

Session with Al Wheelband on Friday, February 24, 1984. I was looking over sort of a questionnaire on the AVRO Disc Flight Program. It consists of some 42 questions. Al's going to have a go at that, his thoughts on some of these. And Al has never seen the questionnaire before so it will be rather interesting.

Al. O.K. Here we go.

1. Was Frost being sent to the special projects group considered a demotion? Or being out of favor at AVRO?

A. Well, of course, I'm a very opinionated man about John Frost and it's very difficult for me to answer this question. I will say that it, in some people's eyes it was probably a demotion. I think in the higher management it wasn't at all considered a demotion. I think there were certainly professional jealousies involved, i.e. Chamberlain, probably. And he was probably quite happy to see Frost not getting involved with the Arrow. And, matter of fact, I don't think John Frost really wanted to get involved with the Arrow. And, but it was more of a natural thing, really, in that he had germed this idea and he wanted to do it. He wanted to do this. He was quite happy to stand aside. In terms of a demotion, I will tell you this, he didn't get any less money. O.K.

2. Was Frost's first independent design a manta shaped tail sitter before Project Y?

A. There was no such thing before Project Y. Project Y was the first thing. And it was, it started off as a flat engine and the first thoughts on getting the flat engine into the air was to sit it on its tail. It was as simple as that. And I think possible Waccla

Cherwinsky was instrumental with him in developing the spade shaped airplane. The manta shaped tail sitter, almost, in my opinion, was a newspaper thing. It may well have been his very first thoughts of burying a flat engine into a circular type airplane, he hadn't given too much thought outside of the engine and when Wacław Cherwinsky and them got together I think that's when the spade shape arrived and that was called Project Y.

3. Was his first design for a big engine disc design?

A. Definitely, a disc. There was no question about it.

4. Was Cherwinsky the reason the Project Y became spade shaped?

A. He, in conjunction with John Frost, I wouldn't like to say. I wasn't in the same room. But, I think possibly it was a collaboration between the two, yes.

5. How much money did the Canadian Defense Research Board come up with to study Project Y?

A. I have no idea. I wasn't an administrator.

6. Which proportion and stability system is Frost demonstrating on the first film on the video tape?

A. I haven't seen the video tape or the film, so I don't know.

7. This model has a central gyro and appears to be compressed _____

A. Oh, I think I know what that one was. That was his very simple demonstration model of how anything, be it an airplane or a flying bedstead, or anything with jets pointing downwards can be stabilized by the gyroscopic couple from a fast moving wheel. I think that's really what it was. And we did set one up with a little motor on it and a disc that spun at fairly high speed, produced quite a gyroscopic couple and we did couple this effectively to some very

simple controls which either opened up or covered over some jet holes. I think there were four in the form of a cross. And they did stabilize itself.

8. Do you have any photographs of yourself and other members of the team dating from that time period?
 - A. I don't think so. I don't think, not that time period.
9. How long was Professor Donald Modell from McGill University on Project Y? Was he also on Y2 big engine version?
 - A. Professor Donald Modell never worked directly at AVRO. Don Modell was always a professor at McGill University and he came in as an advisor, I think more as a friend of John Frost, and he was from Rolls Royce in England, originally. He was a "with it" engine design man. Certainly, farseeing engine design man. In fact, at that time I do believe he was working on a powdered coal to drive jet engines, or to fuel jet engines. But, however, he was very interested in what John Frost was doing. They were great friends and they visited each other on many occasions, but I don't think he ever worked. He could have been given a retainer of some sort for the amount of time that he put in. But he was never employed by AVRO directly. And in terms of how long was he involved, possibly a year and a half, I would think.
10. In your own words, what was Frost's original concept for propulsion and control. What was his concept for propulsion and control.
 - A. Well, no question. His control was coupling the gyro to a control system to direct this air where he wanted it to go. His original concept for propulsion was no question, the flat engine.

