Oral History Interview Transcript

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Interviewer: Doug Hearnshaw

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Transcription of Interview Number 4-C1 BENNETT

Thomas E. Bennett

Interviewed 14 October, 2004

By Doug Hearnshaw

HEARNSHAW: This is a CANDIB Oral History Project interview with Tom Bennett. It is recorded on the fourteenth of October 2004 at the city of Ottawa. Mr. Tom Bennett is introduced by Mr. Tony Thatcher, chairman of the CANDIB committee. And he will also identify those taking part in the discussion or they will identify themselves. This recording is supervised by Douglas Hearnshaw.

THATCHER: I'm Tony Thatcher, chairman of the Canadian Naval Industrial Base Project. It's my privilege to introduce Tom Armstrong Bennett, who is a key member of the eleven man engineering team in de Havilland in Toronto during the 1960s, which was studying the feasibility of designing an ocean going hydrofoil, capable of tracking and destroying modern submarines and this vessel became known as HMCS Bras d'Or. This was a project which involved state of the art design principals and an extensive model test program, challenging shipbuilding techniques, exciting sea trials and one that made an important contribution to the Naval Industrial Base. And with those few words of introduction, I'd like to turn over to Tom.

BENNETT: Good day. I'm Tom Bennett. I was privileged to become part of the eleven-man team, who did the feasibility studies to produce the FHE 400. That went on for, I think, about up to four years and included many, many facets that we had to investigate. And I wrote a few of them down here, on the way up. And the feasibility included determining sea state and wave action, stability and control, foil arrangements, hydrodynamics and dynamics, foil sections, cavitation, material and cathodic protection, power plant transmission and systems, performance, basic layout, propeller design, model design and computer simulation. So the eleven of us investigated this whole range of topics and after some model trials, we presented a paper to the Government supporting the feasibility of building the ship. Eventually that was accepted and de Havilland ended up with the build contract.

The material that I brought with me today – you're probably wondering, well, how did I get hold of it? It just happened to be in my files when I was operating out of the office in Halifax dockyard. And when the whole thing was shut down, everything just went pfff everywhere, so I just took and put it in my car because I figured it was going to the dump if I didn't. And a couple of little things in there that are probably kind of special and it's been in my basement now since 1972. So really, I'm quite happy to get the space back. I hope it will be of some use to you and I'd like to think that if anyone wants to have access to it, wherever it is, that they would be able to access it. I think those are my initial comments.

THATCHER: Excellent. Well, we'll certainly make sure that they go to the right place and are available to future researchers. That's our aim.

BENNETT: Um huh.

THATCHER: Would you like to go through some of the articles you brought?

BENNETT: Yeah. We could pull the box up and just have a quick glance through what there's there. The details of the systems and that in it. [Inaudible, background discussion] … a photograph up here. [PHOTOGRAPH 1] This is another one of a kind. It's a composite of most

of the model testing and the various models we made. That's one I made in my basement, which was…. That's the one I got in big trouble. Sworn to secrecy and then building this thing in the basement and taking it out at home and operating it. One of the first interesting things we found out from it -- we didn't really realize the significance of it -- was when the model went to take off, it would get to a certain point, like this and then it would roll over like that. And it got into a static state. It would just keep going along like this and nothing else would happen. The more and more we learned about that, we realized that we needed movable anhedral tips. And of course, that became a major subject. Now we're talking money. We're not really meeting the basic requirement of the ship because the ship was supposedly not to have any moving controls. It was supposed to be a very simple device with just a bow foil steering. And also the bow foil steering became a little more complex. We ended having to trim it back and forward as well because as you went to go at maximum displacement speed, the bow would start coming up and the drag would increase. So we trimmed the bow foil.

COMMITTEE MEMBER: Just like an airplane.

BENNETT: Yeah. And the bow foil -- we were sitting around one day, having a cup of coffee and I said to the guys, "you know, when we turn this bow foil, the incidence on this foil and the incidence on this foil, are going to be different. The ship's just going to go skittling sideways." So that caused a, oh, what do we do now? We ended up having to develop a very special bow foil section, where the water broke away from the top surface of the foil, via a step. So that the water literally broke away there and virtually developed no lift on the top surface and all the lift was generated on the bottom surface. Well, that increased the drag a bit. It really made the bow foil function. The combination of all these things made it a workable ship, particularly the anhedral tips. As you see in the pictures, you'll see the boat is just going around in a perfectly coordinated turn, just like an airplane. [PHOTOGRAPH 2] Its manoeuvrability was absolutely incredible.

So we went through many model tests. [PHOTOGRAPH 3] This one, we made at de Havilland. It was intended for displacement trials. But I had to generate it such that the weight and balance was right. We weren't really worried about stiffness. Rather than stiffness, the weight and balance had to be right. It was taken over to Teddington in England and operated in their tank. And as it happened, it did get foil borne in the tank, which kind of shows that at low speeds, the foil sections really….

BENNETT, JOAN: I'll hold it up so other people can see it. You know, you referred to….

BENNETT: Oh, I'm sorry. The foils on this were literally just a flat-bottomed surface and a cylindrical top surface. And at these speeds, that worked fine.

COMMITTEE MEMBER: When you say 'cylindrical', do you mean cylindrical or aerofoil?

BENNETT: Radius.

COMMITTEE MEMBER: Aerofoil.

BENNETT: Aerofoil or hydrofoil. More pictures of models. This was where we got some information on needing flow control fairings. This was the quarter scale RX model, which was down at Halifax. I became responsible for this and the bow foil. And we did that back at de Havilland's. Had it built in Toronto then took it down and put it on to this barge. That was Defense research establishment. They operated it until they ran into a ship -- reportedly a Russian cargo ship or something – and knocked the bow foil off and it disappeared into the ocean and they never were able to find it again. Anyway, it was time to put on the more up-to-date bow foil, which actually did away with the center – this was the set we designed. This was their original. They were playing around with different foil arrangements. [PHOTOGRAPH 4] We managed to do away with this mid foil member, here, in the middle of the diamond. [PHOTOGRAPH 5]

BENNETT, JOAN: You can't see that from this end of the table.

COMMITTEE MEMBER: I can.

BENNETT: Am I taking up too much time? Hopefully we won't go through all of this. Behaviour and treatment of galvanic couples in the sea and seawater.

SAKER: That, of course, became very important with cracking problems.

BENNETT: Yes. We didn't have a lot of corrosion, but the biggest problem was cracking.

SAKER: Cracking, well, OK. Hydrogen embrittlement or whatever it was called.

BENNETT: Yes. This was just the geometry of the foil system. This was the foil-borne propeller.[PHOTOGRAPH 6] This is testing the bolts that held it together. [PHOTOGRAPH 7] And I've got a picture of one blade at Ladish. [background noise] I'm not sure what I did with that but it's a beautiful photograph. Certainly it was a lovely photo because…. Have you all had a chance to look at these? [PHOTOGRAPH 8]

COMMITTEE MEMBER: Yeah. We're hoping that we'll get a chance to scan them, if we may.

