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The regular monthly meeting of the Toronto Chapter C.A.H.S. , Tuesday, October 3, 1972 held at the Duncan Hall, C.I.A.G. Building 387 Bloor St. East, Toronto. The topic for the evening is Canada'a Flying Saucer. The AVRO Canada AVRO Car. Guest Speaker is Mr. Bob Johnson with an assist by Mr. Ernest Nemeth, who is a Stress_____ Engineer at Douglas. Bob Johnson, himself, was involved in the building of the Flying Saucer. The introduction is by Alec Perfiolas, our Program Director for the chapter.

Alec Perfiolas.

Ladies and Gentlemen:

Our speakers tonight are two Canadian born gentlemen who both have a little history behind them in their work program of their own. Our first speaker will be Bob Johnson, who in 1937-38 was with the Fairchild Aircraft Company in Quebec, in their repair and overhaul department. Later on, this is late in 1938, he came to the Malton facility and held a number of positions there from Direct Production to Supervisor of the, Superintendent of the Flight Test Program and his current position is in the Program Management at the Douglas Aircraft Company. Assisting Bob will be Ernie Nemeth. He is a graduate aeronautical engineer who was with AVRO's aeronautics department on the saucer program. Subsequently he went to Orenda and is now a Stress Engineer at Douglas Aircraft. So, if you will please, welcome, help me in welcoming our two speakers starting with Bob Johnson.

Applause.

BOB JOHNSON:

I was just seeing if we have any ladies in the audience. I was going to start out with Ladies and Gentlemen. Before I start on the background and history of the AVRO Aircraft Flying Saucer we have some

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slides here and we thought we'd run them through and you'll get a better idea of what the saucer looked like, it's construction and that, and then we'll go ahead with the talk. So, if you like Alec, we'll start the slides.

1 This shows the AVRO Car and the U.S. Military markings. 2 This shows the structure of the AVRO Car. 3 This is the engine arrangement in the AVRO Car. There are three continental J69 engines. 4 This shows the turbo rotor. You can see the turbine blades were put in segments of four. This was to facilitate replacement as they got damaged. 5 This is a general schematic of the AVRO Car. 6 This is half of a (laughter) shot showing the airflow in the hovering condition. 7 This is the airflow diagram in the forward flight condition. 8 This shows the cockpit, there's an interesting item here. The control column is shown on the righthand side. You can see the arm rest. The pilot sat in the seat, had his arm on the arm rest and held the control column. 9 This was the Ames Research Model which was the first saucer. The second one which was kept at AVRO had the control column in the conventional place between the legs. 10 This shows you the control surfaces or the controls, method of control on the AVRO Car. 11 This shows the control stick. 12 This is controls again. It was pneumatic type system. There was no hydraulics on the AVRO Car. 13 This shows you the wingtip and the angular nozzles and the spoilers. 14 This shows you the undercarriage and the method of towing the AVRO Car. 15 This shows you the airflow with the spoilers and the hovering and the forward flight conditions. I guess that's our slides.

Bob Johnson:-

Well, the way we've arranged it tonight, I was going to give you a talk on the background and history of the Flying Saucer program at AVRO

Aircraft which eventually led to the AVRO Car we just saw. And after that Ernie Nemeth will give us a talk on the operational status of the aircraft and then we'll run a 16mm color and sound film which will run about 25 minutes which will show you some of the flight testing which was carried out at Moulton.

First, I'd like to apologize to the program committee, the members and the visitors for fouling up the June 6/1972 meeting but I just spent a few days in the hospital after fracturing an arm and an elbow and I was restricted at home for that meeting. However, I can assure you tonight is definitely Saucer Night.

Now before describing the background and the history and some of the details of this unusual and somewhat mysterious project, I'd like to mention that I did not play as active a role in the Flying Saucer project as Ernie Nemeth here.

While working in the AVRO Aircraft Experimental and Flight Test Departments from 1949 to 1952 I was closely associated with John Frost on the CF100 Fighter Aircraft Project. And it was during this time that John started experimenting and carrying out preliminary design work on the flying saucer concept. Later in 1954 to 1960 while working in the Sales and Service Department I again became involved in the flying saucer project but from the technical publications, sales and service aspect rather than the development and manufacturing phase. The flying saucer project was carried out by AVRO Aircraft Ltd. at it's Malton plant and it covered a span of time from 1949 to 1963, with the first contractual authority starting in 1951.

This was strictly a research development type project with the responsibility to design, develop and test a completely new form of flying vehicle. Due to the advanced design the supersonic military possibilities and the effects of the Korean War and the cold war years, it was necessary to establish and enforce a very strict security system for this project. Of course, this added glamour and intrigue to the project and immediately became a challenge to all the newspaper reporters and photographers in Canada, the States and even some in Britain.

