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William F. Bahret

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William F. Bahret
Interview

Cold War Aerospace Technology History Project

Interview Conducted by Squire L. Brown
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Oral History Transcript

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Interviewee: William F. Bahret
Interviewer: Squire L. Brown
Transcriber: Lynda Kachurek
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Interview One
Video Tape One

Time Log	Transcript
00:00:00	Squire L. Brown: Today is August 22, 2006. We are talking with Mr. William F. Bahret. In his professional career, Mr. Bahret was a specialist in radar signature phenomenon. At the conclusion of his career, he was recognized with various awards from professional societies and from the Air Force for his many contributions to stealth technology. The interview is being conducted in the studios of the Center for Teaching and Learning at Wright State University as part of the Cold War Aerospace Technology History Project. The interviewer is Squire Brown. Thank you very much for talking with us today, Mr. Bahret. Mr. Bahret, you were a participant in the development of technologies for the Air Force during several decades of the Cold War. Will you please provide a synopsis of your professional career, beginning with your university education, and perhaps a few comments on why you chose engineering.
00:01:20	William F. Bahret: Well, as I got out of service at the end of World War II, I went into school. I graduated from the RCA Institute of Technology in New York, and after that, I guess, for the next twenty or more years while I was working, I just kept on going to different schools. I think I've attended almost every one in existence—University of Michigan, Wright State, Ohio State, University of Dayton, Sinclair. And I think some of it rubbed off, but probably not as much as could have. But I enjoyed doing that all the while. Quite often, you know, when you're working and you're busy and you travel, you kind of get a little fouled up in taking courses, because like I was assigned to a project with Germany and so I decided why not learn technical German? So AFIT had a three-semester course. Unfortunately after the first semester, they sent me overseas for about two weeks, and that was the end of that. So, you know that sort of thing. But otherwise, it was very good.

How did I wind up doing this sort of thing? Well, it's kind of interesting. I had an uncle who was a two-star general in the Signal Corps, and, as you know, in the early years, the Air Force was under the Signal Corps. He actually worked in research at Wright Field, and ever since I was a little kid I said, "That's what I want to do." By golly, I wound up doing that. So, I guess I was just lucky.

00:03:16 Brown: Had you had a fascination with radio, electromagnetics, from an early stage, or was that something you just sort of wandered into?

00:03:27 Bahret: Electromagnetics is not something you get a fascination at an early age. In fact, if you can spell it, you're doing pretty well. Now that's a little tough. But, yes, I was always interested in radio and that sort of thing. My dad used to piddle around and build crystal sets and things like that, so, yes, you fiddle around, get shocked now and then, and so forth and so on. But, you learn.

00:03:57 Brown: Your initial assignment to Wright-Patterson Air Force Base was to one of the Air Force laboratories. When you arrived there, was it apparent to you that you were a participant in the Cold War? How did the laboratory leadership convey to you your role to the nation's defense?

00:04:20 Bahret: Well, of course, when you work in the laboratory, you know pretty well that in the normal cycle, it's forever and a day before something gets into the inventory, usually. There are exceptions, and we'll talk about some of those later. And they were pleasant exceptions. But generally speaking, you know, we figured, well we're just going to do research on things that would make the bad guys life a little more miserable. I happened to work in the Electronic Warfare division of the Avionics Lab, as it subsequently became known. And of course in the Electronic Warfare division, we were doing things that supposedly would defeat the other guy's radars or other sensors, and my part in that, of course, was in radar signature. But there were other people doing jammers and processors and receivers and so forth and so on. So collectively, we knew we were trying to beat the other guy, and we had an awful lot of intelligence information that let us get a clue as to what direction they were taking.

00:05:45 Brown: Perhaps this would be a good time to ask you to expand upon the role of intelligence organizations. How did you receive information on Soviet systems? Who provided that? And was it credible?

00:06:02 Bahret: Actually, we worked extremely closely with what was then called Foreign Technology Division. They are the people who are responsible for assessing potential enemy capabilities. As it turned out, many, many years later, after the Cold War simmered down, we actually got to meet

some of our counterparts from Russia, and I have to say that all too often the intelligence assessments were far, far too optimistic in terms of what they were able to do. I guess it scared a lot of people over here, and maybe inspired more things, but the fact of that matter was, when I finally met my counterparts and we sat down and had a big orange together, turned out they were probably twenty years behind us, at least in the signature area particularly. I mean, one of—oh, I don't know if we're getting ahead of ourselves, but—for example, everybody says well if you want to reduce signature, you've got to have radar absorbent materials, magic stuff that just sops up the other guy's radar, you know.

Well, one of the tricks, one of the difficulties in developing things like that is measuring the components that you use to make an absorber. It may not seem like a big thing to you, but let me tell you that we had all kinds of good arithmetic that we could design the materials. We knew what to put in them. But, you know, it's like mother's recipe for duck soup, first you have to find the duck! And it's only when we learned how to make good measurements of materials' properties were we able to actually make a design that was mathematically possible. And we could do it predictably. We never failed after that. But they never got to that point. They had, the fellows I met, they had techniques for measuring materials that were, well, they were the crudest. They were at our starting point twenty years earlier, when we got out there and we didn't know how to do it and we fiddled. They were still fiddling when the Cold War ended. So they would have had troubles.

00:08:49 Brown: Let me make sure that I'm clear on your statements here. At the end of the Cold War when you were able to actually visit the former Soviet Union—today, Russia—you were able to ascertain that the Soviets were perhaps a couple of decades behind the United States, is that correct?

00:09:20 Bahret: Actually, I never did get to visit, but what happened was certain intelligence agencies after the war, they got some of these people to come over here. For example, one day I was called and said, "Show up to Ohio State University." They were having this fellow from a Soviet research establishment in Moscow. He was coming over ostensibly to have lunch and meet the people from Ohio State. In fact, a lot of the people eating there were not from Ohio State, but that's another point. But they made me sit next to him. He spoke excellent English, and we got to talking about this, that and the other thing, and he showed me some pictures of their facilities, and they were just terribly, terribly crude. I don't know whether this is too technical or not, but one of the things in measuring material properties, it's a good thing not to let the edges of a sample dominate things. And the way you do that is you could put it in a wave guide or a coaxial line or something like that, and that eliminates the edge. They still had them on a pole on a flat plate out there in a room like this. They couldn't have gotten the right number if they tried for a hundred

years. And, you know, I didn't say anything to him, but later the other people said, you know, "Bahret, what do you think?" I said, "Do you want to know the truth?" I said, "Yeah, they're way behind. Way behind."