BENNETT: Oh yes. Or I'll get copies for you, if you want them.

COMMITTEE MEMBER: Well, doesn't necessarily want to put you to that….

BENNETT: I'd really like to not lose these. That's the only thing.

COMMITTEE MEMBER: Oh, I can well imagine.

BENNETT: I wish I had that other picture.

BENNETT, JOAN: I'll pass that pile around because not everyone has seen it.

BENNETT: Maybe the picture will turn up somewhere.

BENNETT, JOAN: Is it among the large pictures over here?

BENNETT: It was an eight by ten. [inaudible] Oh, it could be in there.

BENNETT, JOAN: Down there's a scrapbook.

BENNETT: This is a report on the Hull project.

[Background voices]

BENNETT: It's a final design report, which was pretty extensive. It includes everything to do with the vessel.

COMMITTEE MEMBER: This is a goldmine, in this box.

COMMITTEE MEMBER: Yes. I think DHH will be drooling over this.

BENNETT: Super cavitating propeller. That's the profiles of the blades. [PHOTOGRAPH 8] The two high-speed propellers were made by Ladish, in Milwaukee, to our design, our total specification. And they made it out of iconel 718 and designed specifically to get away from any cavitation damage. So the leading edge of the blade was very sharp and the trailing edge was like, this thick. But the cavity broke away and dispersed itself in the water. After the hundred or so hours of running, they were absolutely perfect. There was no sign of cavitation damage actually anywhere on the ship – no cavitation damage. But it was because of the very special attention paid to it, particularly to the propellers and the foil-born pods. You'll notice that they were kind of coke bottle shaped. [PHOTOGRAPH 9] And that really paid off.

Now, tons of stuff in here. I'm just going to go through. Oh, this is a little bit of follow on information. We were left with a very small group, when they cancelled the program, to investigate further developments. And they were only left with about two people. One of them was me and one was our stress man, Saab Morita. He was a good Japanese Canadian. This was the sort of thing they were coming up with as a follow on. Not particularly for the submarine business, I don't think, but going out and chasing foreign ships and shipping, fishing, that sort of thing.

There's an end [?] of the ship. What's this one? [PHOTOGRAPH 10] Control actuator. Oh, the hydraulic actuators, which, of course, in aircraft terms, these hydraulics were just massive. But in general engineering, I guess, they're still big. But they had to be very responsive. Oh, there's another one -- redevelopment of something afterwards. I guess the Government didn't know what to do with us. That was the truth of it. They couldn't have just fired us so they came up with this little project to keep us busy for a while. Knowing that it wasn't going to go anywhere.

SAKER: But I think it was important to get the output from what has been done and what did you do differently were you to go ahead. I think that was an important step.

BENNETT: Yes. This was, of course, for a completely different purpose. My knowledge, it wasn't to chase submarines, this follow on development work. I guess it was using information from the original vessel to come up with something.

SAKER: Yes. I think, wasn't one of the main ideas of what would a new design look like, to avoid the foil cracking problem, was one of the issues, I think. Would it not have been? Because that was a question of speed, probably, and material choices.

BENNETT: Yes. Materials were really very difficult. Speed certainly had an effect on the structure, in that if you drop the speed, you're going to have thicker foil sections.

SAKER: Yes.

BENNETT: One of the problems we had on Bras d'Or was that the anhedral tips, ones that waggled like aerolons. [PHOTOGRAPH 11] And they were built by North American Aviation in Los Angeles. Unfortunately, they were not designed very well from the point of view of balanced welding, from top to bottom, to maintain a good shape. They were so thin, that you couldn't apply other methods. And they had one hell of a job trying to maintain the profile. Every time you put a weld in, it shrinks and the thing kinks and they were pretty bad.

Barry Davis and I had to go down to Los Angeles to sign for these units that they'd built. And we got to the anhedral tips and we both looked and what do we do about this? Poor Barry, he's running this way and that way. He said, "Well, tell you what. I'll sign and then we'll go back and discuss it. You'll have to come down and put your signature on it." And this was the agreement we had with North American.

It turned out that North American just shipped these units up to Sorel. So now we're stuck with them. So they're up there, virtually useless. Wouldn't perform worth a damn. So we decided we'd take them back to the de Havilland plant in Toronto and do something about it. Well, I had to inform our production manager we had to do this. And my name was big mud. He called me a screwball and a junior screwball. Anyway, we had a party that night. He came over to me and said, "Hi Tom. How you doing?" So, got over that one.

We shipped them back to Downsview. And we built the surface up with balsa wood. I forget the actual thickness. They were five percent and I think we went up to six or seven percent thickness in order to blend out this nasty shape. And after we'd done that, we took fibreglass moulds off it, top and bottom. Then we opened that up, took all the balsa wood off, put the tip into the mould

and clamped it down and we pumped urethane in there under pressure. It just did a super job. It stuck to the foil like you wouldn't believe. Afterwards, a little bit of machining brought it down to an absolutely perfect hydrofoil section. They worked a hundred percent, which is where I came up with the idea, well, OK, let's just build a basic core of high strength material and mould the surface out of urethane. And in order to allow a little more freedom on the structural side of things, reduce the speed of the boat by five or ten knots. That was the only way I could think of getting over this terrible cracking problem. Because I don't suppose you ever heard anybody say it, but in my opinion, that would have doomed the ship.

COMMITTEE MEMBER: At some point.

BENNETT: At some point. In fact, it could have not left the dock, after it came back from Bermuda, in my opinion. Not safely.

SAKER: Well, I was there when the first foil crack was discovered. The next week we were supposed to take Pierre Elliott Trudeau out for a spin with Admiral O'Brien, and that was cancelled for good reasons.

BENNETT: Oh dear. [Later comment-I do not recall any cracks in main fittings. The worst crack was along the leading edge of the centre foil]

SAKER: And that crack was in the foil structure around one of the pins. And it almost came through the far side. That would have been catastrophic, for sure.

BENNETT: After it came back from Bermuda, I had a lad who used to go down and look for all these cracks. I was walking down the pier one day and he's coming this way. And we bumped into each other. And he's looking very serious. He said to me, "Tom," he said, "I think we got a crack in the centre foil." "OK. Let's go and look at it." So we went down there and we started poking away at the neoprene coating and out came water. And we just went along and along and along and along. We ended up with two bridges of uncracked material, about that big, in the whole length of foil, from here to the wall.

We were attempting to actually weld it, upside down, on the ship. I was down there standing by the ship one day and there was a bang. I said, "What was that?" Looked underneath the foil and these little bridges had cracked. A few seconds later and another bang and the other one had fallen.