The hush hush AVRO Aircraft Flying Saucer was first disclosed to the public in February 1953 by Bill Stevenson of the Toronto Star. Stevenson reported the aircraft would take off vertically by means of a gyroscopic outer rim, spinning at tremendous speeds. It was supposedly designed to fly horizontally at speeds up to 1500 miles per hour and accompanying this article was a sketch of a D shaped flying saucer. This article was quoted by various newspapers, magazines and news broadcasts ~~from~~ in Canada, the States and Britain and, of course, it swamped AVRO Aircraft in Ottawa with requests for information, photographs, specifications, etc. This in turn created a much tighter security clamp at AVRO Aircraft and every employee was screened and placed on a color coded identification badge system. This controled their movements while at work in the plant.

In December 1954 the Right Honorable C.B. Howe announced that the Canadian government was participating in the AVRO Aircraft Flying Saucer Development program. The August 29, 1955 issue of Aviation Week announced that the U.S. Airforce had signed an Aircraft Development contract with AVRO Aircraft Ltd. at ~~Moulton~~ Malton, Ontario. The Toronto Star of October 26 stated, I quote, Special to the Star - Washington,

October 26 - AVRO's Flying Saucer may force U.S. Airforce to admit that a Flying Saucer does exist. You remember about this time there was real panic on flying saucers, both in the United States and Canada and the U.S. Airforce always took the stand that these just never did exist. Also quote, The United States Air Force, which for seven years has tried unsuccessfully to scotch legends about Flying Saucers will soon be eating it's words if it's top secret Toronto experiment pans out. Also a quote, Air Secretary Donald A. Quarles in a statement attached to a three hundred sixteen page report on flying saucers released last night has admitted a strange aircraft still in the design stage being developed by AVRO Aircraft Canada Ltd. at it's Malton plant could result in a disc shaped aircraft somewhat similar to the popular concept of a flying saucer. The October 31, 1955 issue of Aviation Week carried an article on the AVRO Aircraft Flying Saucer Project with an illustration of a knife edged supersonic saucer. It was very similar to this model here which I'll describe a little later on. Hundreds of evening and weekend car drivers decided that it was a good idea to pass by AVRO Aircraft with the possibility that they might see a flying saucer. This in turn created serious traffic jams at the Toronto Airport and Malton Village as the roads at that time just wouldn't cope with the extra traffic. Some newspaper photographers hired private airplanes to fly over the AVRO Aircraft plant and they photographed everything they could see. Several incidents and violations of the Toronto Air Traffic Control regulations were reported. In fact, I think there was a couple of fines handed out on this. This publicity was the last thing that AVRO Aircraft and and Ottawa wanted so they did everything possible to play it down and to carry on with the saucer project in as normal a way as possible. There are many more articles, broadcasts and incidents but those already

quoted will give you an idea of the enormous interest created by this project.

Now let us review the project which caused so much unwanted publicity, intrigue and mystery. The driving force behind the flying saucer project was J. C. M. Frost. John Frost, who had been sent from England to AVRO Aircraft Canada to take over and complete the design and development of the CF100 Fighter Project. John was a tall, slender, ambitious English aeronautical engineer with a winning smile. He had the ability of working on the daily engineering requirements for the CF100 Fighter Project while at the same time he kept looking ahead for the future aircraft design. He became keenly interested in the vertical take-off and landing (VTOL) possibilities in 1949 and 1950 when the French and British managed to design and test the first jet engine flying test beds. They lifted their own weight vertically off the ground and kept it airborne while tethered to a line. This metal disc, ~~this~~ it doesn't look like a part for a flying saucer but it was actually the first test piece built at Moulton Moulton on the flying saucer project, although at the time we didn't realize that this is what it was for. John Frost approached me in the experimental department with a sketch. Of course it was identified with a CF100 work order number so we all thought it was a CF100 test. And he asked me to make up a metal disc, fit it with ball bearings and mount it on an improvised frame so he could spin test it with compressed air from a standard airline supply system. He also asked for an air pressure gauge and a control valve so he could control the pressure and volume of the air passing over the disc. Well, this created quite a bit of fun because when we set the disc up John came down and he directed the air and he controlled the volume

and he had this thing winding at high speed and nobody could figure out what in hell he was doing. Well, the tests were carried out and John took his readings without giving any explanation of what the tests were for. This caused a considerable discussion and at the time a lot of people, including myself, thought that John had been working too hard on the CF100 project and needed a rest.

After the spin tests John asked me to make sure that we did not lose the metal disc as he might require further tests. So, I kept it locked up in the office and sometime later I asked John if he still required the metal disc? He just smiled and said, "no, we can scrap it now, as the readings were quite satisfactory." He still wasn't ready to say it was a flying saucer at that stage. Instead of scrapping the disc I discovered it made an excellent paper weight on my desk. I kept it for that purpose. At this time we had an office in the flight test building and each time they opened the doors and it was a windy day all your papers on your desk used to blow away. So we used to have paper weights on, this is used, or was used for a paper weight for several years.