00:11:07 Brown: So in your professional estimate, then, they were still not yet capable of producing a stealth aircraft?

00:11:16 Bahret: No, no. No, not anything like we could here. You know, that's true in most countries I've been to, a lot of the NATO countries, for instance. And, you know, they tell you not to say too much, but keep your ears and eyes open as usual, and most of them are still struggling. But, on the other hand, the United States is a pretty big country. And a lot of these other places—Russia's is equally big, of course—but France or Germany or something like there, they're just a little bit bigger than a state here, so you really can't expect them to have either the number of people to think about it or the resources to attack it.

00:12:14 Brown: Let's drop back, return to the U.S., with this question please. You were one of the pioneers in the technology of radar camouflage, later known as stealth. How were you introduced to the subject? And what qualifications were necessary to work in that discipline?

00:12:37 Bahret: Actually, the work on stealth was sort of an accident or a by-product of trying to do other things. As you know, in World War II, radar became available. People were trying to make magnetrons and klystrons and all of the kinds of things to make a radar work. They would sit out there when opposing forces were attacking and they'd look at the radar and say, "Hmm, isn't that interesting." But the fact of the matter was one of the things in, well, in the radar range equation—which is the thing that determines the performance of a radar—one of the numbers in there is the cross-section, the echo size, of a target, be it a tank or a submarine or a satellite or what. And nobody knew what those numbers were. In fact, you probably never heard of a guy named Kip Siegell—he was a great man up at the University of Michigan, and subsequently he had his own outfit—but Kip once made a statement. He said, "If somebody asked me what the echo area of a B-25 is," he said, "I can look in ten books and get you ten different numbers." It was that sort of thing. So when I joined the laboratory, I was assigned to a project where they were trying to learn how to quantify this magic number. And it isn't all that easy. Should I speak about this for a little bit?

00:14:33 Brown: Please do.

00:14:35 Bahret: There are only three ways to determine the radar echo. One is to calculate it. One, of course, is to measure the actual machine. And the

third is, perhaps, to use scale models and make a measurement. Well, measuring the actual machine is jolly, except it is about as useless as air brakes on a turtle when it comes to designing something, because obviously to measure it, you have to have it. It's a done thing.

So what you're looking for, really, are techniques that permit you to design something and predict the outcome. Hence, model measurements or something of that sort, or mathematical techniques are the ways to go, really. The trouble, however, is that no matter which way you go, you have to understand how to model the subject, whether it be an aircraft or satellite or a ship or anything. What about that object creates the echo? Well, it's not always obvious. And so what we were doing was research on those kinds of problems. How do you actually model something and come up with the right answer? Now, mathematical techniques are attractive because you don't have to go to a lot of trouble with facilities and so forth and so on. But remember back in the '50s—today, to do some of these problems, it could—well, I've run programs on a, on IBM 7090s and big computers that lasted all night long! And I'd get a call the next day saying, "Bahret, what are you doing here? You tied the whole facility for the whole thing?" I said, "I'm sorry, but that's how long the equations take." Well picture that, now, twenty years before that, and say, what could you do? Well, you're almost like the guy with the abacus trying to do earthshaking problems. You just can't do it.

So, really theoretical techniques, people worked on them, and so forth and so on, but the model techniques were the main focus because they seemed closest to being realistic and also a much simpler way to get answers. I compare it, for instance, if you have a flying machine, say a B-25, whatever, B-52, if you're on the ground making measurements, there are only a certain range of what we call aspect angles that are possible. Unless you have some kind of a heroic pilot who is likely willing to turn a B-52 upside down and fly, you can't get the top of the aircraft, for instance, if you're on the ground. Those kind of things come into play, whereas, if you have models, you can put it on a support any old way you want. So, again, that's why model measurements were the focus.

But yet, the question was, what really contributes to the echo? Now, if you have the actual machine, and you have a good measurement radar, and you go out and measure it, you can be the village idiot and you get the right number, because what it is, happens. But if you try to model that dude, then the question is, what parts are important and what parts are not? And until you know that answer, you're going to get the wrong number. I'll give you an idea. For instance, you know what a jet tailpipe with an afterburner in it, it's got a lot of hardware in there. Well, how much of that do you really have to model, and how, to get the right answer, even if you make a scale model? Those kind of things forced us into studying what made a significant difference and what didn't. And, for example, for most jet fighter aircraft, in the frontal sector, which is very important, the skin and other things like that make no difference at all,

because the energy that's hitting those is going elsewhere. Whereas, it turned out that jet inlets, antennas on the front of the aircraft, the cockpit canopy and all of that, those were the things that were significant. In fact, for a lot of planes you could model the aircraft without even putting the wings on it, if all you want to know is what it looked like in the front, because two or three major factors dominated the echo, gave it ninety-five percent of it. And those are the kind of things, we had to find those things out by trial and error. We had to build a model, and then we'd make an intake duct or whatever and put a fake engine face in the back there and we'd get a number and then we'd say, well, is that really contributing? And we'd take absorber materials and stuff in the hole and that kind of thing, trial and error. You try to find out what is significant, and eventually you do.

But it's not one, a single answer either, because in radar, of course, you have a tremendous range of frequencies. They go from very low frequencies, which are generally used for early warning and that sort of thing, to very high frequencies, which are used for missile guidance, attack on the, on the aircraft, for instance, if it's an aircraft. And so you have to worry about what contributes to the echo at various parts of the spectrum, and that changes! If you get very, very far down in the frequency spectrum, the details like a jet engine or an antenna or something, are trivial. It's generally the bulk size of the fool thing, you know. I mean a fighter aircraft will look like cross-dipoles, the wings and so forth and so on. And so the answer to what contributes to the echo varies with frequency and with polarization. Radar has polarization just as light does, and you have to worry about all these things. So there was a lot to do to answer the question.

But to get back to your first question, how did it wind up doing signature control, after you began to understand what created the echo, you'd say, "Hmm, isn't that interesting? I wonder if we can do something about that?" And so, you start trying this, that, or the other thing and see what difference it makes. And that's where it got very interesting. I'd like to say too, though, that we had a very small staff, and that meant that every time we discovered a problem, we didn't necessarily have the smarts or the people or anything else to do it ourselves. So what we had to do then was to go out and hire adjunct to our staff as you will—a contractor to do this, or something like that. For example, in radar absorber materials, we're electromagnetic people, electronics guys, and we didn't know diddly about mixing gunk and goos and making absorbers. So we had to go out and get plastics people, or structures people, and so forth and so on. And in that process, I might say, in all truth, that the other labs at the base came into play there, because we weren't stupid enough to think we could solve these problems by ourselves, so we'd go over to Flight Dynamics Laboratory or Materials Laboratory or wherever, and say, "Hey, smart fellow, would you like to work on something pretty interesting?"

