G. Keith Richey: The Cold War Aerospace Technology History Project (Interview 1)

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G. Keith Richey

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Dr. G. Keith Richey
Interview
Cold War Aerospace Technology History Project

Interview Conducted by Squire Brown
Special Collections and Archives
Wright State University
Dr. Squire Brown: Today is August 24, 2006. We are talking with Dr. Keith Richey, former Director of Flight Dynamics Lab Directorate in the Air Force Wright Aeronautical Laboratories at Wright-Patterson Air Force Base (1995-1997). This 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 so much for talking with us today, Dr. Richey.

Dr. G. Keith Richey: Please call me Keith.

Brown: Dr. Richey, 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 include remarks on why you chose the engineering profession.

Richey: All right. I graduated from Ohio State University with a Bachelor’s degree in the summer of 1961. I was going to be a chemical engineer, I thought, but my first class in chemistry at Ohio State convinced me that I didn’t like chemistry very well. So I quickly switched to aeronautical engineering. I had always had some interest in airplanes. My father worked in an airplane factory, and I had taken some tours of what was then North American, or Rockwell, Aviation and was kind of fascinated with the airplanes. I didn’t know a whole lot about airplanes, but aeronautical research seemed to be interesting. It was in the late ‘50s when I was at Ohio State, and we were into the Cold War and the beginnings of the space arena and so forth, so that was interesting.
I graduated from Ohio State in ’61. It was a good time for aeronautical engineers. I had about seven job offers. I actually chose the lowest paying offer I had to come to Wright-Patterson, to what was then the Flight Dynamics Laboratory. And the reason for that was that I wanted to work in an area that I thought I could make a bit of a difference. And I think I believed—and still do—that the government laboratories provided an opportunity for a young engineer to get in right away into some projects, whereas with industry, I was concerned that I would be in a large pool of designers and so forth, and I didn’t want to do that. And our family was from Ohio, so there was an attraction to stay within the Ohio area.

So in ’61, I came to work at what was then part of the Aeronautical Systems Division, and we had a very long office title, about seven different letters, but that was just before, in ’61, the laboratories were removed from the Aeronautical Systems Division and put into what was called the Research and Technology Directorate of then Air Force Systems Command. This is about 1962. I enrolled part-time in a master’s degree program, actually conducted right here at Wright State in the one building on the Wright State campus at that time and took classes from professors that came over from Columbus for Ohio State. Dr. John Lee from the Aero Department at Ohio State was my principal master’s advisor. And in ’65, then, I received a master’s degree from Ohio State.

From ’65 to ’70, I was primarily involved with airframe propulsion integration in the Flight Dynamics Laboratory, and I’ll get back to that a little bit later. In 1970, then, I was awarded a program from the Air Force, what’s called long-term, full-time training, in which in the spring of ’70, I went to the University of Michigan for two years in residence, came back and then three years later finished up my doctorate from the University of Michigan. And that was my educational background: ’61, ’65, and ’75 for degrees.

Brown: Your initial assignment was to one of the Air Force laboratories, the Flight Dynamics Laboratory. When you arrived there, was it apparent to you that you were a participant in the Cold War? And if so, how did the laboratory leadership convey to you your role in the nation’s defense?

Richey: Well, we were certainly aware from the beginning that we were an Air Force Laboratory and concerned with the Air Force mission. We were, of course, in research. At that time in the early ’60s when I first joined the laboratory, we were primarily involved in research which would go beyond the Cold War, most of it. We were involved quite a bit in the early days of supersonic combustion ramjets, in one of the cycles of the so-called aerospace plane programs. Dyna-Soar had just been cancelled, and the Air Force was looking to what they would do in space access or in very high-speed flight—hypersonics—and so I was in a group of inlet
propulsion specialists that was concerned with primarily the inlet system for the supersonic combustion ramjet type of vehicle.