If you watch for the description of the turbo rotor operation in the film you will see how they bled off the jet engine thrust to spin the rotors by using small vanes fastened to the outer rim of the rotor. This is what John was experimenting with but at the time he was not prepared to say that he was working on a flying saucer design. AVRO Aircraft Canada worked closely with the parent company, the British government and the Canadian government and in 1951 it was issued contractual authority, with a very limited amount of funds, to proceed

with the design and development of a vertical take-off and landing type VTOL aircraft. The first design study was for a V shaped supersonic disc type vehicle which resembled a delta configuration with rounded sides. This was a V shaped with rounded sides and a flat back. It was twenty-five feet in length and twenty-one feet in width and was to accomodate a pilot in the prone position. It was to be powered with a maximum size turbo jet engine of pancake design which was to be mounted within the V shaped vehicle. After passing through the engine turbine wheel the exhaust gases were to be guided rearward by turning vanes located in front of openings along the sides of the V shaped vehicle. A substantial amount of the exhaust gases were to be diverted through hollow control surfaces called elevons to the rear of the vehicle for controllability as well as for additional thrust. A full scale mock-up was built and various test work was carried out. There was one other feature of this too. It was an edge on or almost vertical take-off plane design and was supported on a tricycle gear with a very long nose strut which gave the vehicle an approximately 70° angle of inclination in the take-off position.

In December 1952 it was decided to stop work on this design and to swing into a full flying saucer concept. The second vehicle was a true two disc configuration. This is the wind tunnel model of this disc configuration. This decision was based on the results, or this decision was based on the results of various wind tunnel model tests of which this was one of them which indicated that a true disc with a knife edge was much more efficient for supersonic flight than the V shaped concept. It was determined that flight control of the disc could be achieved through directional control of the jet exhaust being directed from a

gap between the upper and lower disc surfaces inboard of the flying saucer perimeter. By directing this jet exhaust up, down or laterally from the perimeter area by control of the exhaust gap dimensions it would produce what is known as a coanda C-O-A-N-D-A effect or bending of the jet exhaust stream. If this is controlled properly it does add extra lift coefficient as it's passing over the surface. This flying saucer was to be powered by six jet engines with a double type, interlocking rotor of intricate design. A considerable amount of testing was carried out on this concept and a good deal of information was gained and later adapted to the sub-sonic AVRO Car which was to follow. That was this one here. So this was really the third design. At this time the flying saucer project was set up in the Sheaffer building which was across the road from the AVRO Aircraft plant. A small cement building which had originally been a paint stores was located at the back of Sheaffer building and was being used as a test area. An interesting incident occurred when they were running the first jet engine and rotor assembly test outside of this building. All the equipment including meters, gauges, wiring, were hooked up and ready to go. The engineers, along with John Frost, the technicians, the firemen and all other persons concerned were also ready to go, the jet engines start up and it turned out to be a wet start and the engine picked up RPM with the flames shooting fifteen feet or more in front of it, or behind it, rather. The engine speed increased and all efforts to stop it with the engine controls failed. In other words, the engine ran wild. The engine picked up RPM and the whine grew louder and louder until finally John Frost ordered the crew to run for safety and led by the firemen, they ran around

the Sheaffer building to wait for the explosion. Suddenly the engine whine started to slow down and gradually it stopped. The whole crew waited until they had made sure it had stopped and then they peered around the end of Sheaffer building just in time to see one of the engineers walking out of the small cement building. He had run into the building to manually shut off the fuel supply valve to the engine. In appreciation they made a large eighteen inch diameter Hero Button and presented it to this engineer. John Frost did the presentation and then all the crew made him wear it across his chest for the full day. This was his reward.

The Canadian government had authorized a total of three hundred and ninety seven thousand dollars for the Flying Saucer Project and they now decided that future development would be too costly for the Canadian government. After various discussions and meetings the U.S. Air Force, Air Research and Development Commission took over the AVRO Aircraft Flying Saucer Project including all design and manufacturing rights. This project had been carried to it's present state by a very small group of engineers and technicians identified as a special projects group of AVRO Aircraft. Due to the lack of sufficient funding it had been kept to a bare minimum. The period of time between 1953 to 1957 was spent in carrying out a series of design and programs in order to develop the shape, size, controls and various service systems required for the supersonic knife edged flying saucer concept. Everyone wanted the end product but nobody was ready to accept the high risk responsibility of committing millions of dollars based on the engineering and test information available at that time. This was still strictly research and development at that stage.

