibilty studies completed by the U S Air Force, Avro and Orenda Engines acquired information and data on the concepts of vertical take-off and operation of an aircraft over normally inaccessible terrain.

To accomplish these aims, two aircraft were built at the Avro Aircraft factory in Malton, and research continued until the late 1950's.

The Avrocar was circular in shape, curved on top, (see accompanying photographs), with a large annular turborotor located in the centre of the vehicle. There were two cockpits with bubble canopies, one for the pilot and one for the observer, located in the periphery of the skirt. A top view reveals a circular machine, with a skirt arranged around the outside, and visible vanes for directing exhaust gases and airflow out the rear of the craft. In many ways it resembled a hover craft designed to operate in ground effect as an air-cushsion vehicle whilst accelerating to a point where it would function as an aircraft supported by aerodynamic forces generated by its forward speed. Unfortunately, the designers' expectations for this resultant high performance were not to be met.

Mr. John Frost was brought in from deHavilland Aircraft in England to head the design team responsible for the Avro's VTOL projects, and the Avrocar happened to be the first of a series of pro-



Heading: *the Avrocar hovers in untethered flight at Malton.* ***Left, bottom:*** *the figure provides scale for this aerial view of Avro's "flying saucer."* ***Above:*** *a partial cutaway drawing of the Avrocar.*

jects, lasting from 1947 to 1961. He had previously been involved as a project designer for the deHavilland 110m and after completing the Avro project, departed for Australia.

EARLY DEVELOPMENT

The principles embodied in the Avrocar had been under study by Avro for a number of years, and in 1955 a special projects group headed by Frost, discovered the principle of ground cushion, while studying the flat-rising vertical take-off aeroplane. In actual fact, a man named Sir John Isaac Thorneycroft had been conducting air cushion experiments as long ago as the 1870's, but was unable to set them to fly. Several variations of the concept have been proposed in the past for a variety of uses. The Canadian Federal Government initially began the funding for the projects, but later were assisted by the United States Army and the USAF, who believed it to have potential as a tactical weapon. Ironically, while the Arrow was sitting on the Avro ramp awaiting the cutting torches, Avro personnel were busily engaged in this novel project, which came to a similar end.

The craft was 18 feet in diameter and had an all-up weight of 6000 pounds. Powered by three small Continental J69 turbojet engines producing 1000 lb thrust (454 kgp), buried within the wing, providing exhaust gases which were ducted to the large turborotor. Thus spinning on its gimbals, it created a downward flow of air which was deflected aft, thus creating vertical lift and a forward velocity. Controls in the form of spoilers were used to deflect exhausted air vertically and horizontally for pitch and yaw control.

The first stage of construction was to build a full scale wooden mock-up, once all the basic design criteria had been established. It consisted of a superstructure of beams and platforms interspersed with wooden ribs, and a plywood skin. Built in two halves, it allowed for proper placement of crew compartments, control systems, engines, fuel tanks, and ancillary equipment. Throughout the project, the mock-up continued to provide valuable data on clearances and arrangements for various installations.

At about the same time, work was being done on a 1/20th scale model to be used in a wind tunnel for the purpose of studying hovering and forward flight. Later, a 1/5th scale model was made for testing in the Massey memorial Wind Tunnel at Wright Air Development Centre, (WEDC). Many tests were conducted for proper overall shape and balance, experimenting with aerodynamic characteristics. Next, full scale segments of the outer wing and peripheral nozzles were built and shipped to Nobel, Ontario, for tests by Orenda engines. Utilizing actual Orenda turbojet engines to create air flow, they tufted these wing segments and learned about airflows and differing pressures. A simulator was built to develop parameters for the control systems which helped to determine data on response to disturbances coupling characteristics, and effects on handling.

Now the planning for the actual metal construction, and tooling could begin. Ten jigs were required for the basic body assembly. A segregated, security guarded area was set up and a select group of approximately fifteen people had access to it through the duration of the project. The area was used to fabricate the 1700 detailed parts and for the actual assembly. Gradually the aircraft took shape, as wing segments were separately fabricated, then assembled. Ducts were formed between the ribs to duct the exhaust air. After the main structure was completed and the landing gear installed, the vehicle was removed from the final assembly jig, workmen installed the three J69 engines, and the three independent fuel tanks.

One person whom the author interviewed was Howard Currie, a tool and die maker who helped to create the specialized tools and jigs required in this room.