COMMITTEE MEMBER: All the stresses came out.

BENNETT: The stresses in the foil that has not been stress-relieved, is just fierce. I always felt that it was more the stresses of the welding that caused a lot of the cracking. On top of that, there was hydrogen embrittlement too, I guess.

I'm taking a lot of time. Is this all right?

COMMITTEE MEMBER: Yes.

BENNETT: There's all kinds of other stuff in here; program review. There's even some drawings in here. More photographs of the hull. There's the new Bow foil. The dihedral foil member, here, was manufactured from one billet by Ladish. It had complex shapes, of course, curved on the bottom to blend in to the pod. And they machined those perfectly. And they were shipped to North American where they built the bow foil.

Random motion and the randomness of the hydrofoil motion in the random seaway. This was done by my very good friend, Gord Oates, who is no longer with us unfortunately. He was a brilliant person. And he did the complete computer simulation on the old Avro computer that they used for the CF 105. And it was one these big things, you know, you have a board with a

million wires in it. Some how they managed to achieve a complete simulation of the vessel. It was incredible.

Now, as a matter of interest, the foil members were bolted on to the hull with one and a half inch diameter Inconel 718 bolts, made especially for us. We even told them what material we wanted them made of. And here we are, trying to bolt these foils onto the boat. And we had these, what they call PLI washers, which are made of four sections. When the bolt is up to its tension, this will be crushed to the point that you cannot turn the outer rings. And they were there. They had an eight mounting [?] times multiplier, up there twenty feet up in the air, trying to do these things up and getting nowhere.

And we were in there watching one night. Suddenly, an almighty crash. And this whole assembly unit, the arms and the mounting pier fell bang, on top of the foil. Fortunately, it didn't do too much damage. But anyway, everybody suspected, oh, these darn washers are wrong. They're no good. So they got sent back to DHC and they put them on the Tinious Alson machine. And they found they were perfect.

So, now what's wrong? Well obviously, the nut and bolt was just seizing up on each other. And we were just winding them up like torsion springs. They were, you know, bolts about this long. So I phoned the company who made them. They said, oh, just put Mollycoat G [?] on them. So I got a tube of this and went running back to Sorel, coated it on the bolts. No problems. No problems. So these are a sample of what was quite an exciting moment. I happened to come across this, somewhere or another. The Navy made this as a basic model for the ship's…. what do you call it?

COMMITTEE MEMBER: Crest.

BENNETT: Ship's crest.

COMMITTEE MEMBER: Having trouble getting it….

BENNETT: And of course, it depicts the golden arm, the arrow. So it was very appropriate. This was a kind of a minor problem that we had. The down shafts for the foil-borne propeller, the transmission, inside the ship there were, the shafts were about four inches diameter. And then we had these universal bearings to allow for all kinds of deflection at the hull side. The casing of the outer ones came up against here and the inner ones against – actually the shafts. I forget the exact details. And obviously, the hull was flexing a little bit and causing the shafts to bang together. You can see how that burred over.

COMMITTEE MEMBER: Yes.

BENNETT: That would have been one problem we would have to solve but that's a minor one.

BENNETT, JOAN: Your scrapbook is here behind you.

BENNETT: Oh yeah? Oh, golly. Yeah. [background discussion] This is a scrapbook, which my wife made up.

BENNETT, JOAN: Your ex-wife.

BENNETT: Actually, I didn't need to mention it. My ex-wife. Joan and I've been together since God knows when.

BENNETT, JOAN: Ninety-four.

BENNETT: Twenty years, anyway. And this is our original crew here. [PHOTOGRAPH 12]

BENNETT, JOAN: You could hold that up.

BENNETT: Well, I can't show it to everybody at the same time, unfortunately.

WILLIAMS: When you say crew, you're talking about design crew?

BENNETT: The design crew are here but more than that. The contractual people and the kind of senior management people are in here.

WILLIAMS: Is there a picture of just the design team or was that never kept at all?

BENNETT: Personal pictures, I think, that we took. There are some around. I may have one. But some of them anyway. But most of them are here. [PHOTOGRAPH 13] You probably know Rolfe, Rolfe Monteith. He was a Navy rep.

COMMITTEE MEMBER: That is Rolfe, is it?

BENNETT: Yes.

COMMITTEE MEMBER: He's our chairman.

COMMITTEE MEMBER: Is that Ed Bowkett?

BENNETT: He's a troublemaker. No, that is Fred Bullard. The famous de Havilland Fred Bullard.

BENNETT, JOAN: He hasn't changed at all.

COMMITTEE MEMBER: That's Dick….

BENNETT: Dick Becker.

COMMITTEE MEMBER: That's Dick Becker.

BENNETT: Harry Befford, he's the guy that told me I was a….

BENNETT, JOAN: Junior screwball.

BENNETT: Junior screwball.

COMMITTEE MEMBER: Oh, I thought that was Dick. That sounds like something Dick would say.

BENNETT: Yes. Yes.

COMMITTEE MEMBER: That's Saab, is it?

BENNETT: That's Saab. Yes.

COMMITTEE MEMBER: I remember him.

COMMITTEE MEMBER: Let's break up for a second, please.

BENNETT: There's one of the inspectors. I forget his name.

COMMITTEE MEMBER: Martin Callow.

BENNETT: Martin Callow. Phil Halsey, who was on the management side. This was our kind of artist type. That is Marshall.

BENNETT, JOAN: Dave Marshall.

BENNETT: Dave Marshall. I forget his name. He was the metallurgical man. I forget his name.

COMMITTEE MEMBER: Tom Drummond.

BENNETT: That was Gord Nobbits, a very intelligent, brilliant fellow, who did the simulation. Bill Billings, he did the hull design. That funny guy back there's – I still didn't have hair. That

was Harry Befford, senior management. And Bill Heaslip, engineering manager. And I forget where these two fit in. This was when I went to sea on it. Ian Sturgess, was that….

COMMITTEE MEMBER: Yeah. He was the XO. It says, commanding officer.

COMMITTEE MEMBER: He was the last commanding officer.

COMMITTEE MEMBER: Was he?

COMMITTEE MEMBER: Yeah.

COMMITTEE MEMBER: After Gord Edwards?

COMMITTEE MEMBER: After Gord Edwards.

COMMITTEE MEMBER: After Gordie.

BENNETT: This was the sort of thing I had to install, the water detector in the centre foil. Came from the Defence Department research people. [background discussion] That was Gordie Edwards, the final captain.

COMMITTEE MEMBER: He's always got a girl in the picture.

COMMITTEE MEMBER: That sounds like Gord.

BENNETT: Yeah, really? Well, I think that's his wife.

COMMITTEE MEMBER: I don't think so.

BENNETT: No? Oh. I didn't know he was a ranger.