However, one of my first assignments, I can think back, involved a Cold War system that was never built. It was called “SLAM/Pluto,” a very interesting system. The engine for SLAM/Pluto was a nuclear ramjet. Now, it was never built, but it was quite a capable system, and it delivered hydrogen bombs, so that tells you it was a Cold War system. It was to fly at Mach 3 at sea level. Now this is really difficult. It takes a lot of thrust to fly Mach 3 at sea level. But I was involved with a project that had to do with the inlet system for this missile, which would fly at Mach 3 on the deck. And it was a very unusual inlet. We called it the “double sugar-scoop” inlet, and it was what’s called isentropic double compression, but it was designed for Mach 3. So that kind of even then, even though it wasn’t said, “This is a Cold War system,” it kind of reminded me that it was. That was in the early days.

So the lab management, they didn’t drill into us that, you know, we are, in the laboratory, we’re on the front line of something for the then Cold War—this is in the early ‘60s—but we certainly knew that we were in a military organization and had a military mission, and whatever the threat might be, that was what we were to address.

Brown: As we speak of technology this morning, perhaps it would be useful for the record to define technology. Today, 2006, the term technology has entered American vocabulary in a variety of ways, but in this time period of the Cold War, in the 1960s, how was technology defined, and was that a definition that changed over the years?

Richey: I don’t think it really changed. In the laboratory, we were involved with what was called applied research, which in parlance of budgets is called 6.2. In applied research, if a project became larger or needed a demonstration of technology, it would move into 6.3, advanced development. But I was primarily involved in, in most of my career, particularly in the early ‘60s, in exploratory development or applied research, 6.2. And so this is not basic research as we think about it. But it is certainly applying principles of science to a project. In my case it was primarily the propulsion integration aspects and other aerodynamic characteristics of fighter and some hypersonic aircraft. We didn’t do much in the early ‘60s on transports, didn’t do too much in bombers, but primarily what you would call fighter-attack aircraft.

So I don’t think the definition has changed in the laboratory. Basically it starts with applied research and then moves into development. It is R&D, but in the technology sense, it’s pretty well up on the learning curve.

Brown: I would like to ask you a question regarding the origins of an idea, the very beginnings of a technology. Some scholars have suggested
that successful technology development is characterized by a network of participants, perhaps a peer-to-peer network rather than the classical hierarchical structure that we commonly associate with large organizations, particularly military organizations such as the Air Force. What was your impression of the path of a technology from concept and maturity?

Richey: Well, I think it is more of the peer-to-peer. You know, we have a lot of smart people in the laboratory. I was pleased I was able to work with a lot of smart people, and they had good ideas on their own, but we also would network with engineers in industry, with NASA, sometimes with the Navy, even from time to time with scientists in other parts of the world, particularly Europe at the time. And you would come up with an idea, and you’d say, well, that would make sense, and also would fit the Air Force mission, for whatever type of system we were considering. So we always had the application in mind. A good example was the two-dimensional nozzle, which came up later on. That was an idea that mostly came out of NASA but then we took it several steps further in collaboration with NASA to eventually flight test it on the F-15 and then a version of that ended up in the F-22 Raptor fighter as we see it today.

So very little top down. You know, the principles and the guidance where the direction was came from top down, but most of the technology ideas came out of either people in the laboratory themselves or from a peer-to-peer interaction or from some article written by a scientist anywhere in the world; we might pick up an idea through the AIAA or something like that and say now let’s apply that idea to something the Air Force might be interested in. And through a combination of in-house research and contracted research, then, we would develop the idea. Most of our work was through contractors. We did some work in-house. We did some testing in-house. We did some analysis. But the bulk of our product development in technology, if you will, came through contracted research and development, which we—the laboratory engineers—would review, monitor, and oversee.

Brown: To the public at large, they understand that the Air Force acquires weapon systems through these defense contractors. Could you perhaps elaborate a little bit more on the relationship between the Air Force and these contractors, and to particularly address the question of why it was necessary for the Air Force to have laboratories at Wright-Patterson? Why could not we rely solely upon these commercial firms for all of our technology, aircraft, and missiles?

Richey: Well the relationship with the contractors was always very good. It was collegial. Certainly, we wanted them to do a good job when they got on contract, and they wanted to do a good job. They wanted to make a profit, of course, for the company. But in the area of exploratory
development and applied research, the engineers and the contractors, they just liked to do technology work. And they weren’t really concerned whether it was going to make a big profit for the company or result in a product. They knew it had application, but we and they were involved in research, so it was a collaboration. And the engineers and the lab worked with the contractors for discussion, for dialogue, and for guidance of the contracted program.