And so the thing began to grow like topsy because there were so many facets to it, and it got more and more interesting all the time. For example, one of the problems had to do with antennas. Now, you talk to antenna people, strictly antenna people, about this, and they'll say, "What's the problem? I know all about my antenna." The fact of the matter is the poor soul doesn't know diddly about his antenna. He knows how it works as it was designed to work in a certain narrow part of the spectrum, but you see the bad guys have the option of using any part of the spectrum they choose. And you ask most antenna men, "How does that antenna work at three time the operating frequency? Or ten percent of the operating frequency?" "Duh." They just don't know. They'd never had to worry about it.

Well, when you get into this day and game, you worry about it. And it turns out that even though you may have, for instance, an x-band antenna, ten gigahertz on a radar on an aircraft—common for fighters, for instance—if the guy, well, what happens if I look at that with twenty gigahertz? Let me tell you what happens. It looks as big as a house! But it has nothing to do with the operation of that thing on the aircraft. But we have to worry about it. So, that's a big project to try to solve some of those things, because the last thing in the world that anybody will sit for is you fouling up their handiwork. And when you come in there and say, "Well that antenna just won't do." They say, "Well, excuse you, we'll call you. Don't call us!" So we had to get people, and that was a long-term project. I mean this took probably ten or fifteen years to really come up with a good solution.

00:26:41 Brown: And what time period would this have been—the 1950s, the 1960s?

00:26:47 Bahret: Yes, well, most of the basic problems were identified by the late 1950s. In fact, in the very early 1960s, most people don't know it but we retrofit the entire Hound Dog fleet with reduced signature techniques. And they flew for ten years more with that, and nobody even knew they were there. In fact, there's one in the Air Force Museum.

00:27:19 Brown: And the Hound Dog was a missile that went with the B-52 bombers, intended to attack the Soviet Union?

00:27:28 Bahret: True. It was a nuclear-powered, long-range, jet-engine missile, and it was just like a skinny shape, basically. There was no inlet. There was no cockpit, no nothing. I don't mean no inlet. No antenna or anything like that. It was inertially guided. But there was an inlet. And, this, you ask, "Well how did this happen?" Well, I can tell you how this happened.

When we first started to make measurements, we built a facility in the lab, and people kept coming and saying, "Hey, how about you measure

our thing," and so forth and so on. Well, the lab chief came up and said, "Bahret, you're supposed to be doing research. You're not supposed to be doing routine measurements." He said, "If all these people want this work, set up a facility someplace—routine measurement facility—and we'll send all the models down there or whatever." And so it happened. We got the first facility of the kind was down at Radiation Incorporated, down in Melbourne, Florida. Out in the middle of their garbage dump, by the way, to keep it secure.

But anyhow, guy named Jack Copa [name?], he was a captain down in the Hound Dog SPO at the time. He subsequently got to be the commander of the system—I mean the space command out on the west coast—but at the time was a captain, and he came up and said, "Bahret, you measured our Hound Dog missile, and it looks as big as a fighter airplane." He said, "I don't believe it." I said, "But, Jack, I didn't make it up. We measured it." "I don't believe you," he said. "Okay, Jack, let's go." We went down to Florida, went out in the dump, and we put the missile up and—bigger than a house! And he said, "Why is that?" I said, "Because it's got that big engine inlet." He says, "Can you prove that?" I said, "Sure." I had the guys go out and put a metal cone over the engine so that nothing got in. It all just scattered. The echo went out of sight, you know, down. He says, "That's, that's amazing." I said, "No, it's not. That's what should happen." He said, "What can we do about it?" And I said, "Well, I think I know how I can do something about it." So they subsequently gave a contract to the guy out in Tulsa who was building it, and they made a fix that went in the engine inlet. Never in fifteen years did they ever have a downtime on a B-52 because the Hound Dog missile didn't work. And by the way, every time the B-52 took off or landed, they powered up the Hound Dog engines to help. That was reliable.

Well, that got me into trouble, by the way. There was a general named Egan who was then the head of NORAD, the North American Air Defense Command out in Colorado Springs. And one day, I was patiently sitting at my desk doing something, and the secretary came in and said, "Mr. Bahret, there's a two-star general at the door, in a flying suit, and he wants you." I said, "What I'd do now?" Now at the time, we were in "The Barn," which we'll talk about later, but it's an obscure building on the base. And so, he came in, and we sat down. He said, "Bahret," he said, "is this Hound Dog really as small as you, as we think?" I said, "Yeah." He said, "Well the reason I like to ask you that is because every once in a while the Air Defense Command fighters used to run intercepts on them." They would actually fire a Hound Dog off a B-52. And he says, "Several times lately, my group has looked up and seen this thing right in front of their cockpit, and we didn't like that." So we talked and talked. He says, "Okay." He went away. Well, turned out, you know I don't know how he gets friends like this, but he had flown in from Colorado Springs. He'd gone out to the base and picked up a T-33, flew in over here at the base, called for a base taxi, got over to my building, got

the taxi, went back and got in his plane and left. Guess what happened? We have a thing on the base called protocol. They take a dim view of two-stars generals running around the base in flying suits without escorts. And they came up and started to give me grief, you know, and said, "Bahret, what's the matter with you? You're not supposed to have that." I said, "Okay. What do you want me to do the next time a two-star general shows up at the door?" Well, that was the end of that. Lot of fun.

00:32:38 Brown: Again, some questions related to the early years. In the post-World War II period, immediately after the end of the war, a very important document was produced, and that would be the report entitled *Toward New Horizons* by the Scientific Advisory Group. And the product of that would really set the research and development agenda for the Air Force for well into the Cold War. In the section on counter-measures, there's an interesting statement on camouflage against detection by radar, which would suggest that even in those early years that they appreciated what could be done. And yet it would be some time before stealth technology would really be a priority. Was it difficult to get the concept of stealth accepted within the Air Force?

00:33:39 Bahret: I would have to say yes. And I think the reason was that we were in the laboratories. But there was a whole other organization at Wright Field called the Systems SPOs, okay. And, generally speaking, they were run by managers, shall we say, many of them non-technical. They pretty much listened to their contractors, and their contractors were always pushing the state of the art just to use techniques that had been known for years. I mean, you know, they were always asking them to build an aircraft that flew twice the speed and twice as far and so forth, and they were pushed just to do that. And they weren't too anxious to hear some jerk from the laboratory come along and say, "Well now, boys, we have to do this." Okay? So between the SPO mentality and—not that I have anything against it, you understand, they've done remarkable things—but between that thinking and the contractor influence, there wasn't a lot of dancing in the streets over the prospect of having to incorporate this sort of thing. Took a while.