COMMITTEE MEMBER: Caught again.

BENNETT: Lots of loose stuff in there. I guess that that was the model that I built, running in the tank down at the Canadian National Exhibition. And this was the ship's little brochure. That was Ian Sturgess. That's all there.

COMMITTEE MEMBER: That's Gordie.

BENNETT: Ian Sturgess was there somewhere. Anyway, they used to hand this out to anybody that came on the ship. And then it starts off, in the beginning, the model boat in the basement. Oh, it's a sailboat I was building there. And that was the actual first photograph of that particular model. These were people operating it and Dick there. Our senior people came up to see it operate and I ran it into the side of a fishing boat and broke a foil. I said, "Well, sorry guys. Give me a better radio control" which they did. Oh, here's the…. Who was asking about the group?

WILLIAMS: Jim.

BENNETT: This is it. I think they're all there. [background discussion] Do you know of many of these people?

WILLIAMS: No, I was with de Havilland but in the UK.

BENNETT: Oh, where that's where I did my training. In 1941. Well, that's me. That's Gordon Callow, the….

WILLIAMS: I don't know the people. [To CRUICKSHANK] Can you do something with that?

CRUICKSHANK: I didn't bring my camera.

WILSON: Let me try. Do you mind, Tom? Just let me see if I can. I might be able to.

BENNETT: Is this turning into something different?

THATCHER: We'll sort of allow some questions and get some sort of general discussion going.

BENNETT: Yeah. OK. Good. Just get through this and….

WILLIAMS: Now, which one is you?

BENNETT: The kind of bald headed one or at least one of the bald headed ones.

WILLIAMS: OK. Who was your actual leader?

BENNETT: Um, our leader's really not here. That was Dick Becker.

WILLIAMS: OK.

BENNETT: So these people all reported to Dick Becker. So they all represent that list of requirements.

WILLIAMS: That's in your article?

BENNETT: Well, no, it's not in there, actually.

WILLIAMS: There's a list, though.

BENNETT: I scribbled this up on the way. Oh, there's a list of names in there. All the names are there.

WILLIAMS: So all of these, there's five, there's ten.

BENNETT: Yeah.

WILLIAMS: OK. There's a few missing. So, that's the guy?

BENNETT: Dick Vicker, yeah.

WILLIAMS: OK. Terrific.

BENNETT: Well, wait. Dick's there. There's Dick.

COMMITTEE MEMBER: There's Dick.

HEARNSHAW: Tom Bennett interview. Tape one, end of side one.

END OF SIDE ONE

HEARNSHAW: Tom Bennett interview, tape one, side two.

CRUICKSHANK: What are your qualifications? You're obviously a very highly qualified gentleman to be in the position of responsibility that you were in that very, very advanced program. It was referred to by our chairman as being the state of the art. It seems to me that it was a long way past the state-of-the-art. Where did you come from?

BENNETT: I took my training with de Havilland Aircraft Company in England. And I joined their apprenticeship scheme in 1941. It was a fabulous training facility.

CRUICKSHANK: I went there, yes.

BENNETT: Unfortunately, just before I arrived on the scene, a bomb had hit the one building where they contained the whole technical school and killed about 27 students.

COMMITTEE MEMBER: Was this in Hatfield?

BENNETT: Yes. That was the one bomb that hit de Havillands. And then they dispersed the various departments, like sheet metal, carpentry, machining and that, into different places all around within about five miles. So I arrived on the scene there where everything was like five miles away from where I was living. I did a lot of bicycle riding. And I transferred from each of

these departments on about a three-monthly basis. I went through all the basic hands-on tools and that. And then I was transferred into the factory.

In the meantime by the way, we were doing our academic studies after hours in the local school with the de Havilland personnel giving the lectures. I ended up in the experimental department in de Havillands, which was an absolute eye opener to a young kid. I was only about 16-17. And here, I became known as a model maker, model airplanes. We built a high altitude Mosquito to get to the German Ju-88s that were coming over at high altitude. Nothing could get up to get them. So we extended the wing tips, pressurized it and everything. And a pilot came in to pick this up. It was kind of one-of-a-kind, you know, to catch these things. And he asked the company if he could have a model. Well, I was shuffled off into a back room. And I opened the door and I walk into this room and here is a mock-up of the first Vampire, the jet Vampire, and the Hornet. I don't know whether you're familiar with the Hornet airplane. And the Hornet, here were wooden mock-ups to two airplanes. It blew my mind. Anyway, I worked in there and produced this model. Ended up working on the prototypes of both of those airplanes and the Comet.

And in 1950, I guess, I left de Havillands. They encourage you to leave and go out and get experience and come back. And they'd take you back. So I went to South Africa and worked in some little mining company, designing stuff I knew nothing about. But it seemed to work. Went back to de Havillands and they took me on. I said, "I'm leaving for Canada in six months." Fine, fine. So anyway, in six months, I left for Canada. But I should say, in the meantime about part of my time back in de Havillands, I worked with the de Havilland engineering people, who were sent over to do the two-seat version of the Vampire. When I came back to Canada, they were back. And of course, I was in like Flynn. I was there ever since. And at de Havillands, I did a bit of almost everything and anything.

COMMITTEE MEMBER: De Havillands wouldn't send you to Grandfield or any of those places?

BENNETT: No. I didn't. The training school, now, has become the University of Hertfordshire, the de Havilland University of Hertfordshire. That's what it's developed in to.

COMMITTEE MEMBER: Right. Their own college.

BENNETT: Yes. So we were doing university stuff, you know, but at ad hock places.

COMMITTEE MEMBER: Tremendous career.

BENNETT: Yes.

BENNETT, JOAN: You also did some work for Canadair, didn't you? De Havilland subconded you.

BENNETT: I was subconded to Canadair to do the back end of the Challenger, including the engine mounts and fin and rudder, air conditioning and all that stuff.

COMMITTEE MEMBER: The original 601.

BENNETT: Yes.

WILLIAMS: I'm Jim Williams. Just by way of background, I was with de Havilland in the UK, after I got out of the Navy. I had been in the Fleet Air Arm and in the last two of my eight years, I spent dealing with aircraft manufacturers. That was between '50 and '52. So I went to all of the aircraft manufacturers in the UK, looking at designs for Navy aircraft, so as we could maintain them onboard ship. Then, you mentioned de Havilland. I came to Canada in '57 so I was with de Havillands first then came to Canadair. The result of that is that I have a fair background in

aircraft design [and] the techniques that we used in that time period. Subsequently, later on, I became involved in ship systems and then ship programs and ship design. So I've seen both sides of the fence.

The question that I have for you is almost philosophical. You were used to doing work one way and then the Bras d'Or came along and the method of doing work was not going to be the same: you weren't going to be able to build a mock-up in Toronto and your design-proving model was going to be built at Sorel. What kind of problems did that give to you and your team in terms of transitioning yourselves from how you designed the aircraft and prove it, to how you design the ship and prove it?