11. Could it have worked?

A. Of course it could have worked. No question. I may interrupt a little bit here and say, could it have worked? The engine itself, the control system itself, definitely could have worked. I think there was some basic aerodynamic misgivings about the system. I think I explained it to Les once before in that the lift on any airfoil, be it round, square, or whatever, appears. The induced lift due to forward speed usually appears at about the quarter coil of the wing whereas, the CG should be, more or less, in a line with the quarter coil of the wing in order to balance the airplane properly. Then, of course, in a round airplane, in a hovering condition this CG has to be in the center of the circle and when you start developing sufficient lift to lift the airplane off the ground due to aerodynamic lift, then that lift would appear at about the quarter coil of the vehicle, so you can see there's a misbalance and you get a very large nose up pitching movement. John Frost always said that he had more thrust than he needed and he would use a lot of his thrust to effectively blow in a downward direction at the back to correct this large movement. But, I think maybe, if anything, that's possibly the where the AVRO car, if it did, in fact, come unstuck, that's really where it came unstuck.

12. What was the effect on the design group with the influx of engineers from the Arrow program after black Friday?

A. Well, I guess what we can say is that there were some engineers that AVRO really wanted to keep and they didn't have, know what to do with them, so they threw quite a few of them into the design

group. And, of course, the effect on the design group was pretty catastrophic because, here we were working for several years and watched this thing develop in its finest detail only to be shown by a bunch of guys, who were, you know, had been extremely successful in their previous project, who were pretty smart-alec, if you want to put it that way. And they were all conventional thinkers and they immediately started thinking conventionally about the thing and trying to make it into an airplane as know airplanes and of course, they really destroyed the circular plan form, the hovering characteristics, they made a, they really compromised the whole thing by the. Well, you can't really blame them, but they they were conventional guys that had been working on conventional airplanes. They just suffered a great big setback. They were, I guess they thought they were pretty smart and they probably were and they were just, too many ideas came in all at once. And, I think, if we can go back to one of the other questions, there was still some professional jealousy which had probably come down the line to a certain extent for Chamberlain and this group on the Arrow that everyone laughed at John Frost and, of course, when John Frost was the only guy left at AVRO with any money to spend I think they, they had that, they didn't exactly hate the guy, but they thought he was a bit queer and they, and some of them, I think, tried to prove that the thing wasn't any good...To be blunt about it.

13. Why did Frost resist having hydraulics on the disc design?

A. I don't know that he really resisted having hydraulics. I think

he figured that hydraulics weren't necessary. We had large volumes of high pressure air. Pneumatics were fine. They're lighter anyway and I think time has proven now that pneumatics are becoming more and more popular. They are certainly lighter. They certainly don't have the fire potential that hydraulics have and I think the answer to that question is that he honestly thought and I agree with him, that he didn't need hydraulics.

14. Can you remember the names or organizations from which the American Army and Air Force officers came from?
 - A. Well, whew!! Wright Patterson Air Force Base, Dayton, Ohio. American Army and Air Force Officers came from. Wright Patterson rings a bell all the way down the line. We tested, of course, in lots of government agencies. We tested at the Boston Wind Tunnels. We tested at Dayton, of course. We tested at Ames Research Center which is NASA. I think, I don't really know. I wasn't an administrator. These guys used to come and go. I think a large proportion of them came from Dayton, Ohio, and the Pentagon too.
15. Do you remember a Lieutenant _____, no I don't. Mainsberg from the Pentagon? No, I don't remember him.
16. Des always expressed an opinion that the original AVRO car spoiler control system was a good one and bind it, or bound or whatever because of temperature of the mixed gases exhausted from the fan could this system have worked with a co^d-jet?
 - A. It was in a co^d-jet. The problem with the AVRO car at that time was that we drove the fan with a tip driven turbine with hot gas. This was supposed to mix with all the cold gas and by the time it got

out to the tip it was supposed to be relatively cold and unfortunately in some areas of the AVRO car this didn't mix very well. And the hot air used to cling to the upper surface of the inside of the airplane and come screaming out of these spoilers and that's what caused the trouble. I was a spoiler control man and in the wind tunnel models which of course were driven with cold air, cold compressed in the wind tunnel, the spoiler/^{system}worked exceedingly well. And, in my own opinion, I remember being very disappointed at the time along with a lot of other people that John Frost, we thought, was being too hasty in dismissing the thing. I think, in retrospect, he was under an awful lot of pressure to get the thing in the air and he got pretty desperate when the thing didn't work first time. There's no doubt, in my mind, that the spoiler system would have worked. And would have worked very well. And probably in the end would have been a much better control, but it really didn't get the proper chance it should have got.