Funding was authorized to keep the project going but it was not sufficient to allow for any conclusive action. By 1957 AVRO Aircraft realized that the program had reached the point where a firm decision was required based on the two existing possibilities available at that time. Number one was to arrange for sufficient funding to allow for the expansion of a special projects group along with a suitable facility, there was very little room available at AVRO at that time due to their other programs. And sufficient capital equipment to the extent that it could carry out the ambitious program of manufacturing and testing a knife edged supersonic flying saucer. Or the alternate, number two - change the program to reduce the funding requirements. The design wind tunnel and static testing carried out to date indicated that a subsonic flying saucer was practical and could be the type of program which would meet the funding possibilities. It was decided to proceed with the second possibility and this was the start of the AVRO Aircraft AVRO Car program. That is this one here, which was actually built. A general design scheme was finalized with a minimum of detail engineering. And a sales brochure was prepared showing various types of subsonic flying saucers with U.S. markings and different military roles, that first slide was one of those tonight. A general design scheme was finalized with a minimum, sorry, I read that. Arrangements were made after we had this brochure made up, arrangements were made for Eric Johnson. He was the Chief Administrative Engineer of the Special Products Group. And arrangements were made for a visit and a sales presentation to both the U.S. Air Force and U.S. Army officers at Wright Patterson Air Force Base in Ohio. After this visit on very short notice the U.S. Army sent a group of high ranking officers to

AVRO Aircraft to review the Flying Saucer Program and they immediately became interested in the AVRO Car design possibilities. This visit was followed very closely by a group of high ranking officers of the U.S. Air Force, who had also become interested in the AVRO Car design. Now, from these visits AVRO Aircraft received a U.S. Army request for proposal on the AVRO Car. This was dated March 18, 1958. A lot of people wonder why the AVRO Car is identified as U.S. Air Force as well as U.S. Army. This is the reason for it. There was a dual sponsored contract. The approved model specification for AVRO Car One was identified Army V2-9AV and was dated May 20, 1958. The U.S. Air Force System 606A Program was redirected from the knife edged supersonic saucer to support the AVRO Car One Program. This is where the joint responsibility came in. Additional funding of over 2 million dollars was arranged and a firm contract was signed on June 2, 1958. The turbo-rotor design, development and manufacture was subcontracted to Orenda Engines, Ltd. Avro Aircraft undertook to build and deliver one AVRO Car plus one complete set of detailed parts within one year from the contract date. The contract also included a mock-up and a testing program on aerodynamic models and turbo rotor. It was increased by a supplemental agreement in March, 1958 to manufacture a second vehicle, additional turbo rotors and to do full scale tests and the National Aeronautics and Space Administration, NASA, Ames Research Center Wind Tunnel at Sunnyvale, California. At this stage of development the AVRO Car was contractually committed to meet the following minimum performance requirements.

1. The vehicle would take off and hover at a minimum height of six feet above the ground for a maximum duration of ten minutes with a payload of one thousand lbs. including the pilot and crew.

2. The vehicle would take off, accomplish transmission to forward flight, carry the above payload a distance of 25 nautical miles and land with the payload under sea level standard conditions.
3. The vehicle would obtain a maximum forward air speed of 25 knots in zero wind.

This was a most ambitious program for a project which at this time was still in the research and development stage.

The first vehicle was completed and rolled out in early May, 1959. This was a remarkable feat when you consider the lack of detail engineering at the time the contract was signed.

The second vehicle was finished in mid-August 1959 which was less than six months from the contractual authority date.

The first AVRO Car underwent a series of static test, rig tests which compiled a total of 32 hours of engines on testing. Now, this was where the first main, major problem appeared. The turbo rotor efficiency was well below normal requirements. Actual tests carried out in the static rig test indicated that it was from 30 to 50% efficient. The compressor blade efficiency at the hub, it was in close to the turbo rotor at the hub location was good, but dropped off rapidly to zero out the outboard edge of the blades. To supply redesigned turbo rotors meant additional funding, additional development and testing and a considerable amount of time. Of course, none of these were available. So, after completing the static rig test, the first vehicle was prepared for water shipment in late November, 1959

to the Ames Research Center Wind Tunnel in California. The Flying Saucer was transported in one piece at night with heavy security from AVRO Aircraft to the Cherry Beach area of the Toronto Harbour for loading into a large barge. On arrival the barge was found to be full of scrap metal which had to be unloaded. And, of course, time was a major problem as the winter freeze-up was due at any time and this was the only way to transport the flying saucer in one piece. Finally the saucer, spare engine and parts were loaded, made secure and the barge was taken in tow by a tug. The barge was towed across Lake Ontario through the Erie Canal down the Hudson River to New York. At New York the saucer was transferred to a U.S. Navy Merchant Ship for the balance of the sea journey. Stops were made at Norfolk and New Orleans before passing through the Panama Canal and up the west coast to Oakland, California. It was then transferred to another barge and towed up the bay and it arrived at the Ames Research Center just before Christmas, 1959. Gord Kells who was Superintendent of Manufacturing for the AVRO Car Project and at present is Manager of Production Engineering at Douglas (Canada) DACAN accompanied this shipment on it's complete journey. Gord said, "It was not only a very enjoyable trip but it came at the right time of the year." He remembers officials coming aboard at the Panama Canal and wishing them all a Merry Christmas with the temperature at 90° and a beautiful sunny day.