00:35:19 Brown: Mr. Bahret, we're going a short break right now, before we resume the questioning.

00:35:25 Bahret: Okay.

[Recording paused]

00:35:29 Brown: Mr. Bahret, you've spoken about the need for facilities to do this work. Much of the investigations took place in a building here at Wright-

Patterson, Building 821, that was known locally as "The Barn" because of its unique shape. Why was this building chosen?

00:35:55 Bahret: Well, can I tell you an interesting story about the building?

00:35:58 Brown: Please do.

00:35:59 Bahret: We have all kinds of digressions here. As you know, things sometimes take a long time to be brought to fruition. Now in World War II, they were developing radars, some of which were fairly large, physically. Well, doing that out in a rainstorm is not really a good way to work, so somebody said, "Why don't we design a building that the radars can penetrate?" So I don't remember where, it may have been down at Naval Research Lab or Pax River or someplace, somebody built a building out of wood, and it was the same design as, as Building 821. And the Air Force decided hey, we want one of those, too. So I guess it must have been in the 1945 or '44, something like that, they put in to get one. It was built, finally, in 1948, and by that time, everybody forgot what the devil they wanted it for! So it lay up on the hill there for a long time empty.

Meantime, we were looking for a wide-open, big building that we could put facilities in—because you have to have certain amount of room to do this—to measure aircraft characteristics and materials and other things. And so we were allowed to move into 821, and we put an anechoic chamber in there. I wish I had a picture to show you, but by today's standards, it's so crude that people would giggle. But nevertheless it was the only game in town. It was kind of interesting in a way because the building was transparent, and, to some degree, and we had kind of sensitive equipment, had to make it that way deliberately. Well, it turned out that Building 821 is located right beside what used to be the road to Wright Field garbage dump. And so we would have a model ballistic missile nose cone or something up, measuring it, and the garbage truck would go by on the road. And we found out there wasn't a lot of call for data on a ballistic missile with a garbage truck behind it. So we subsequently had to put metal plates and other things there on the side, you know, to hide them. How did we get on that? But anyhow, yes, we moved into the building and subsequently used it for twenty years.

00:39:02 Brown: You mentioned putting anechoic chambers inside the structure. Can you give a layman's description of what an anechoic chamber would be?

00:39:12 Bahret: Yes. The idea, of course, is to keep the surroundings from entering into the measurement. And that can be tricky because what it requires is that you build materials that can basically be almost non-reflective. That's impossible, of course, but what you can do is reduce the reflection very much. And typically these absorber materials that are used

in what we call anechoic chambers are pyramidal structures made of carbon foam and that sort of thing. And if they're well-designed, you can cover a wall with this material and reduce the echo from that wall by five or six orders of magnitude. That's a lot. And, generally speaking, that's fairly effective in this kind of thing. But, you know, it's expensive to build these things. These absorber materials, of course, take a lot of work to build, and then you have to install them in fancy ways and so forth and so on. Yes, the anechoic chamber and, I might add, the supports for models were always the subject of continuing worry. Because you see, in the work of reducing signature, it's a guaranteed employment type of thing because every time you know how to get the signature down, then you have to go back and build a chamber which has lower echoes, then you can build the signature down, and on ad nauseam, you know. So it's a lot of interesting things.

00:41:27 Brown: Let me ask you to make a connection, then, between the work you previously described—the necessary work of being able to do the mathematical models and the predictions with the use of the experimental facilities in The Barn. Was that a direct correlation? Was there a direct tie between the two?

00:41:47 Bahret: I have to say that because of the computer limitations as well as limitations on electromagnetic theory, the mathematical approach was never up to the measurement approach. An example: I've been asked to talk and everything at a lot of big time conferences of electromagnetic's theorists. One I recall was one of the University of Illinois in Chicago, and they had just about everybody you could name who could even spell electromagnetics. And one night, well, you know, you had canned speeches and all, this fellow gave his pet theory—and incidentally it's sort of a bad thing and I've had a thing with the universities over this. If I had my way, universities would trade professors every once in a while, and the answer is, what reason why? Because Professor X, he gets on to a certain approach, and he teaches his students that approach, and they continue that approach, and that's that university. Go to another university, it's the same, different thing, okay. And what you'd like to have is somebody who could step in there and compare different ones or combine them or do something like this, but that's very hard to happen with the university system. But that's another subject.

But anyhow, one evening after the formal hour—anyway, dinner was over and everything—some of the fellows got me in a little corner of a small conference room in this big building, and we started talking. And they wanted to know if I had my druthers, what would theorists really be worrying about? Well that started at about 7:30, after dinner, and I think at 11 o'clock, the room was filled, the hall was filled, and all these people—somehow the word got around—and here was questions and, you

know, just like that. And what they were interested in what I thought we ought to do, but they hadn't a clue as to how to do it.

And the end, and this is what I'm talking about, theoreticians are very good at calculating scattering from a surface, but as I've said several times now, the things that cause big echoes are not surfaces, but they are what we call apertures. Apertures are anything—garbage pail, antenna, an inlet—that captures energy, and it runs in and around and everything and comes back out somehow. In apertures—a wave guide is a good example—there are modes to the way like waves or something like that, wave structures, you know, that move in the ocean. Well, electromagnetic waves behave like that when they get into confined spaces. Well, as I said before, you don't have to worry about the simple case where like a wave guide duct is the right size to propagate a certain frequency. What you have to worry about is a frequency far removed from that. And when that happens, the mode theory goes to pot, and all hell breaks loose. By itself, it'll happen with the radar, and you don't even know about it. You don't have to. But if you want to predict it, you have to understand that, and to this day, apertures bug electromagnetic theorists because all the possibilities, things that can happen. And that's why we sat there and talked for hours that night, and these were all the smart guys in the country. I wasn't one of them, but you know somebody has to tell them, well, here's the problem, fellows. Not scattering from a surface. They were good at that. Sorry.

00:46:48 Brown: As the basic knowledge of radar signature, these echoes, begin to develop, at some point this begins to transition into the idea of applying these theories to a complete vehicle, a complete airplane. When did that transition begin to occur, and what was the motivation?