17. Why didn't they just build a new turbo-rotor or fix the old one before going into test? It appears that the lack of thrust was the primary and unsolvable problem.
- A. Well, the answer to that of course is that the time scale was such that the airplane was three parts built before the rotor was tested and finished. The whole thing had to come together quite quickly. And it was a great disappointment to everyone. And, in retrospect, I don't think it was all together Orinda's fault. I think, possibly, when we looked at the G.E. rotor, further on, we found that they had a much better system of straightner vanes, underneath the rotating blades - to straighten the air out. And I think we pro.. Orinda's or AVRO's, or John Frost made a miscalculation in that

they assumed that when the air came through this fan it was going to be straightened out by some probably, I don't know, ten or twelve turning vanes that we had there which I seem to remember the G.E. one that I saw down at Ames had like thirty-three turning vanes and they did a good job of straightening the air out. I think what happened is that the air came out of this turbo rotor at such an angle that it just bashed itself against the all the radial ribs inside the airplane. In fact, I know it did because we had all, we were fixing smashed in ribs like every hour running in the tunnel we had to go and fix ribs that were getting bent out of shape by all this air impinging on them at some great angle and the primary problem was that the air wasn't straightened out after it came through the fan. O.K. Why didn't they build any turbos? They didn't have time.

18. Was the central jet incorporated with - or after the original spoiler control on the AVRO car?
- A. The central jet was incorporated after the spoiler control was thrown away from the AVRO car and the AVRO car had what we call a suck on problem. The faster you turn the engines over the harder it wanted to suck down onto the ground. It was too close to the ground and it got sucked into it's boundary layer. So, in a desperation effort to get the thing a certain amount above the the ground where it could work properly there was a central jet put on to effectively fill this vacuum under the airplane with some pressure to push the airplane up the first couple of feet or a foot and a half so that the real, and form this trunk of compressed air which _____ came underneath the airplane. And

this was where the central jet...it was a panic measure to get the airplane off the ground. The first time we ran it, we went out on hovering trials and it was tethered, the thing just never left the ground. It was a great embarrassment. It was discovered that it was quite fundamental and it was quite correct and we needed these central jets. That central jets were required in the ground effect, but once you got out of the ground effect, you didn't need them - then you could close them off and use this trunk that formed under the airplane of compressed air.

19. What is your opinion of the final configuration of the AVRO?
Could it have been flown with more thrust?
- A. Why, of course. You know, anything can be flown if you put enough thrust on it. The question in my mind is certainly we could have, in fact we did some schemes with the 2J85 and the thing would have sufficient thrust to fly but I think it had a stability problem. I think it had control problems which would have required a lot more testing and a lot more aerodynamic thought put in before we may have finished up with a tailplane, quite frankly.
20. Why did Frost and the group persist in using a disc shape with it's inherent aerodynamic problems?
- A. I think they insisted on using a dish shape because it was the very best shape for ground hover. It was the very best shape for take-off and I believe that we all thought and I think it could have been done, the control problem could have been cured.

With sufficient power we could have used some of that power to offset the C.G., C.P. difference.

21. What was the nature of the error found in the Wright Patterson and M.I.T. wind tunnel test that caused the loss of interest in the knife-edged supersonic versions of the disc program.
 - A. This comes as a shock to me because I don't think there was any real error found, as I remember. I don't think there was ever a real problem. Not that I knew of anyway. We'd have to go to the final reports to find out if that's true.
22. Did the members of the special project group take a lot of kidding within the company because of participation on the flying saucer program?
 - A. No, we didn't. No, we didn't. As a matter of fact we were very quiet about it and everyone else was very quiet about it and, to be honest with you, although we weren't aloof, we didn't mix. I think they were involved in their problem and we were involved with our problems and we didn't really mix in a technical level. Of course, we were very closely security guarded and we were very very security conscious and we would never discuss what was going on in the office outside so they didn't know what was going on and because of our attitude they didn't ask. It was as simple as that. I don't think there was any animosity, no. I had lots of friends that worked on the Arrow program and I had lots of friends that worked on the C-100 program at that time and all the other programs at that time that were going on. And, no, no, we used to bowl on the same bowling teams and go to the same parties on

Saturday nights and., but we just didn't discuss what was going on. We weren't allowed to. It was that simple.