Well, the first series of Ames Wind Tunnel tests started after the Christmas holidays and consisted of 36 hours of testing. The second series of Wind Tunnel tests consisted of 54 hours of testing and were carried out over a three week period. There were no major problems in maintaining the AVRO Car during these tests. But it did continually

bump the sides of the Wind Tunnel damaging the wing tip section. The support group at AVRO were kept busy building and shipping replacement parts on short notice in order to keep the AVRO Car serviceable. A total of 90 hours of Wind Tunnel testing was carried out in the Ames Research Wind Tunnel. These tests confirmed that the air cushioned vehicle HAD capabilities of a flying saucer but that additional research and development would be required for the transition to flight phase.

The second vehicle was retained at AVRO Aircraft to undergo a series of flight tests. 'SPUD' POTOCKI was the AVRO Test Pilot assigned to the AVRO Car One Flight Test Program. This vehicle logged a total of over 68 hours. Now this isn't flying time. This is engine on time, which was logged. BECause the actual flying time didn't amount to hours. I believe that the longest time that it was airborne was about 12 minutes. After the starting OF its hovering trials in September, 1959 the color film to be shown tonight covers part of this flight test program.

SPUD LOG 34 hrs + 5 min

In early 1960 it was realized that a further program would be required in order to modify AVRO Car One so as to meet the model specifications. Orenda Engines stated that it would require a sum of one to one and a half million dollars to redesign, develop and supply new turbo rotors. There is no doubt that the change of aircraft policy by the Canadian government starting with the cancellation of the AVRO Arrow on Black Friday, February, 1959 also had a very definite effect on the future of the AVRO Car One project. In early 1960, some people involved say this happened in late 1959, it was December '59 or January '60. The

U.S. Army and U.S. Air Force reviewed the possibility of transferring the whole project to the United States and even interviewed the Special Products group to determine how many were interested. However, nothing developed beyond this point. Various meetings and proposals were carried out up to February, 1960 but the funding was not available and the interest in the AVRO Car had disappeared. The secret security classification was rescinded and all correspondence issued after July, 1960 did not require a security classification. You probably NOTED that some of the slides used tonight were identified as secret. It should be noted that the manual from which these slides were made carries the following overprint: Declassified in accordance with U.S.A.F., SRCL, dated July 25, 1960. John Frost left AVRO Aircraft sold off all his belongings and moved to New Zealand. He is now employed in the Engineering Department of Air New Zealand.

AVRO
~~AFRO~~ Air Craft issued a proposal for further development of the AVRO Car One in June 1961. But it did not receive any consideration. This proposal did not bear any security classifications.

In 1962 the second vehicle was dismantled at AVRO Air Craft. It was shipped in October or November 1963, with all parts and drawings to the United States. Now, as far as is known at the present, this vehicle was reassembled and placed on a display stand in front of either a U.S. Army Training or Storage Depot somewhere in Alabama. The first vehicle was placed on display at the Ames Research Center in California. I know one fellow who saw it as late as 1964. This was the end of the AVRO Aircraft Flying Saucer Project. Due to the strict security regulations created by the U.S. Army and U.S. Air Force Military require-

ments, plus the Canadian government political implications, John Frost and small Special Products group did not receive the recognition or the credit they deserved. Most people do not realize the volume of complex engineering, development and testing which was required to develop this completely new concept of flying vehicle. While the AVRO Car One did not reach it's transition to forward flight in free air from an air cushion vehicle, it did prove the feasibilty of a flying saucer design, using the air flow principle for operation and control of the vehicle. It should also be realized that a great deal of the knowledge gained from the flying saucer project was adapted and is still being used today in such VTOL aircraft as ~~Hawk or Sidley~~ THE HAWKER SIDDELEY Harrier. I assume a lot of you saw the demonstration at the ~~X~~ CANADIAN NATIONAL EXHIBITION this year.

Ernie and I would like to give you a short general description of AVRO Car One so that you'll have some idea of it's construction and complexity prior to seeing the color film.