BENNETT: I don't know I can answer it precisely but what happened was that a few people were picked out of the basic de Havilland engineering team to be put on to this hydrofoil project. But in addition to that, we had to get further specialists, like hydrodynamics. And stability control, we had people. Materials we got a special person for. And we were all put in to a separate glass cage and locked up.

WILLIAMS: Was your access to design techniques that you had available to you on designing the aircraft, like walking out on the shop floor and looking at the mock-up and stuff like that, was not really available to you in the simple way. Did you, at the time, were able to use CAD or something that would take the place of that minute-by-minute?

BENNETT: I think we drew on our past experience. We certainly had no access, as you say, to go out to the shops and see anything or have anything made, other than models.

WILLIAMS: They were full-scale models?

BENNETT: Oh, at least four.

BENNETT, JOAN: Not four.

BENNETT: Oh, did you say full? We never made a full full-scale model but we made a hull section out of the mould, which was basically the engine room because of the complexity in the engine room. But other than that, no, there was no models made other then the test models.

COMMITTEE MEMBER: You had your tank models.

WILLIAMS: That's after the fact. We're talking about during the design phase.

COMMITTEE MEMBER: Sorry.

BENNETT, JOAN: You did that while you were designing. Didn't you do that first model that's in the Museum of Science and Tech?

BENNETT: The model designs and tests were done at an early stage, before….

BENNETT, JOAN: Before the Navy even bought into it.

BENNETT: Really got into the full sized ship. I'm not answering your question, I don't think.

[inaudible]

BENNETT: I think I just brought my basic skills with me and adapted them in a different field. After all, the….

WILLIAMS: Yeah, that's your technical skill. It's the process that I was more concerned about. I had a lot of problems when I moved into the ship side of industry in Canada, in my mind as to, in my mind, how archaic they were in the way they were designing ships. And, you know, we would design something, like for the frigate. We'd say, OK, we've got a cable run from here to there, going through these compartments. We had no way, except through fairly rudimentary

computer assisted design, at that time, to determine what bends and wrinkles and wriggles these cables would take. And therefore, when they ended up, you know, how long should they be? So the shipyard couldn't make up a cable run, like we could in an aircraft with a connector at each end already on and go strap it in and connect it up. They'd put one end in, run it through and then they'd have the open end that was not finished. And they'd have to finish it in situ. And it was different from ship to ship. You had to do it one by one. Whereas in aircraft, you'd say that's the harness for that run. Fifty aircraft, make fifty of those harnesses and they'd fit.

BENNETT: The hydrofoil, in size, was relative to an airplane size really. Not compared to the destroyer escorts and things like that. So de Havillands had the techniques for manufacturing cables pre-soldered and everything. And I think the hydrofoil was so close to an airplane that we were able to do that.

WILLIAMS: Yeah. I don't think that in each case the cable lengths would be very different because you'd have through-bulkhead connectors and that. I suspect that de Havillands, because of their background, were able to be a little bit more definitive in their designs, just on paper and it would work.

BENNETT: Yes. I would say that. Well certainly on the job eventually, there were obviously things that had to be changed and that. But as far as somebody going from looking at airplanes then to looking at hydrofoils, you're bringing your basic engineering with you and the concepts are really much the same.

WILLIAMS: But the environment in which they're going to live is quite different.

BENNETT: Oh, well yeah. That's where the feasibility studies come in.

WILLIAMS: Yeah. Yeah. Because if you go back a long, long way, Vickers in the UK was building ships then they set up a little company to build airplanes and they applied hydrodynamics to aerodynamics. Then you went full circle to the Bras d'Or.

BENNETT: Well, you know, we had no interference from Naval architects. The company did at one time, I think, hire a Naval architect and because of the totally different environment, he just didn't last.

WILLIAMS: Yeah, that's the answer to my question. It's what you should have said and we could have cut out all this. [Everyone laughs]

COMMITTEE MEMBER: It's like flying in treacle.

SAKER: I was wondering if I could just add a comment to an excellent question. And as having been someone who actually ran the boat for a while, there was often sometimes derogatory comments about aircraft manufacturers, what do they know about boats. Because there would be the odd problem that would pop up, they would see that it was an aircraft solution in a maritime environment. Having said that, to me the things that worked really well in those vessels, were the propulsion pods. The two displacement propulsion pods, you know, the two foil-born propulsion pods, in which you certainly didn't want to get any seawater and anything else like that and you didn't want to have problems because, you know, if you have to break into those things that was a big, big, big job.

BENNETT: That was a big job.

SAKER: And I think to that extent, it was interesting talking about the transmission runs down the struts and into the foil-born pods. I can remember that being one of the big issues we had, too, with those high-speed shafts turning and is there enough oil supply. If there isn't, do we, you know, have to slow down? Literally every one of those lines was instrumented with temperature

gauges. So we were checking oil temperatures and watching them like a hawk, especially foil-born. So I think in that respect, it was very, very successful.

And I always used to say, reference the cost of this thing, given the undertaking that was made. I mean this was very much an experimental craft. And it had all sorts of features in it that were quite fortuitous and allowed, well, we've run in to a problem here but now we've got this backup system and we'll be able to do something about it. It impressed the hell out of me, I must say, in my time on the…. Foil structure and cracking problem was a bit unnerving but apart from that, it was – it wasn't a problem until we discovered it and then it became quite an issue. I'd just like to….

BENNETT: I was so disappointed. I really kind of felt our metallurgical people let us down somehow or other.

SAKER: Yeah. Well, you were pushing the limit; 250 PSI steel and all that kind of stuff was really pushing the limit.

BENNETT: The decision not to stress relieve the components due to the distortion, really, that was part of the problem.

SAKER: And the other thing I don't believe that was done was a cost cutting measure, was no stress testing of a full foil, I think. The initial idea was to build a complete centre foil and put it through a….

BENNETT: We did. A centre foil.

SAKER: You did? And it worked?

BENNETT: Yes.

SAKER: You passed that.

BENNETT: Yes.

SAKER: OK.

BENNETT: There are pictures of it somewhere.

SAKER: OK.

BENNETT: Under test.

SAKER: Oh, sorry. I was just going to ask one other. You allude to it in the front of your little narrative you built there – Dick Becker being very secretive. I don't know whether you care to comment on how did de Havilland get this contract in the first place? Do you have any idea how it happened?

BENNETT: Dick and I were doing a lot of work on the Tracker, the development part. And that, of course, introduced us to the Navy. And then somehow or another, Dick must have got in contact with – who would be cooking this [?]?

SAKER: Eames.

BENNETT: The Defence research people.

SAKER: Yeah. Mike Eames.