Orenda developed the central turborotor, using a copper brazing technique for the turbine blades. In total, there were 31 compressor blades mounted on the annular ring, thus creating both fan air and compressed air. An inner wing was added with integral anti-swirl vanes, this assembly being incorporated around the rotor blades. Testing of this turbo-rotor assembly consumed 150 hours in a ground based testing rig using an Orenda jet engine for thrust. Instrumentation and controls were separate for the test rig inside the main building; results of the tests were considered satisfactory. So, following weight and balance calculations, the entire aircraft was moved outside to a test area, two months ahead of schedule. Here the three integral engines were run at full throttle by the technicians in the control room.

FLIGHT TESTING

The time had now come to begin actual flight testing, conducted by an Avro test pilot, Spud Potecki, on the ramp areas to the west of what is now Douglas Aircraft. Simultaneously, the number one aircraft was crated and shipped to the NASA 40-by-80 foot wind tunnel at Ames Research Centre in California while number two flew at Malton. Three steel cables were loosely attached to the saucer to allow limited movement in all directions, with additional wires and cables running to the control room for instrumentation. In free flight , no particular problems were encountered over ice and snow, and the machine was stable enough in ground effect that it could be flown at three to four feet altitude with hands off. The aerodynamic centre (centre of pressure) was found to be 28% of the root chord. The wing, therefore, had a negative static margin and was both statically and dynamically unstable in aerodynamic (forward) flight, thus requiring artificial stabilization. The turbine-fan combination was allowed to move 1/2 of a degree relative to the aircraft. When the aircraft pitched or rolled, the fan, due to its gyroscopic couples, absorbed some of the freedom against a strong spring. The movement was magnified 20 times by a mechanical linkage and the resulting motion applied to the control system. This in turn directed the peripheral jet to produce corrective pitching and rolling moments from the jet reactions at the rim of the vehicle. To rise vertically, the spoilers were operated to deflect the air downwards, so forming a circular curtain of air beneath the vehicle. Transition to forward flight was effected by operating the spoilers to deflect the air backwards over the upper and lower wing surfaces to form a jet flap at the rear.

Another area of interest was the operation over rough, unprepared ground, in areas where conventional vehicles could not manoeuvre. Here, landing pads replaced the three sets of wheels, and it was flown over gravel, grass, earth mounds, and four-foot ditches. After a short briefing, a USAF pilot was able to check out easily in the Avrocar.

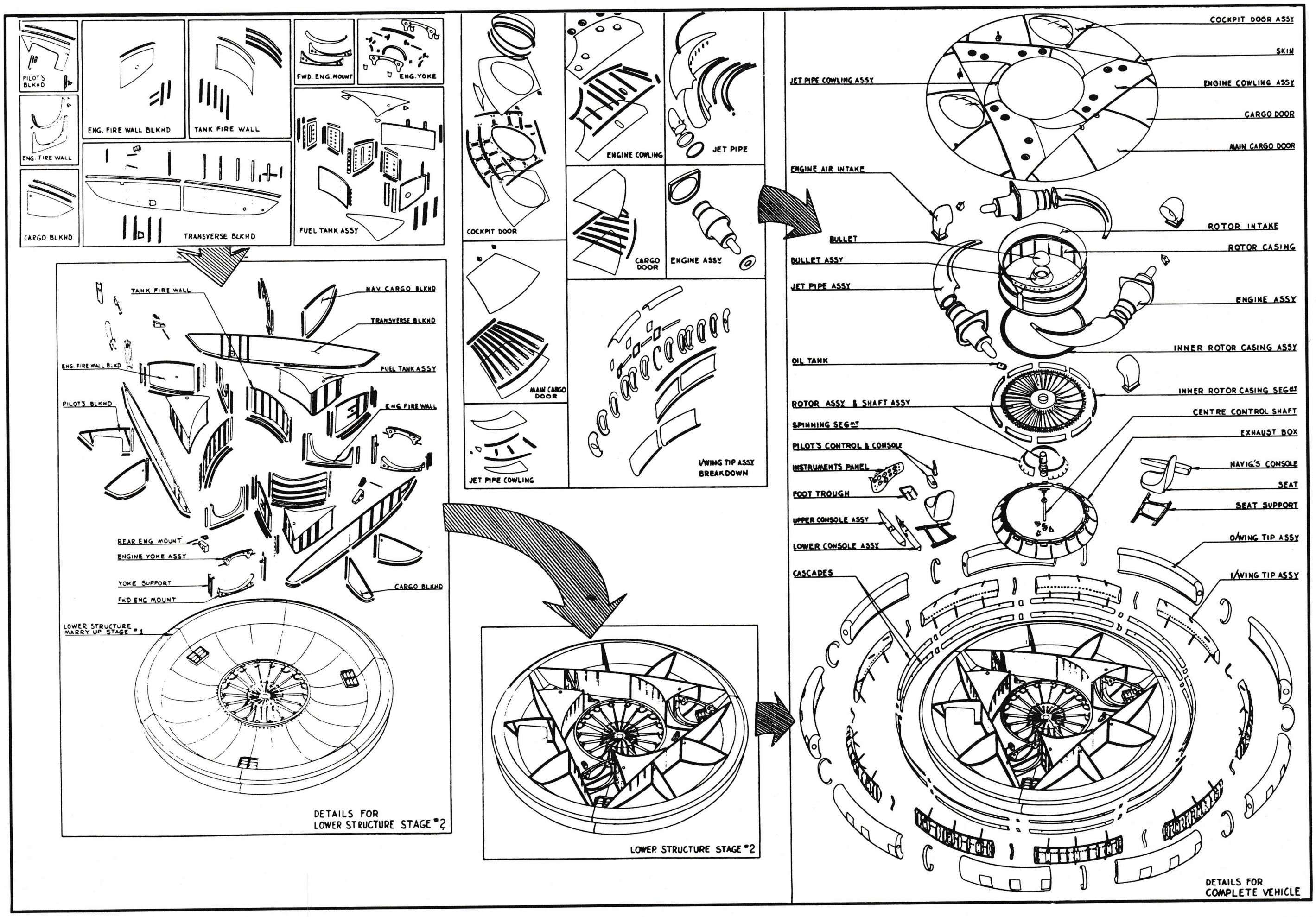
All was not well, however, and in high speed testing during 1961, it was discovered that above four feet altitude, serious problems developed due to internal aerodynamic losses and uncontrollable pitching. The development was completed in December 1961, and the project was abandoned. One of the two Avrocars was stripped and scrapped at Malton and the second was donated to the Smithsonian Institute in Washington and subsequently placed on display at the US Army Transportation Museum at Fort Eustis, Va. In 1967, the Avrocar was loaned to the Man and his World Pavilion for Expo '67. In 1990, it is to be loaned to Rockcliffe Collection in Ottawa, Ontario. "It is hoped that this experimentation will be an invaluable aid to scientific exploration and endeavour in many parts of the world."