00:47:16 Bahret: Oh, I think motivation after a while was very clear. It became obvious that classic design approaches, brute force techniques, did not work. Vietnam was a case in point. We had the highest performance aircraft. We had jammers, everything else. We had "Wild Weasels," and still we lost a lot of planes and a lot of people. And I had a friend named Bill Eveston [name?], he's dead now, but he used to head up the Advanced Development Group in the lab for Electronic Warfare. Mostly they were at the stage of building jammers and things like this that would go on aircraft. And Bill and I used to give talks sometimes, and I'd get up and tell them, "Well, folks, you know, if you reduce the echo of the airplane by a factor of ten, which is relatively easy to do, even as a retrofit," I said, "that means you can reduce the size of the jammer by a factor of ten." That means you have a lot less weight, a lot less cost, a lot less maintenance, and so forth and so on. And Bill Eveston [name?] used to invariably stand up and say, "Bahret, you're blowing smoke." He said, "If we had an aircraft that was ten times smaller," he says, "I'd still use the same jammer, except now it would be effective."

When those things began to sink in, I think people got very, very serious about this. They realized what I said was true. It may cost you more money in the design stages and everything in the first few aircraft or whatever it is you're building, but, my lord, you saved that money back over the lifetime of the machine. I mean look at the F-117 as a case in point, for God's sakes. I mean, we lost one and that was an accidental shot. Some guy, you know, they weren't shooting at the airplane. They were just shooting into the air, and the laws of physics say one of them is bound to hit someday. That was the only one ever lost. And those things were not, you know, some of those were not lost to the Russians. They understood what they were up against now.

00:50:15 Brown: Let me ask you to amplify a little bit on the Air Force's experience in Southeast Asia, in Vietnam, and how it affected Air Force thinking. Certainly that conflict created unanticipated demands on the Air Force. It was a conflict quite unlike what had been anticipated for Western Europe or a strategic conflict with the Soviet Union, and as you suggested, the Air Force began to have real difficulties in accomplishing their missions. Did that begin to, in itself, create demands for new technology, and did the Cold War and the Soviet threat become lesser? Was there a shift in emphasis?

00:51:10 Bahret: Oh, no, I think the thought was that the Cold War, if it became a hot war, would be Vietnam squared. They would just have that many more of the same threats. So anything that was done to improve things in Vietnam would clearly help in the larger conflict.

One example—but, and this is I said early on, you know, when things get tough, all of a sudden bureaucracies go away and all kinds of good things happen in a hurry because everybody stands aside. Case in point was the weapon that was used a lot in Vietnam, the anti-radiation missile. There were two kinds. One was the Shrike and the other was what they called the Standard ARM. These were the two missiles that were commonly used. These missiles, if you don't know, cost around four hundred thousand dollars a piece. An anti-radiation missile has a very, very small warhead. To do any damage, it really has to hit the target straight on. I mean, for instance, a lot of times they would hit an antenna. Well, the other guy just through another antenna on the radar, it was fine. So then finally, the other guy learned, "Well, hey, you know, if I see one coming, I just turn the radar off for a minute, it loses its guidance." And so we probably scare a few guys picking in the rice paddy next door, but conflict-wise, we didn't do anything. And so it turned out that the effectiveness of these expensive anti-radiation missiles—thousands and thousands of which were shot—was about four percent. Four percent of them did any significant damage. Now, that's pretty poor, okay. You know, that's like the command at Bunker Hill, "Don't fire 'til you see the

white of their eyes," and then half of the guys were blind and some of them were cross-eyed and so forth, you know. Not very effective.

And so somebody came in, again, you know, no paperwork, no nothing. "Bahret, we have a problem. Somehow or other, those guys know we're coming, and what can you do to help us?" And they said, "What would you need to answer the question?" I said, "Well, for one thing, we'd need a couple of missiles. One of each, you know. We have to have something to study or measure." They said, "You got it." And within a week, they ordered Texas Instrument who made the Shrike and General Dynamics out in San Diego who made the Standard ARM, they ordered them to run a production run, just keep one going down the line except don't put the warhead in it and don't put the propellant in it. And we had that, set it up on the range, measured it, and told them how to fix the problem. And that took probably three weeks. Now in at normal cycle, that'd take, if you did it in three years, you'd be lucky, you know. But in those days, you needed it now, and it was a matter of saving lives, you know. Drop your fork and get on with the job.

End of Video Tape 1

[not on video, but included in audio file]

00:55:05 Brown: Let me call a pause once again. We'll take a, take a break for a few minutes and, and then we'll resume.

00:55:06 Bahret: Okay.]

Start of Video Tape 2

00:00:00 Brown: Mr. Bahret, periodically the Air Force or other defense agencies, or in some case our allies, would conduct a technology forecasting exercise, an attempt to predict the future, an attempt to predict the role that technology might have. Was signature technology ever considered in one of those projects? And did you participate? And what was your contribution?

00:00:31 Bahret: Yes, it certainly was. In fact, one of the biggest ones that NATO ever had was a thing called Project 2000, and this took place in the late, well, eighty-six, mid-1980s. I was assigned to that. It is a bit of a bitter story from my wife's viewpoint because it started in Paris in January of the year, two days after we had a humongous snowstorm, and I left and she was there standing with a snow shovel, which didn't sit too well.

But, yes, I was sent to participate in that. And some of those problems got a little tricky because we didn't share—and I suspect we still don't—everything we know. And so it became a little touchy sometimes to say, "Well, boys." They'd say, "Okay, what are we going to see in the year 2000?" And I'd say, "You're going to see low signature as a requirement on all vehicles." But, you see, you couldn't elaborate. I couldn't give a course on that, because then you're getting into touchy ground and you had to ask— "Take my word for it, guys, and put it down as a thing to worry about."

Because it affects, you see, not only the offensive systems—airplanes and ships—but the defensive systems that NATO was worrying about—radars and everything else. And it's a real problem to the radar guy. I mean, there have been symposia, one I recall up at Massachusetts Institute of Technology, where these people were talking about the design of advanced radar systems. And they asked me to go up and tell them about this stealth nonsense and how it affected them. And there were times when they'd ask, "What can I do about our current operating systems," and I'd say, "Pray." Because I think that's one of the main reasons, not the main reason, one of the big reasons that the Cold War ended because the Russians, they knew they were dead in the water with, you know, ten thousand or how many radars all over the place and none of them could cope with this new threat. And they couldn't afford to go back and redesign those.

00:03:35 Brown: In the 1970s, the Air Force began to sponsor construction of experimental vehicles, specifically to exploit new theories, new knowledge of stealth technologies. Were you aware of this initiative? Were you personally involved? Did you see this as a culmination of all of the years of work assembling the basic knowledge of signature reduction?