BENNETT: Yeah. And I think that may be where it started. Then, of course, it had to go back to Ottawa and then be negotiated from there. But Dick Becker, at that time, within the company was the sole person involved. Not even the chief executive officer, at that point.

SAKER: Yeah. It sounds like it was a directed contract. I don't know the history of it. Maybe Pat…?

BARNHOUSE: Pat Barnhouse speaking, if you can hear me. It was, in fact, a directed contract. It had a lot to do with the cancellation of the Avro Arrow. The Government, it wasn't the National Defence that originally funded this, the first study. It was, what was then, DDP, Directorate of Defence Production, Department of Defence Production, sorry, who had some kind of mandate from the Government to encourage aircraft technology in Canada, post Arrow. We'd lost all that technology, all the people, all the understandings. The Government saw this was happening and decided they ought to have to invest at least a modicum of money back into supporting aircraft technology in Canada. And that really was the start of the – what do you call it – the thing that provided the start-up money, the seed money for the hydrofoil project. And then it was a matter of the Government, shall we say coercing, no, not coercing, convincing the DND to get involved with the project, literally. That has been a very difficult scenario to actually figure out because most people who were involved are now dead and it was all done with no paperwork. It was done, you know, let's drop into somebody's office and talk, literally. We found out some of it, Hal Smith found out some of it but it literally was done very, very much on the old boy network, you go ahead and do this. It won't be put on paper at all.

SAKER: It's Mike Saker back again. You also alluded, at the beginning of this thing, in the fact that at the same time, the Americans were going for a fully submerged foil design and the Brits were doing the hovercraft design and the Canadians were doing the surface-piercing design. And there was a desire, I think, amongst those three nations to sort out or solve anti-submarine warfare, high-speed chase. How do you do it? And so these three competing designs, in a way -- this is my understanding of how it went – with the idea being that we come out the other end and we'd kind of pick a winner amongst them all. And, of course, that never happened because everybody was convinced their solution worked. The UK, [were] doing what they were doing because they really were interested in getting across the Channel with a ferry and that was one of the outputs of theirs. And the Americans used surface-piercing design in Vietnam. In fact, they did a lot of stuff there but they were able to lift the foils out of the water.

BENNETT: They … foils.

And I can recall operating the Bras d'Or, the big difficulty with the hydrofoil is that it actually was a deep sea draft vessel, twenty-three and a half feet draft, which meant that if you were chasing fishing boats or anything like that and they wanted to get away, all they had to do is go across a sandbar or something. Unless you were foil-borne, you could go after them foil-borne but you couldn't settle down unless you had twenty-four feet of water.

BENNETT: Tom Bennett speaking. I recall that there was a tripartite meeting between the UK, Canada and the US to discuss this submarine problem. The outcome of that is exactly what you mentioned, that they would do the hovercraft in England, we would do the hydrofoil with fixed foils and the Americans would do the submerged foils with electronic control and the height sensing. Whereas, Bras d'Or height sensed just depending on how fast you went. The boat came out of the water higher. And it became completely stable.

SAKER: Yeah. Yeah.

McCULLOUGH: Brian McCullough here. I'm sorry. Go ahead Don.

WILSON: Don Wilson. I wanted to get us back to the Defence Industrial Base approach here and ask you a question about trying to apply aircraft technology to ship building and how you made out with MIL Industries in Sorel for the building a vessel that must have been somewhat foreign to the shipyard workers in the shipyard.

BENNETT: Well, the shipyard basically built the hull, which involved aluminium welding, upside down. They had to build a completely new hangar to do this because of the environmental requirements for clean welding. Then we -- that's de Havillands -- did the foils, which were akin to aircraft wings, if you like. So that the basic concepts there are really the same. You've got spars, ribs, skins, big fittings, of course, but it's actually all the same as aircraft structure. So that fitted in to our world. As far as the hull being built, I think that fitted in with MIL.

WILSON: Did they find themselves having to deal with some -- because I was there subsequently for the DDH280 program and they were having to make some adjustments to their thinking to be able to work in thousandths of an inch instead of quarters and halves of an inch. And I just wondered if that, if you encountered that or was the amalgamation or the integration of the foils and the rest, with the hull, a fairly straightforward thing?

BENNETT: De Havillands thought that they should make the foil foundation for the main foils back at the old Avro plant. We built that and it was shipped by rail and inserted into MIL's hull upside down. I think that dealt with that. Then the bow foil, MIL just configured that. They were very good, from my point of view but I had really very little to do with the hull.

WILSON: Thanks Tom.

McCULLOUGH: Brian McCullough here. Tom, what year did you leave the hydrofoil program?

BENNETT: Nineteen seventy-two.

McCULLOUGH: Nineteen seventy-two. I noticed at the Science and Technology Museum in Ottawa, there must be a prototype. Is it Baddeck? Pat, is that what it is? Did you have any involvement with that vessel? They've got it sitting up on a barge of some sort in the museum.

BENNETT: No. We actually went around researching what other people were doing, visiting Grumman, for instance, and Boeing and anybody else who was in the field.

McCULLOUGH: So that wasn't a de Havilland?

BENNETT: That was not a de Havilland boat. No. I forget who built that.

COMMITTEE MEMBER: It was built in the UK.

BENNETT: That's right. It was built in the UK and it didn't work….

COMMITTEE MEMBER: [inaudible] Saunders Rowe ? I'm not certain. It was built in the UK.

BENNETT: And it didn't work worth a hoot. It was totally unstable, apparently. It came back to Canada and I think it was refoiled here by somebody. I guess it functioned after a fashion.

HEARNSHAW: I'm Doug Hearnshaw. I'd like to ask a question of how de Havilland related to the Navy, during the contract in regard to approval of drawings and supervision of construction and work that was going on at the MIL plant and at de Havilland and probably even with some of the subcontractors. So Tom, how did the Navy interact with you over the contract?

BENNETT: I don't think there was a lot of interaction, actually. Certainly at Sorel, there were Navy representatives. At de Havilland, when we were doing the basic feasibility study, we did not have a permanent resident from the Navy. It was all done by letters and telephone and what have you.

HEARNSHAW: You would make periodic reports to the Navy of progress, I suppose?

BENNETT: Oh yes. And you'll find some of that in this stuff.

HEARNSHAW: Did they actually get involved in approval of drawings or….?

BENNETT: No. No.

HEARNSHAW: Not even DREA, the research group?

BENNETT: Not that I know of.

COMMITTEE MEMBER: I think that the design authority for this was….

BENNETT: Was de Havilland.

COMMITTEE MEMBER: De Havilland.

BENNETT: Yeah.

COMMITTEE MEMBER: It was a package.

HEARNSHAW: Thank you.