And the reason that the laboratory is important is to know what direction to go, what contracted programs to initiate, to steer, and then to apply. And also to then transport that knowledge back into the system developers and what was called the XR community at the time, in ASD, the advanced concepts people, so they could look at these technologies and see how they might apply to future systems. Plus the fact that in the laboratories, as I said before, ideas were bubbling up and ideas were being discussed with the contractor engineers, so it was pretty much a peer type of relationship. And, you know, we would argue and discuss and go back and forth, but it was all in a professional and collegial way.

So it was a good mix of the talents in the lab and the talents in the industry. Without the lab, I think that it would have been more serendipity as to what would happen, and I don’t think the Air Force would have had as much return on its investment, be it contract or be it in-house. As I said before, the fraction of the Air Force dollars in R&D was probably about ten percent in-house and about ninety percent contracted at the time. So even if you took the ten percent and reduced it to zero, you wouldn’t save a whole lot of money, but that interaction was a lot of “oil in the gears” that made things, I think, run pretty smoothly.

Brown: Continuing in the context of your career and your work, we’re talking about the Cold War, which was commonly defined as a period of political and military rivalry between the United States and the Soviet Union. How did that rivalry manifest itself in the laboratory projects? And did you specifically consider Soviet technologies in formulating your work?

Richey: We did, particularly in my research. In the mid-’60s—I mentioned the work in hypersonics that was in somewhat response to a threat, but it was a far future threat—about in the mid-1960s, though, the Air Force decided that it needed more research in a lower supersonic regime, particularly in the Mach 2 or Mach 3 arena, and so they diminished the funding for hypersonic research. Hypersonic research, as you know, Squire, kind of goes up and down. That was one of the down periods.

But there was increased emphasis, then, in the mid-’60s, in so-called TACAIR. What was then the Tactical Air Command was bringing on some new systems. They were coming out of the F-105 and the Vietnam War was on, and particularly the F-111 sparked an interest, a
renewed interest in airframe propulsion integration, and I can elaborate on that in a little bit. But that certainly was a Cold War system, the F-111, because it was designed to fly below the radar, on the deck, at high subsonic or even transonic speeds, and below the so-called threat radar, and of course had a high-altitude mission as well above any Soviet surface-to-air missile threat. So that we were now seeing, at least indirectly in the areas of research we were doing, the impact of the Soviet threat.

We would also receive intelligence briefings. I had a clearance, and we would, through the old Foreign Technology Division, be privy sometimes to things they were showing in their research and even had a chance to go over and look at some material that they had received by various means of Soviet aircraft to get an idea of what the Soviet Air Force was up to. Our impression at the time was the Soviets in the aircraft business were unique in some cases, but they weren’t too much advanced over what we had. But they were certainly formidable in terms of the way they applied their aircraft.

Brown: If I might, let me continue to ask questions along this line of the United States in comparison with the Soviet Union. The history of the engineering organizations at Wright-Patterson provides numerous examples of new technologies that were emerging and finding application on combat aircraft, applications that would make them superior to a potential adversary such as the Soviet Union. What were some other examples of technologies in the Cold War that provided the Air Force with an advantage over the Soviet Union? And can you cite specific examples of combat aircraft systems that were in the inventory and operationally used by the Air Force?

Richey: Well the Cold War goes up to about ’92, fall of the Berlin Wall you said came down in ’89 and the dissolution of the Soviet Union in ’92, so if we look at the period of the ’60s, ’70s, and ’80s, there was a lot of technology that resulted in Air Force systems having great superiority over the Soviet class of aircraft. We were in what was called probably at least a generation three fighter—now we’re in generation five with the JSF—but the Soviets were probably in about generation two of turbine engine fighter aircraft.

So in the ’60s and ’70s, we—the Air Force—had the F-111, and then we had the F-16 and the F-15, Navy had the F-18 and the F-14. We also brought in the bombers, the B-1 at that time, and these were far superior, really, to anything the Soviets were doing. Soviets caught up to some extent later, but up until 1990, the push on fighter aircraft resulted in a combat edge, if you will, over the MiG-21, over some other Soviet aircraft, the Flanker was coming in, the Su-27 was there. The MiG-29 hadn’t come in yet at that time. But the things that evolved this from the laboratory was primarily propulsion—engines, superior engines. Also
engines that had much more reliability at high power than anything the Soviets had. They had some engines, but they’d burn out quick.