23. Were Project 1794 and PV 704 the same aircraft?

A. Well, we'll stop there and won't go on with the rest of it because first of all, 1794 and PV 704 weren't airplanes. 1794 and PV 704 were lumps of money. And as I remember it PV704 which is Private Venture 704 was AVRO money, may, could well have been some Canadian government money, which was given to the special projects group to do design studies on the future of the supersonic airplane, a cold flow supersonic airplane. 1794, as I remember, was USAF or American at any rate, money given to the special projects group to produce the six viper test rig. O.K. If not, what was the difference? Well, I think I've explained that.

24. Do you have any photos of any of the aircraft?

A. Well, I have some photographs of the AVRO car, Y2 704 AVRO car, yeah. I think Les probably has some of my pictures and I think probably _____ the rest.

25. Were mock-ups built of anything other than Project Y and the AVRO car?

A. No. Lots of wind tunnel models - no mock-ups.

26. What happened to the Project Y mock-up?

A. Destroyed. AVRO car mock-up I don't really remember. There may have been an AVRO car mock-up but we got quickly into the real airplane that I don't really remember. There may have been a segment of the AVRO car in a mock-up stage, just one segment maybe.

A slice through it or something. But, I don't remember. Certainly the Project Y was destroyed into very small pieces for security reasons.

27. Who specifically was opposed within AVRO to the disc programs?

A. I think I answered that question before but I don't like to mention names because I'd be remiss because I really don't know. I think there were differences of opinion between the higher echelon of the design group anyway. The higher echelon of the design personnel. That's probably as far as I know, where it stopped.

28. How was Frost able to systematically get funding for the period 52 and 61?

A. He was a bloody genius, that's how he got it. He just went after the money and when we found that the money was running out he'd find someone else. It's as simple as that. He was a dynamo. He really was a dynamo.

29. What do you remember about the 60 - 61 Canadian government contract for the advanced version of the AVRO car _____ 85's?

The little I remember about it, it was an outcome of these Arrow guys, some of their ideas, elliptical wings, wing tips, fins, rudders, tail planes. One of the schemes was TG-85's. I think probably a submission was made and I don't think that we got the money. That's all I remember.

30. How close were you when the project ended to success or failure?

I don't understand the question. How close were you when the project ended ...

A. If you want to stop there, I was very, very close.

Oh, how close were you to success?

- A. Quite a long way away. Failure you never think about. We, I've explained before, we had some serious aerodynamic problems with the airplane. We also had some serious lack of thrust which could have been of course resolved by some better engines and a better fan. We'd needed a lot more money. We'd needed to build certainly, not a new fan but certainly the downstream of the fan we'd have to put a lot more stuff in there and we could have done with a lot more thrust. There was some possibly ^{maybe} caused a lot by the bad cross flow problem we had. We had some structural problems. You realize the airplane had to come out at some 5,000 pounds, all that weight and we were dealing with practically Reynolds Wrap in the way of gauges, you know like, 014 and 018 and 332 rivets at 3/4 inch pitch. So, the thing was, we used to talk about it as ^{being made of} Reynolds Wrap. I mean, it was a very fragile thing. Mainly, because we were strapped by the amount of thrust we had and so we had to keep the weight to an absolute minimum.
31. What were the circumstances of John Frost's departure from AVRO?
- A. Well, I can only remember John Frost coming...we went on holiday in August and Fred Mitchell apparently took what was left of the AVRO car reports and the submission had been made for a continuation by John Frost prior to going away on holiday and Fred Mitchell, who was then Chief Engineer decided that AVRO should no longer be in the saucer business. He had himself been to Washington over the summer holidays and told the Americans that we, AVRO would no longer be involved in the AVRO flying saucer. And when John Frost

came back from his holiday, Fred Mitchell went in and put his head around the door and said, "John, you are fired." And then he went out the door and he came back and put his head around and he says, "You can take that bugger Des Earl with you too." And John Frost came out to my drawing board which was right outside of his office and he had tears in his eyes and he told me the story. And he said, "What do you think they've done to me?" "I've been responsible for 10 million dollars worth of contracts into this company and I haven't cost them any money." However, that was how close I was.

32. Who was Claude J. Williams and what was his part in the program?

A. Claude J. Williams was a great friend of mine. He was a designer. He worked from practically the inception of the program with John Frost, right through to the end of the AVRO car program. At which time, in fact, I think perhaps he left soon after the Arrow was cancelled but certainly about the same time John Frost went, Claude Williams went. He's now in Seattle. He was an excellent designer and he was responsible for most of the control, design of the control systems on the, on all of our airplane programs.