THATCHER: This is Tony Thatcher. The question I have relates to what happened after, and whether or not de Havilland had any more involvement with the Navy and [whether] any of the techniques and that sort of thing [were ever] utilized. Did anything come back in another program directly or [were] any of the subcontractors that were involved, involved in other future Naval activities?

BENNETT: I don't' think de Havillands benefited very much from the project. As far as other possibilities, I always thought that the propeller designs should have been picked up by someone. I really couldn't say much more, I don't think. Foiling techniques, maybe, could have been used.

THATCHER: Thank you. Anyone else?

WILLIAMS: I'd just like to ask a question of something that Pat mentioned. It's Jim Williams. This concept that the Bras d'Or was perhaps an initiative of the Government to try to retain some of the aircraft design capability in Canada, if I understood your remarks. The timing with the program, as I remember it because I was with Canadair in '58, I guess, maybe early '59, when the Arrow was cancelled and we were doing the missile system, which was chopped at eleven o'clock on Friday morning and everybody sent home. That resulted in the people who were doing that work sort of disappearing and Avro collapsing. And it's four years then, before I see on paper, how long before de Havilland, which had not been involved in that Avro program.

BARNHOUSE: Actually, it's about 1960, the first small contract.

WILLIAMS: Is that right? So there was only a year but it was with de Havilland.

BARNHOUSE: It was '60-'61. It was very early on.

WILLIAMS: With de Havillands and not with any remnants of Avro.

BARNHOUSE: Yeah.

McCULLOUGH: Brian McCullough here. But by that time, most of the Avro people, the engineering personnel, had disappeared. I think a lot of them went….

COMMITTEE MEMBER: Yeah. They went south, so.

McCULLOUGH: Went down to NASA.

WILLIAMS: To do the F 5 or went back to the UK.

McCULLOUGH: And doing the Apollo program for NASA.

BENNETT, JOAN: A lot of those people were Tom's classmates.

COMMITTEE MEMBER: Yeah.

BENNETT, JOAN: That did that, plus the Arm, the Canadarm.

CRUICKSHANK: Don Cruickshank here. I was at Cranfield, doing a Masters in Aeronautics, at that time. Half a dozen of my classmates were Avro engineers, who were over there, suddenly didn't have a job. But part of the cancellation was that they could do their course.

COMMITTEE MEMBER: OK.

THATCHER: Well, I wish to thank you, Tom, for an excellent presentation of the fine information that you've passed on to us. And we'll make sure it gets to the right spot, available for others in the future. I'd also like to thank you for answering our questions here. Again, those will be suitably transcribed and put with the data. So, thank you very, very much.

[applause]

BENNETT: I found this meeting thoroughly enjoyable. It's been more freewheeling then I thought it might have been.

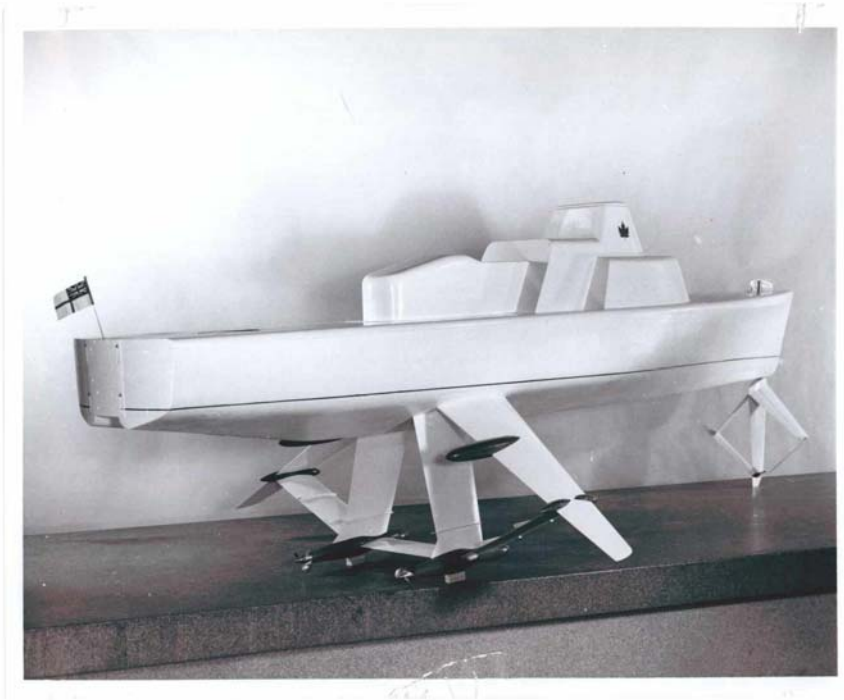
COMMITTEE MEMBER: Well, it's probably better that way.

SAKER: We'll have to capture that comment for the next person.

HEARNSHAW: Tom Bennett interview, tape one, end of side two.