00:04:08 Bahret: It certainly made me feel good, if that's what you mean. Yes, I was involved in almost every vehicle, exotic vehicle, you can think of, starting with the U-2. Spent a lot of time out at the Skunk Works. Kelly Johnson and I had many a strong debate over some of the techniques, which he said would never work. But if you look at the F-117, you'll find out someone else at least disagreed with him.

One thing was windshield canopy coatings and things like that. It became rather easy to come up with coatings you could put on windshields and keep the energy from going in the cockpit, for instance, and reflecting off things like the bulkhead and the pilot's head and all other kinds of dense objects. But Kelly didn't think much of that idea. He said, "Bahret," he said, "you put that coating on there and the guy's going to see ten sets of instruments at night, because they reflect." And I said, "Kelly, go to the camera people and ask them about anti-reflective coatings and put that over this other thing. I don't care what you put over it. Just put

this on there to begin with." And eventually, again you asked before was it tough to convince some of them, yes, it was.

But one of the interesting things which we haven't talked about too much, I've talked something about echo sources and how you might do something about them and all. But that's all well and good, but the most powerful technique of all is shaping. And that's where flight dynamics people and the propulsion people and everybody else get in the act because if you shape the thing properly, oh man, are you way ahead of the game. Again, F-117 is the case in point. And that twists the aerodynamics guys, the structures guys and other people out of their normal routine because it's back to the drawing boards now. We've got to start over with some new stupid looking shape and make that fly. And that's sometimes more difficult that it appears.

00:07:01 Brown: I can assure you, coming from the flight dynamics viewpoint, it was very difficult to accept. It was very hard to get used to this notion of incorporating low-signature requirements into a vehicle, into the stealth class of vehicles. It was a great challenge throughout the industry.

00:07:25 Bahret: Yes, well, it bothers me sometimes that the public, encouraged by the media, get heartburn over the cost of some of these systems. But they don't understand for one minute what goes into making one of them. You know, I take the people through the Air Force Museum a lot, and one of the things I worked on—I won't say helped design, but I was involved with—was the SR-71. Well, most people don't have the foggiest idea of what went into the SR-71 design. I mean, and mind you we had to make absorber materials that would stand up to these things. Most people, okay, I tell them this. When this plane is flying at 75,000 feet at Mach 3, the stagnation temperature—the temperature the surface arises—is 637 degrees Fahrenheit. Now, I said, you probably don't know what 637 degrees Fahrenheit is. But, I say, go home, turn on your electric range and when the burner gets red-hot, it's around 637 degrees Fahrenheit.

Now, what does that tell us? Six-hundred thirty-seven degrees Fahrenheit is far above the flash-point of any jet engine fuel. What does that mean? It means when you get the plane up there cooking, it's going to explode, unless you make a fuel that can stand more than 637 degrees. What else does it mean? It means that the tires on which the plane would land would normally drip out of the wheel wells after a little while, because it's far above the melting point of rubber tires. So what? You have to design tires that can stand 637 degrees. Fifty million dollars for that airplane? You bet your booties! But, by George, if you didn't do it, the thing would never fly. And that's what happens when you get into the stealth design. You start having to make all these changes.

00:09:55 Brown: Let me shift slightly and, and ask you about the workforce within the laboratories, your colleagues who worked here, and your relationship

with the universities and the graduate programs there. The workforce at Wright-Patterson is characterized by a rather unique blend of civilian specialists and military officers. Did you find that to be a satisfactory arrangement?

00:10:26 Bahret: Well, in the end, in accordance with the Peter Principle, where, you know, you rise to your level of mediocrity, I was a branch chief, and I had about fifty scientists and engineers working. A percentage of them were military, and good technical people for the most part. But I always had trouble with the notion of the military people in the labs. A good example is most of the people they put in as lab chiefs--and I'm not saying this to be nasty to anybody, please—but normally, the military had the idea that any person could do any job, which I personally think is nonsense. But they would grab someone of the proper rank and put them in that chair. We had a brilliant guy. He had a Ph.D., but he was the head of one of the most sophisticated electronics labs in the world. He had a Ph.D. in aeronautical engineering. Well that was very nice, but he couldn't, he didn't know a microwave from a permanent wave, and it just doesn't fit.

And personally, I like the way that most countries in the world do it. They have a central research organization which serves all the services. And military people can work there, but basically they have to take off their uniform and become another worker-bee. And any of the services who want work done there, they come in and they say, "Here, I'd like you to do this." And the guy says, "Well, okay, this is what it will cost." And they go at it like that. And the reason they do it is because so many of the needs of the different services overlap, and so over here we have each service with its own little laboratory duplicating all the time. And personally I don't think that's smart.

00:13:12 Brown: What about the relationship with universities, engineering departments within universities, their graduate programs.

00:13:22 Bahret: Well, I have to say we were very lucky. We, as I said before, we had to get people who could do some of these problems for the length of time that it takes. In other words, it was labor intensive, if you will. And we didn't have the people. So we went to these different universities to get work done, and in the process, there were certain advantages that accrued to the laboratory. For example, at Ohio State University, I regularly used to get a list of the Ph.D. graduating class. And that let me look over and get some of the better people, and I had some really good people. I tell you I would stack my branch up against anybody. But it got pretty bad after a while because, I don't know what it is in this country, but a lot of people are just not willing to work the way that some of the people in other countries. One of the graduating classes in electromagnetics from Ohio State University, out of thirty-three people,

three were Americans. Now, why is that bad? Because I can't hire the other thirty. They don't have clearances, and most of them couldn't get clearances. Three out of thirty, ten percent. Come on. We're going to go down the tubes if that keeps up for very long. But, it was an advantage to know all these people.

I was also frequently on the team that was sent by the Personnel Office to go up and recruit, and another opportunity to be a little self-serving. That was a lot of fun. I enjoyed that.

00:15:41 Brown: Mr. Bahret, if I could, some final reflections on the Cold War. With the fall of the Berlin Wall in 1989, the final collapse of the Soviet Union in 1992, all of that seemed to occur very quickly. And to many individuals, it was a surprise. Did the conclusion of the Cold War, the end of the Cold War, the swiftness with which it happened, did that surprise you? Or had you foreseen some of these events?

00:16:18 Bahret: Well, of course I had no way of knowing when something like that would happen, but we, again in my former life, I had opportunities while I worked, as I told you, with the intelligence people an awful lot. In fact, they used to ask us to do assessments of what we thought the Soviets would be doing in a certain area, you know, in terms of, well, measuring. Were they developing low cross-section vehicles? Well, you have to have certain kinds of facilities to do that, and, if they'd give us photographs taken even from satellites, you could tell from the design, the layout, and everything else, you knew that that the facility did not have the ability to even measure something that had very low echo because the supports and everything were too big. You could tell from that.