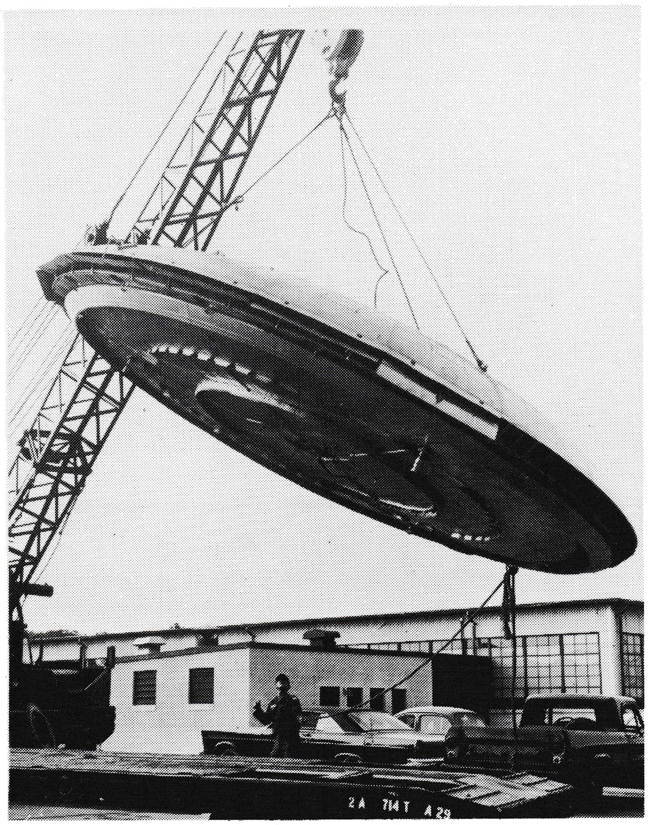
For additional insights into the nature of construction and flight testing, the author interviewed Mr. Howard Currie, a tool-and-die maker, and Mr. Victor Leblanc an instrument technician.

Howard Currie – Mr. Currie worked for Victory Aircraft building tools and jigs as a lead hand on Lancaster bombers; later, in 1952, rejoining Avro Aircraft to work on the CF-100 and the Avrocar. He talked at length about the plants, equipment, and the cancellation of the Jetliner project by C,D. Howe in 1959. He was there amid the despair of `Black Friday' when the Arrow project was axed, 15,000 people placed out of work, and he witnessed Canada's aerospace industry take a back burner to the rest of the world.