TRANSCRIPTION ENDS

Tom Bennett Interview
Photographs

Photograph Number	Picture or file
1	
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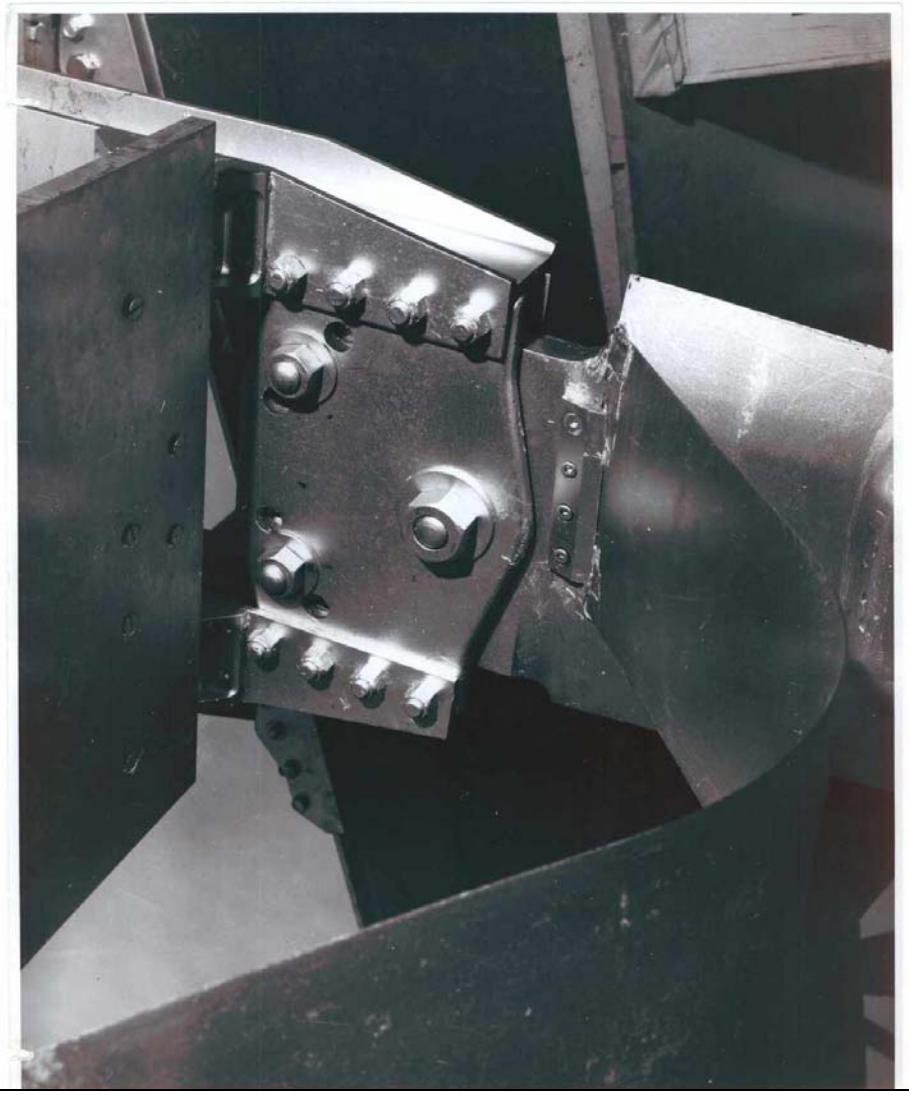
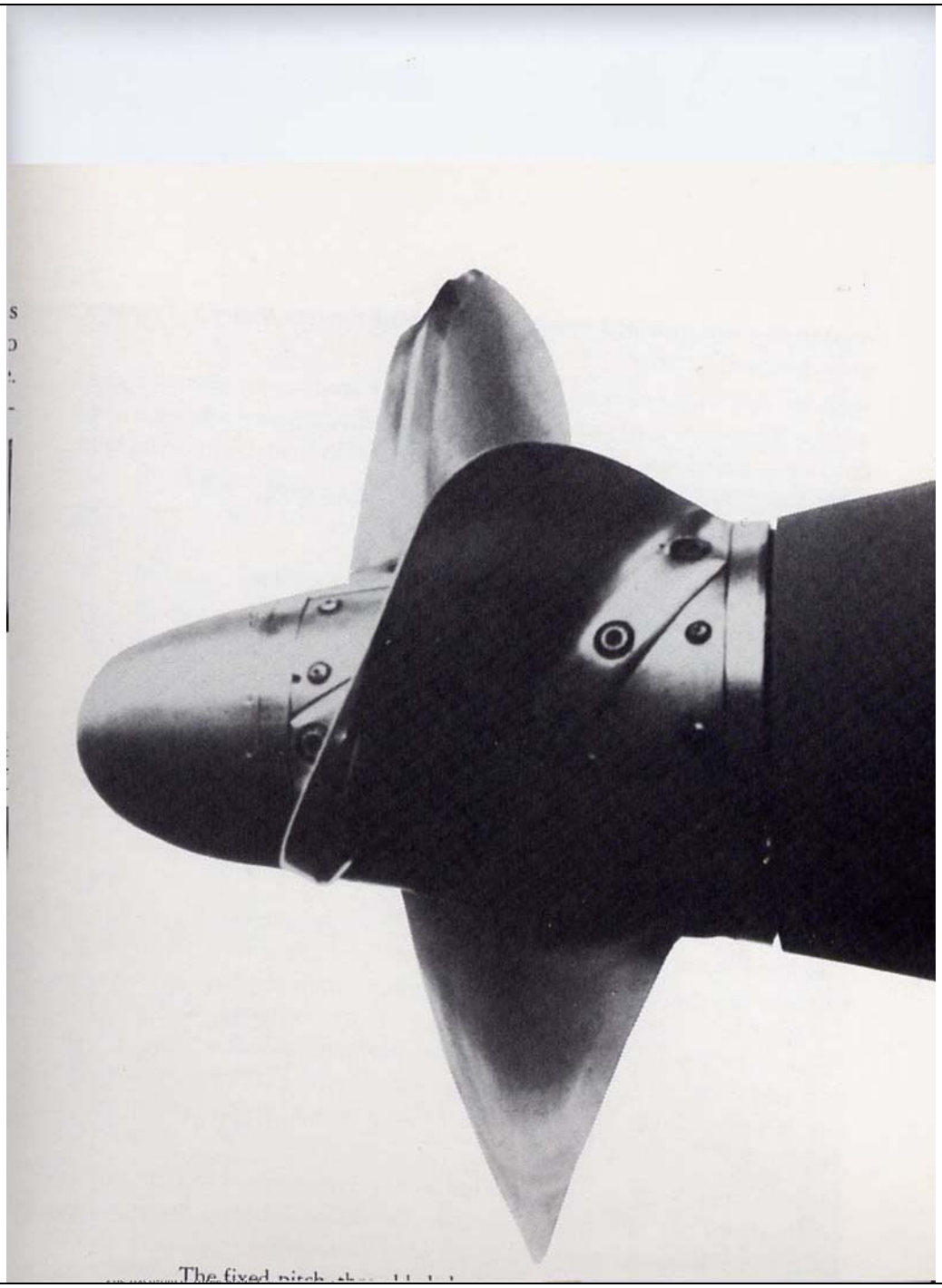
7	

8		

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10	

11	 BOW FOIL DIHEDRAL FORGED & MACHINED BY LADISH Ladish Co CUDAHY, WISCONSIN 186
12	

12a	FHE 400 Project Team, Left to right, Front row: Harry Beffort (production manager), Garry Rutledge (project manager), Rolfe Monteith (project manager RCN), Dick Becker (project engineer), Fred Buller (DHC chief designer). Back row, Unknown, Fred Hamm, Bill Heaslip (enginering), Doug Annan (DHC director), Tom Bennett, Bill Billings, Peter Hedgecock, Unkown, Dave Marshall (tall), Unkown (artist of picture), Martyn Callow, Saab Morita, Phil Halsey, Unkown (DHC inspection).
13	
13a	CORE DESIGN TEAM FHE 400 HYDROFOIL. TAKEN 1962/1964. AT D.H. CANADA DOWNSVIEW. TOP LEFT TOM BENNETT (LAYOUTS & FOIL DESIGN) BOTTOM LEFT MARTYN CALLOW. SYSTEMS. NEXT (TALL) ? WEIGHT & BALANCE " BELOW ? PERFORMANCE " MIDDLE DICK BECKER " FRONT & CENTRE SAAB MORITA. STRESS " TOP (FACE ONLY) GORDON OATES. SIMULATION. " (WHITE SHIRT) BARRY DAVIS. HYDRODYNAMICS " TONY STONEL ? " RYE CASE SEA STATE " BILL BILLINGS. HULL DESIGN.