AVRO Car One was an 18 foot diameter circular structure. It was a light all wing experimental subsonic flying vehicle with vertical take-off and landing capabilities. The design was developed from a knife edged supersonic flying saucer program. Crew accomodation consisted of two single seat cabs, each enclosed by a transparent canopy and cargo and equipment were stowed in trunks enclosed by detachable panels. The vehicle was fitted with three landing gear legs each incorporated an internal pneumatic shock absorber and solid twin wheels which were free To Rotate to caster. The AVRO Car was a cambered wing section with a thickness to cord ratio of approximately 20% and was symmetrical about the vertical center line. This assisted building the AVRO Car

because the shape ~~of~~ was circular 17 meant that there was a lot more common parts in the AVRO Car than there was in the conventional aircraft. The airplane consisted of primary and secondary structure. The primary structure consisted of a central base and three pie shaped wing segments married into a single platform which carried the secondary structure and all the equipment. The secondary structure consisted of a wing tip which ran right around the air-craft. It also had a turbo rotor casing, turbo rotor air inlet, and then compartments or partitions with doors and detachable panels. The power plant of this vehicle consisted of three small gas turbines which acted as gas generators to drive a centrally located turbine compressor combination called a turbo rotor. These engines were Continental, J69-T-9 tubro jet engines with a military rating of 927 lbs. static thrust. 927 static pounds thrust. At 22,700 2207 RPM . They are quite small engines, they were 27 inches in overall diameter and weighed 364 lbs. each. They were arranged in a tangent and were symmetrical in plan above the turbo rotor. A fuel tank of approximately 57 U.S. gallons, (quite small tanks) was located between each engine compartment and was protected by an aluminum alloy partition and a stainless steel firewall. An oil tank of 1.8 U.S. gallons was located in each engine compartment and a turbo rotor oil tank was mounted on the turbo rotor shaft assembly. The turbo rotor was fabricated from stainless steel with a hub and shaft assembly. There were 31 compressor blades with an outer rim carrying 124 turbine blades. The turbine blades were made up in segments of 4 to facilitate replacement. The turbo rotor was 60 inches in diameter and had a maximum rating of 2,570 RPM. The AVRO Car weights were adjusted as the manufacturing progress. As you look at these weights

there was various manuals issued from 1958 right through to 1961 and each manual you look at will have a different empty weight or a different useful load weight although the gross weight of 5,650 lbs.was standard through the whole program. The closest weights to the actual were probably following: Empty weight - 3,222 lbs. Useful Load - 2,428 lbs. Gross Weight: 5,650 lbs. The contract weight was stated as: Gross Weight of 5,650 lbs. including the payload of 2,000 lbs. and fuel for over 100 miles.

I'd now like to turn the meeting over to Ernie Nemeth who had kindly agreed to review the operational aspects of the AVRO Car One. Ernie was a Special Products Engineer on the Flying Saucer Project and he spent some time in developing and testing the control system, which was used on the AVRO Car. Some of these tests were carried out at the Nobel Test Center.

pilot? activated by changing the gap between sensing nozzles so that when you twisted the central grip, by way of a cam, you changed position of a plate between two nozzles and thereby changed the, you had about a 30° control deflection fore and aft on that. Those were the primary flight controls. Trim Two wheels were incorporated which biased the pressure to create the similar effects, either lateral roll or pitch changes. One additional control was incorporated and that was the cruise control which consisted of an actuator that moved a gate and opened up holes at the aft of the airplane to fill in the hollow in behind, to get rid of the base drag. ~~My~~ MAY I have the next SLIDE

please, _____. This is a close up of the nozzle again. I don't think we have to go much further on that. Fine, thank you very much. There are no further slides. Could I have the lights on now please, for a few minutes? Well, I believe I've covered the control of this airplane mechanically speaking as far as I intended to do. A little more scratchily than I had intended to do. I must apologize for that. One feature that I had neglected to mention and that was the stabilization. It was an important feature. The central rotor was gimballed, that is that big fan was gimballed. And it was restrained, there was an elastic restraint on this whole thing so that when the aircraft pitched it served as a rate gyro and movements of this thing were transmitted to that central collection of cables so that if there was a pitch disturbance, for instance, then the spoilers would be deflected and there would be corresponding deflection of the peripheral jet. This is, as Bob has mentioned, was subjected to full scale tests in the 40 x 41 tunnel, Ames Wind Tunnel and it was flown extensively by Spud ~~Petawky~~ POTOCKI. The program did not come to fruition as many had hoped but certainly a lot was accomplished. I think that if it had continued it would have greatly helped the positive atmosphere in aerospace industry. Thank you very much. APPLAUSE!!!

BOB JOHNSON:-

I would just like to apologize to the ladies, I didn't realize that we had ladies in the audience and I'd like to say thank you for coming to the meeting. The other point was Ken MOLSON mentioned that one of these AVRO Car's is in the Smithsonian Institute. I didn't realize it! One other item I wanted to do was I wanted to thank Tommy Thompson for his assistance in helping us with the slides and the photo board here tonight. Tommy was working nightshift so he wasn't able to come out.