Also, in my branch, I had one group that did foreign material exploitation, which means by means of, by hook or by crook, we got a hold of, somebody got hold of and brought us, Soviet equipment. And so we had a bit of an idea of where they stood. And, I don't know. I never had the warm feeling as did a lot of people that they were, you know, the ten-foot gorilla. They just didn't have that power. I'm not saying they were stupid or anything like that, but they just didn't have the technology edge that would keep them out front at all. And, to me, that said, you know, the handwriting was on the wall. They just couldn't keep going the way they did. I mean, they did a job on the Germans in World War II, but that was mainly because they sacrificed lives as if they didn't matter. They just, you know, if the Germans killed two hundred, they sent in two thousand, and sure, you're going to win like that. But attrition, particularly if you get into a nuclear environment, attrition is going to beat you every day.

00:19:08 Brown: And so in the decades then that we have come to think of as the Cold War, and the ultimate outcome of it, how would you characterize the significance of Wright Field, this large Air Force installation devoted to

engineering, to technology, to the acquisition of future systems. How would you describe the overall significance of this place during the Cold War?

00:19:39 Bahret: Oh, I think it had a tremendous influence, because, again, the technology in so many areas was being advanced. And from what we could gather, the other guy wasn't doing so well in some of these things. And, I don't want to say it's all good news and bad news. For example, as you know, all Air Force airplanes have to land on runways. No Soviet airplanes have to land on runways. They're all built to take off from a field. It means a whole lot of differences in design, but I guess I think that you can do more by taking off on a runway than you can on a field because you can't carry the payload, you can't do this, that, and the other thing off a dirt field. And so you know things like that. I think our technology was just advancing so quickly, and, in that time, there were so many planes on the drawing boards and everything that it seemed like we were just destined to win.

I might also say that the Wright Field laboratories were not restricted to Air Force things. Particularly in the signature area, we had the good fortune to work on literally everything from submarines to satellites, tanks, helicopters for the Army, ships for the Navy, submarines for the Navy, satellites for the Air Force and others. And that made the job a lot of fun, but it also meant that you could cross fertilize by using something from here over here and so forth and so on, which was a big advantage. Big advantage. And I think that also contributed. If you look, for instance, at the design of any Navy ship, you will find that they no longer have boxy sides, which we always wondered about. They used to say, it's against the law to give aid and comfort to the enemy, we'd wonder why they'd build a ship like that? And they don't any more. And so, lessons learned.

00:22:45 Brown: As we close here, I'll simply ask you if, on reflection of the various topics we've covered this afternoon, is there anything that we have failed to mention, any subject that we perhaps inadvertently skipped over, something that you would like to add here as we close. If you want to take a few moments to reflect.

00:23:13 Bahret: Well, I just wish that we could get into classified information, because it's some of the actual numbers that make you understand the significance of some of the things I've talked about. I haven't described specifically how any technique, how much it reduces or anything like that, but it in those numbers that you begin to realize the impact that this work can have on system performance. And it's profound, I mean, when you can't see the other guy. And it's not matter of seeing him perfectly well. To bring a missile to bear on a target, you have to have constant track. You can't have a track now and then a gap and then a track now. That

doesn't work. You have to have a steady track while the missile is guiding, otherwise it doesn't know where to go. So, again, it's the numbers and things of that sort. There's a lot that goes into these things.

I said before that shaping, for instance, was an important parameter. It's impossible to shape everything so that from any aspect angle—top, bottom, side, or any—it's invisible. You can't do it. So what you have to do, you have to go in there and study the bad guy and how he operates and then see how he's going to view you, and then worry about those aspect angles which are most important. And a lot is involved in a system design. You have to know how that system is going to operate in a hostile environment, and it just gets all the more fascinating for working with all the people who can do all these kinds of studies and see what you can come up with. It's a fascinating subject. I loved it.

00:25:40 Brown: Mr. Bahret, you've mentioned your participation in a NATO exercise and some sharing of information with our allies in Western Europe. There are other significant countries that also are involved in military technology, one of those being the country of Sweden, not a member of NATO, but clearly a country with very advanced technology. Did you have an opportunity to work with the Swedes, with the Swedish military establishments and their technology organizations?

00:26:22 Bahret: As a matter of fact, I did. It was out of the blue. You have to understand that we were a small group, and we were the only game in town. So anybody who anywhere wanted to know anything about this basically came down and said, "Hey, can you help us a little bit?" So one day I was called by the Pentagon, and they said, "We want you to go over to Sweden and give them some technical advice on signature work because we know they're doing some of that." And they sent a colonel from the Pentagon along with us to baby-sit me so I didn't say anything wrong. And they said, "Just don't go too far with what you say over there."

But basically it boiled down to, back in 1963, we were the first technical support group from the United States to go over to Sweden to help them. And, yes, they were not part of NATO, but I can tell you they appreciated what we did so much that in a week's time, they took us through every one of their facilities, their underground bunkers. They operated radars. They dropped chaff, and they did everything. They showed us all they did. They were really open and above board.

But the week started with them getting up and we—the audience of three, there was another major with us, he was from the countermeasures group over at ASD—we three were the audience. And they paraded I don't know how many Swedish scientists and engineers up there, and they talked on what they were doing, this, that, and the other thing. But it turned out that I listened to my counterpart describe their work. They were working on the Viggen, the Swedish aircraft, the Viggen. And, oh mercy,

I felt, I didn't know what to do. I nudged the colonel in the middle. I said, "What do you want me to do? Obviously they are totally wrong. They're wasting their time and their money and everything." He said, "Tell them." I said, "Yes, sir." So next day, they said, "Okay, America, it's your turn." We got up, and I started talking, because they scheduled the time we would talk, and I started talking about where I thought they were, you know, kind of like I said, well, I didn't mind you thinking, but I didn't much like what you thought. And we went from there. And I told them where they were wrong, and how to do it right, and so forth. Well, by the end of that day, the auditorium was filled. I don't know how many people, two hundred people or something sitting there, waiting to hear how they should be doing business on these things. And they were let me say extremely grateful. They put on a dog and pony show the rest of the week that I could not believe. We had our own aircraft with crews to fly us around to the different bases and everything of this sort. It was—and, oh, we never had a lunch or dinner that wasn't hosted by a general officer—it was quite an experience.