Victor Leblanc – Currently operates a repair and test facility for aircraft instruments about 1/2 mile from where the Avrocar flew. "My function was to work on pneumatics and instruments, using strain gauges to check the strains on the metal structure. The gauges consisted of a small strip of platinum glued between two pieces of paper, then attached to the aircraft. Any bending would cause a change in resistance of the wire and

Below: *Component and exploded drawings of the Avrocar.* ***Right:*** *The Avrocar is lifted from the low bed trailer which carried it to the US Army Transportation Museum at Fort Eustis, Virginia, USA.* Avro drawing and transportation Museum photo.





allow readings to be taken.

The first prototype was the `Viper 6', named after the English engines. Later models used the J69 and were too underpowered to fly out of the ground effect. Pilots had a flame-resistant suit which had a hose and fan connected to it for cooling purposes. As a result of the tremendous heat in the cockpit, all the instruments had turned brown. Although the pilots wore ear plugs, the sound level was unbearable, and there was no communication between the pilots across the rotor. Radios were not installed. Although tried on models, vertical fins and rudders were not necessary since the aft vanes for air deflection worked quite efficiently. Inside the machine, the pilot had a small control stick on the right side which was made of a small chamber, about 8" long with another pipe inside it. Moving left or right opened a series of ports, thus controlling pitch and roll, by adjusting the spoilers on the outside skirt.

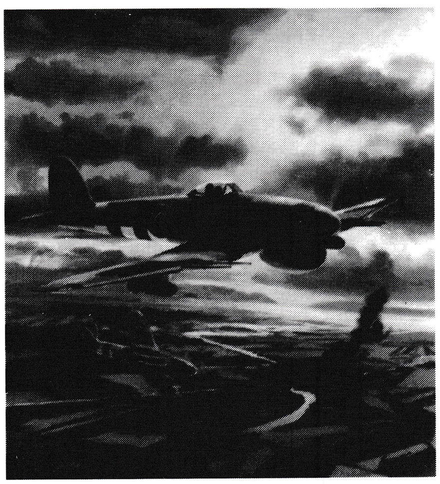
The aircraft was built of very light clad aluminum, .020 which was stressed to make it very strong. A small baggage area was located in the rear, behind the fuel tanks.

This all took place 20 years ago and if you want me to remember any more, I'll have to be put under hypnosis."

ALAN C. DARES

The author, Alan Dares, would like to take this opportunity to thank those people who contributed freely of their time to answer technical questions and to discuss the development of this interesting, though unsuccessful part of aviation heritage in Canada.

Cover Stories



TYPHOONS OF NO 440 SQUADRON IN ACTION

Painted by Garfield Ingram

Garfield Ingram's convincing study of a pair of RCAF Typhoons about to attack an enemy armour concentration, identified by the column of smoke, was commissioned by CANAV Books as jacket art for Hugh Halliday's book *Typhoon and Tempest: The Canadian Story*, published in 1992.

This is the third appearance of the big Hawker fighter on the cover of the *Journal*, the first being in a painting by Les Waller for the Vol 18, No 1, Spring '80 issue. The second, by Frank Wootton, was on Vol 20, No 2, Summer '84.

Garfield Ingram is a Toronto-based architectural illustrator, a 1983 graduate of the Ryerson Institute interior design programme. His main area of interest has been plastic modelling, and he has been very active in IPMS circles. Modelling and architectural illustration led quite naturally to painting aeroplanes. At first, this was for fun, but Garfield sold the occasional work and did some box art for Hobbycraft. In 1992 he produced his first book jackets, the first for McMillan's *Behind the Glory* by Ted Barris, then for the CANAV title.

Garfield is an avid glider pilot and a flying instructor with the York Soaring Association. He originally got the aviation bug when he was seven years old. The pivotal point then was a book called *Knights of the Air*. What turned the young boy on was the book's jacket art done by another keen young man (at the time), Bill Wheeler.

L. MILBERRY

NOORDUYN NORSEMAN V

The fall colours of Ontario's wilderness provide a striking backdrop for CF-DTL, a Norseman V owned and operated by Northland Air Services of Ignace, Ontario. The firm, which was once known as Muskoka Air Trails, is owned by long time CAHS member Gord Hughes. The next issue of *Journal* will contain the story of this pioneer firm as told by Brad McLellan.

BILL WHEELER

The *Journal* has proven to be a very effective vehicle for promoting the CAHS. We would urge members, whenever the opportunity affords, to give it all possible exposure. Show it to friends and any others who may have an interest in our Society.