THANKS.

We thought now we'd have a question and answer period. If you have any questions Ernie and I will try and answer them. Yes?

Q. _____

A. Not on the AVRO Project, no.

Q. _____

A. I'm not aware of it personally, I've not heard of one that's, I can't see why that shouldn't be so, but for want of an application. Maybe there is continuing activity in the field. It was secret once maybe there is unknown activity now, I don't know.

Q. _____

A. The high bypass free show fan jet. Well, not exactly. The principle we are talking about here is 3 OFF gas turbines driving a wheel, driving a turbo rotor, so the high bypass ratio jets are different concepts of propulsion. I mean you can probably in some roundabout way show that there is a similarity by using hot gases to drive the turbines. I can't think of any other way in which they are similar. There is a high bypass consideration here, of course. Very high bypass ratio, in fact, these are compared to the modern day engines.

Q. WERE ANY OF THESE IDEAS PATENTED?

A. When you say patented I don't know what you mean.

Q. DID AVRO REGISTER ANY PATENTS IN THE USA OR CANADA?

A. I don't know if AVRO ever patented what they designed. This is a military type contract. Do you know of any patents?

A. There were many patents but I don't know what they were. I'm afraid I was not too closely associated with patenting.

Q. Did it ever fly over water?

A. Well, unfortunately, you see, it was a research and development contract which was dragged out primarily because of the shortage of funding. And when they went to the AVRO Car it was very late in the program. And, of course, by this time the ARROW had been cancelled, the Americans were, well, they weren't too happy about putting more funds into it under the Canadian conditions that existed at that time. They were interested in one stage and taking it down to the states and developing it further, but this didn't develop. And unfortunately the AVRO Car came a little late in the program. I think if it had of come earlier it would have had a larger possibility of moving into that next stage of development which probably would have put it into a transition to flight phase.

Q. Was there any decent altitude achieved with it?

A. No, actually the maximum cushion effect was about 3'6" to 4'. I would say 4' was maximum.

Q. _____

A. No, not the inflight. Not the transition, no. It would have needed further development for that. It's very unfortunate it didn't get into a further development stage because it had the possibilities. But interest, funds dried up just too quickly. I understand they are in the States, I believe you were mentioning, _____ that Goodyear and Goodrich were experimenting with saucer designs again so, it's quite possible that sooner or later you will see flying saucers, no doubt about it.

Q. What was the difference with the knife edge design?

A. The knife edged one was a very ambitious program. It was supersonic design. And of course to design a new concept of flying vehicle was one thing, to make it supersonic was another. And it would have taken millions and millions of dollars to develop it and this money just wasn't available.

Q. Were you able to prove in any of your preliminary data that if you were able to reach an inflex condition _____

A. Which things?

Q. _____

A. The AVRO Car or this other thing?

Q. The AVRO Car.

A. The AVRO Car was never intended to be a high speed machine. Design speed was in the order of 200 miles an hour.

Q. The original concept _____ was a high speed supersonic ac wasn't it?

A. This air-craft here was, had a design speed of Mach 4 at an altitude of 90,000 feet and during the course of our investigations on this among many other concepts was fundamentally an R and D oriented program right through to the end which only by sheer necessity showed itself in kind of a final product. But we did run into various problems, obstacles, the transonic drag rise is such that in one of the concepts that we looked at, in order to get through we had to zoom dive through to be able to fly at a higher Mach number. Otherwise we just couldn't make it. We'd be hung up at Mach, somewhere around Mach ~~20.5~~ 2.5 or 3 or something like that.

Q. What was the configuration for various of the controls / control modes?

_____

_____

A. Yes, Well, the configuration of the jets during hover, for instance, was very important. We found in our early tests that the simple cushion of air, that is a cushion which directed straight down posed certain problems once you got beyond a certain height. We found that we got very large lift to thrust ratios at heights less than about .5 of a diameter. We'd go up to about 2 1/2 lift to thrust ratio, that's around the maximum we got for the concepts we are looking at. But then when you went up beyond about 25 there was a dramatic drop-off, in fact, we would end up having something about 30% only 30% of the jets reaction in free flight, free air, so there was a lot of brain searching on this and eventually we discovered that by focusing the jet, bringing it in directing the peripheral jet right in towards the middle so as to make somewhat of a mushroom kind of arrangement, the jet would come to the middle and then you would have a column, tree trunk situation we'd be able to sustain something like 80% of the thrust in the way of lift, completely clear of the ground. So, the transition position had to take this into consideration. And that free flight, of course, we just could not, in the AVRO Car we were not able to go straight up with the power available, out of the cushion. The transition required flight in the cushion and then taking the most efficient configuration, incidentally, when you are close to the ground remains peripheral configuration so that in the transition and as you proceded along gaining speed the transition required - and incidentally, the manner in which he did that, as you saw in the film, he tilted the aircraft forward

and you brought some up the procedure for transition was to, as your height increased, bring that cushion together and swing it backward by differential control of your swish dish, or your ring spoiler. And the complete mix on this I'm not familiar with and I can't recall much of it at this point. But there were mix of the extent of focus, extent of differential control, pitch and also a proper timing schedule for opening up the back end of the machine because through this we got additional propulsive thrust. These are areas that were not fully resolved.