But we had other opportunities that were, again being the only game in town, I was constantly—I was on that P-2000 study I mentioned for NATO, but I was also put on an A-Guard lecture series on radar echo, and that went from place to place. Again, the people in Europe who get on these committees, they like to travel. And I mean you wind up all over the place. This radar echo lecture series, there were probably, oh, ten of us, I guess, and it was a three-day lecture series. And we went from, God where all, we were down in Munich, we were up in London. Oh, that was funny because they had us in the zoo, and then people thought that was an appropriate place for you nuts. And we went to Norway. The Norway people were the smartest, because you see, they paid for this lecture series no matter where it was. I didn't get any money, but somebody did. And the Norwegians, they put us in a place called Bolkesjo, which you probably haven't visited recently. It is in the wintertime a ski resort way out in the mountains near where the Germans had that heavy water plant out there. And it's beautiful country, except it's so far out in nowheresville that there was no one left the place at night. And they loved it because here they were, they had all the speakers captive, and all they had to do was buy you a big orange, and you'd talk for another hour, and they had free lectures all night long. We had one of the guys was even sitting in the swimming pool, and the people in the pool were asking him questions. But, you know, those things were fun experiences I have to say. And I think it influenced people, too. They had an awful lot of good questions, those folks, because again they didn't have the research facilities or the money to do all these things. And this was an opportunity for them to save a lot of money, to get it for free.

00:32:59 Brown: Now you mentioned the trips to Europe, the trips to Sweden, were there reciprocal visits? Were there professional relationships that continued afterwards with individuals coming over here?

00:33:11 Bahret: Oh, indeed. In fact, in many of these places, after they learned of some of the facilities we have here, they would get money and bring models over or anything to have them measured or so forth. And then when they finished doing that, they'd come by Wright Field and show me the data and say, "What do you think?" So they got a lot of free help, I can tell you. But, you know, our government thought that was great. I guess the State Department has as much to do with some of these things as we do. And I'll tell you a story. My wife is deceased now, but a friend I met over there in Europe—my counterpart in Sweden—was a guy named Pere Erik Jung [name?] and he also liked to travel. And so he came over here all the time, and at the time, you know, in the '60s, I don't know if any of you had the pleasure of going to Sweden, it's a beautiful place, but you can't afford it. It's terribly expensive. In the '60s, steak in Sweden cost $25 a pound. So what my friend Jung would do, he would be out in say L.A. and coming back through here on his way back to Sweden. He'd call my wife, and he'd say, "Jo, can you get me some steaks?" And she had a regular routine. She'd go up to the meat cutter, and she'd get him one inch steaks. And it turned out, if we froze them, wrapped them in newspaper, put them in plastic bags, and he put them in his suitcase, they would still be frozen when they got to Sweden. And so we had a regular thing going there, where'd she'd get him a dozen steaks or something like that, and we were paying, you know, two or three dollars a pound maybe, and he was saving $22 dollars a pound or something. And, yes, lot of good things. Not a lot of people we work with from England of course, we shared a lot of stuff with them.

I haven't mentioned though that in working in signature, it doesn't always mean you're trying to reduce it. Camouflage in nature means blending in with the background. The animals know this. So you really don't always want to make something zero echo. If you made a tank zero, for instance, on the ground it would stand out like a black hole. It would be just as obvious as if you left it alone in the first place. So it's like I said about Professor Harold Hill, you better know the territory. And so we spent a lot of time trying to go the other way, and increase echo. Why? The greatest, most effective counter-measure to an enemy defense is saturation. If you present him with a lot of targets, and he can't tell them one from the other, he's either going to spend the gross national product in one attack trying to shoot down the one real plane among fifty decoys, or he's going to lose. The plane's going to get to him. So we tried to make devices, echo enhancement we called them, that we could put on small decoys or drones or something like that and you just send them in willy-nilly and let the other fellow figure it out if he could. And this works, by the way, again, ground, air, and in the satellites, everywhere it works. It's

beautiful, and it's just kind of amazing how many things you can do for a few bucks that costs the other guy millions to counter. It's an interesting game.

00:38:06 Brown: Is that basic strategy applicable to the Navy, to seagoing vessels as it is to airborne systems?

00:38:18 Bahret: Well, it's tougher because the Navy vessels generally have much larger echo to contend with, but, yes, the Navy has, as a matter of fact, they use decoys all the time as a counter-measure to anti-ship missiles and all, sea-skimming missiles and everything that come in and whomp the ship. They use decoys as a way to pull them away from the real target. But again you see the Navy ships have much, much higher cross-sections than we have to contend with in the Air Force, so it's a little different. But, they do that sort of thing all the time. Of course, one of the best examples of it was the Israeli attack in the Baca Valley years ago, when they wiped out the other guy's Air Force in a day or two, using decoys to get their missiles in the air and expended. Then they'd go in and attack after the missiles were used. Yes, it's a very powerful technique, and it's cost effective. These things that I'm talking about are small, you know. They may only be three or four feet long, and maybe a few inches in diameter, but they look like a big airplane. And the other fellow has a problem. And they're easy to build.

00:39:54 Brown: Mr. Bahret, you've mentioned your travels, both overseas, here within the United States. You've mentioned how individuals come from everywhere to Wright Field. They came to visit your facilities. You went to other places to give lectures and to talk. In that process, undoubtedly, you met many notable personalities, some at high levels of government, others perhaps in industry. Do you recall any specific individual that you thought was very influential, or had insight into how the United States should pursue stealth technology?

00:40:40 Bahret: Oh, that's a very hard question because it was always one of the delights of my life to be in a position of meeting and working with so many, many fine people. Again being the only game in town, you know, I got places where a lot of other people did not. And, I gave a talk in the White House one time, and I gave a talk to LeMay when he was the Chief of Staff and all this kind of stuff. I don't belong in those places, you know, but it would be hard to put my finger on any particular individual. It's kind of interesting, the guy who was the vice president of Northrop and who was the chief designer of the B-2, he used to come to The Barn frequently and he'd say, "Bill, do you mind if I just sit here and take notes on how you guys do things and what you do, and so forth and so on." John Cashen was his name. I said, "Be my guest, John, just don't get the

way when I'm doing something. That's all." He said, "I won't." But, you know, you meet all kinds of fabulous people. It just makes life interesting.

00:42:02 Brown: Mr. Bahret, thank you for your time your this afternoon. We've appreciated all that you've told us. We will now bring this interview to a close.

00:42:12 Bahret: Thank you, sir. Thank you for the opportunity.

End of Video Tape Two.
End of Interview