33. Who was John Dubry and what was his part in the program?

A. John Dubry was an eccentric mathematician, very, very clever man. I say eccentric. He certainly was. He was responsible for all the stability and control mathematical calculations that were made from probably early Y2 until, well, he was... He actually went during the latter part of the AVRO car program, he left the, our little group and he went to work on the Arrow. I remember he went

to work on the air conditioning system on the Arrow for perhaps about a year before it was cancelled.

34. In your opinion, what was the most promising design?

A. I suppose you mean in John Frost's stable. Very difficult. What was the most promising design. Well, I guess you can dream but the first one. The first flat riser, really. Had we, I think the whole thing was designed around this flat engine and everyone's dream was to build this flat engine and one day somebody will. I still think if we could have built a flat engine I would have been very, very, very happy.

35. In your opinion, what was the least promising design?

A. Well, the least promising designs were when the Arrow guys got involved, I guess. Apart from that the whole thing you have to realize was just a compromise and it just went down and down and down due to lack of funds, due to certain problems that developed, mostly due to lack of funds. Some political decisions had to be made. The least promising design I wouldn't like to say. You know, funnily enough, in retrospect I'll have to say the AVRO car. You know, really, because that was probably the lowest, the lowest that we could possibly get. And I think possibly we went to low and I think the idea of the AVRO car was to make the smallest possible, lightest possible, cheapest possible demonstration vehicle to demonstrate the circular plan form airplane would take off and fly. And I think in retrospect that the airplane was probably too small and we were probably batting on a sticky wicket when we started and it got worse as we went along. If we

could have had the luxury of 10,000 pounds instead of 5,000 pounds we could possible have made, probably made a much more robust airplane.

36. Was the program worth doing from a technical point of view?

A. Yes, of course it was. Course, it was. There are so many spin-offs from this thing that it's hard to believe. The Augmenter Wing program which John Worthy is heading up now at DeHavilland was a direct outcome of the John Frost stuff. It's still going strong. The Augmenter Wing/^{airplane} is flying now. He's already into augmented veto fighters from this program. The A bang, which I'm convinced John Frost developed and I think possibly designed and conceived is being used all over the world in various programs. Is probably being used in the space program more than anywhere else in that they have gyros now _____ of A bangs, that run for practically years without any power input on them and they are as accurate that you wouldn't believe. So you had many, many spin-offs. If nothing else it kept me in work for a long time and I know a lot of other people and we weren't just going to work to get the money, we were going to work because we enjoyed it and we were doing what we thought was very worthwhile work. Certainly, it was well worth doing.

37. What is any first or _____ things came out of the program?

A. I think I just told you.

38. Can you think of anything developed during the program which was later applied to other aircraft?

A. Well, I think I've told you that, too. Augmenter wings. I think

possibly the G.E. Fan which has powered several _____ type airplanes in the United States. I'm convinced that the turbo-rotor that was made for the AVRO car was directly copied by General Electric and became quite a successful fan because they had a lot more power than we did to drive it and they probably had a lot more money to, in fact they spent, I think, way more money on the fan itself than we spent on the whole damned AVRO car program.

39. Were there separate schools of thought within the SPG about what direction.....
- A. All the time. Constant arguments, bickering, and people getting mad. There only has to be one boss and I guess it was he who made the decision, but, sure, when you get a bunch of half intelligent guys keen and as _____ about the program, of course. There are constant differences of opinion, but there were one or two that got a little bit bitter. But, in general, it was all taken in good faith. After all, there is only one boss and you do what he eventually thinks is right.
40. What do you remember about the final knife edge proposal for the use of _____ for a supersonic fighter bomber with an airplane nose on the leading edge?
- A. I think, all I can remember about that, it was just another pretty picture that was drawn during the negotiations to get some more money from some one. And it was pretty wild. I can only say that we got more money so.... I imagine it did its job.
41. Can you think of anything not covered which is important?
- A. Well, I think I've probably been speaking into Des' machine for a

and he's got lot's of information from me in the past. I think I'll skip that one.

42. Can you think of anyone who should also be interviewed?

A. I think we've discussed that pretty thoroughly too, Les, so how about that?

L. Thank you very much, Al. That's quite a tour, really, to answer that many questions and I think you did a yeoman job. I don't think there's too much new from what you've told me before but you've elaborated a little bit and thank you very much, indeed. I think we'll just turn it off and have a rest.