Q. _____

A. I can't recall. I can only remember nominally I think it was 30 to 40 miles an hour.

A. Yeah, 30 knots I think was mentioned in the film. That was about maximum. I recall there was some pretty hair raising episodes. As you saw, the airplane was flown in a fairly confined area and I remember on one occasion Spud was flying between D2 and the building area, it's now Douglas, and he was unable to stop it. It was whistling along at a fairly high clip and was going to hit Building A so he ended up really honking back on the _____ rather the, I talk in both terms because I've been associated with rotary aircraft as well. The joy stick, so he ended up flipping the airplane almost on it's end and then the darn thing, I guess the hammerhead,_____ around like that and then came back down. That's about the highest it ever got.

Q. _____ vertical _____ column near the center of the disc as we see in the diagram on the film it appears that there's a bleed on the _____ going to the periphery. That was

actually part of the supporting curtain?

A. I'm sorry, I didn't get that. I was distracted in the middle of your .....

Q. Inboard, that's approximately where the main rotor was, there appears to be a bleed off of the _____ a vertical column....

A. There was, you are absolutely correct, in the original designs this was not provided. Originally, they did not put this bleed in and then they found, they thought that by putting that central bleed in it would help to fill in the mushroom column. That's correct, yes.

Q. How much lift generated over the top of that surface _____ air flow _____

A. During off speed operation? Not very much.

Q. Not very much, just strictly, _____ when they moved it forward.

A. There was just very slight peaking around the intake, around the intake, but it was trivial compared to the thrust that there was here at the bottom as a result of positive pressure.

Q. Why was it conceived so small _____

A. No, as a matter of fact we had at one stage in the project, we had an aircraft on the board that was something in the order of a thousand feet in diameter. And it was sort of like, the concept was that it would carry a whole lot of little ones, too.

A. I think one of the main reasons for this was the amount of dollars available in funding. This pretty well controlled the size of the project.

Q. _____

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Q. _____

A. I'm not aware of any restriction with the small size might have imposed. I think there was, the logistics, first of all, the application that was most _____ , then also what engines were available and...

Q. _____

_____

_____

_____

A. The machine he is talking about we came to call the 6 Viper Test Rig because they , not that they were poisonous or anything like that but they used six Viper engines to drive the centrally turbo-rotor. This concept was closely related to that configuration there. It also incorporated after burners. It had after burners all around the periphery. We used if for to break through the sonic barrier.

Q. What kind of a problem _____

A. Actually, I think that in the early stages of operation this happened. I don't think there is anything disasterous at all. The partial power loss, not a failure... You are thinking of vibrations and that sort? As far as I'm aware it happened on the AVRO Car on occasion and there was nothing catastrophic about it. It depends _____ on speed _____.

Q. _____

A. I can only say off the top of my head. I wasn't too much concerned with that, but I saw the thing flying in winds probably of 15, 15 miles an hour, 15 - 20 miles an hour.

Q. _____

A. _____

A. The _____ was quite stable under those conditions. It didn't collapse. Of course, once you, once you draft clear, if we had been able to go up higher from the ground with the circular cushion then it may have _____ the problem. This was a problem incidentally, stability. Stability of a peripheral cushion far from the ground that was one of the problems, too. Apart from the fact that you lost thrust. But, if you were far from the ground the thing, when it tilted over, the cushion would slip to one side or break down and then you would get a rolling movement or pitching movement, depending on which way you tilted, you could just flip the thing over on it's back. So that's one of the important considerations in the transition.

Any other questions?

Well, just to give you a _____ in closing. September 18 Aviation Week there is a short article here I just want to read it to you. It's called "The Fighting Frisbee". (laughter) Naval Air Systems Commands desire to develop a new method of delivering flares has led it to investigate an air launched illumination system using the gyroscopically destabilized disc. In other words, a frisbee. Naval Ammunication Depot had wind tunnel tests conducted on a plastic toy along with clay pigeons and reported promising results. Last week in a paper entitled "Adaption of the Frisbee Flight Principle To Delivery of Special Weapons".. That's September 18, 1972. So they are now known as Frisbees. If there isn't any other questions I'd like to thank you all for coming to the meeting. Applause.