The other thing was in the flight control system, the fly-by-wire, digital fly-by-wire and triplex redundant fly-by-wire, allowing the airplane design to have negative static stability. With an analog system or hydromechanical system, you had to have positive static stability because the pilot couldn’t control the airplane. In the case of fly-by-wire, the airplane is controlled by the computer. So that the airplane could be designed for negative static stability, which means it’s much more agile and so G’s can be pulled quickly. Now this blacked out the pilot in a few cases, so we had to watch that—called G-induced loss of consciousness—if you pull G’s too fast. Well, maybe the answer there is to take the pilot out of the airplane. That’s another story. But in the ‘60s and ‘70s we had the advent of the F-16 fly-by-wire, the F-15 with not as much reduced static stability, but some. The F-16 had negative static stability, and it was the first airplane to do that.

Along with the propulsion and the control system, there were advancements along the way in aerodynamics of the wings, of the intake and nozzle systems, refining both the inlet and the nozzle systems to be more reliable, have higher performance, particularly at higher angles of attack. And so we were getting our edge over the Soviets primarily in terms of what we called close-in combat, which was within visual range with hard maneuvering and setting up for a solution of either guns or short-range missiles. If you have strictly long-range missiles, then this maneuverability is not as important, but you still want some maneuverability for self-defense. If you pick up the fact that a missile is coming close, you want to hard maneuver to get away from it, and you do not want your engine to stall while you’re doing maneuvers, either offensively or defensively.

So in the technologies that we’re developing in the ‘60s and ‘70s and into the ‘80s, we were going way ahead of what we knew the threat was. But the idea was that, you know, we knew in some cases if we got into combat we might be smaller in numbers than the adversary and would have to make sure we could hold our own with respect to combat. And combat simulations were going on, and there were several very important red-flag simulations out at Nellis, in flight of threat-simulated aircraft. I think they used F-5s, to simulate the MiG-21. And they were showing that the U.S. aircraft were superior.

Brown: You mentioned a couple of Soviet tactical aircraft that have made their appearance in this time period, and when photographs and drawings of them began to be published, some aerospace commentators suggested that it appeared that the Soviets had adapted some conceptual work or research work done here in the United States. Would you speculate on whether or not there was a flow of technology from the U.S. to the Soviet Union?
Richey: Well, you can always speculate, but the MiG-29 and the Su-Sukhoi-27, have inlets underneath the wings, two inlets under the wings. And so the flow over the airplane from the fuselage to the wings was kind of straightened out or shielded as the flow, before the flow entered the twin inlets beneath. The Flight Dynamics Laboratory in the early '60s, late '60s, had investigated a series of air intakes in a program called “Tailor-Mate.” It was done by General Dynamics down in Ft. Worth, and they explored a wide variety of inlet-airframe combinations for tactical aircraft. One of the configurations they studied was a single inlet beneath the fuselage, again somewhat protected by the wing of this notional aircraft. And that became the inlet for the F-16, and that legacy is quite clear. A fellow by the name of Harry Hillaker, so-called “father of the F-16,” in print attributes the inlet system for the F-16 to the Flight Dynamics Laboratory, and it’s based on the research that the group I ran did.

However, at the same we investigated this dual inlet for a dual engine airplane. Well, the F-16, of course, is single engine, but this dual inlet, both under the wings, shielded, was a very good system also. Well, that is the inlet you see on the MiG-29 and the Su-27. How they got it, I don’t know. There was some AIAA papers, which were cleared, which showed the basic configurations, but we never published the detailed performance data of those configurations, and of course I’ve not seen the performance data on those inlets from the Soviet systems, but, boy, they sure look a lot like that Tailor-Mate configuration that we did. So I think they probably got the idea from those. And they also, then, seemed to work pretty well. I’m not aware of any particular issues of compressor stall with those airplanes.

Brown: In the 1950s, it was common to find articles describing the weapon systems of the future of being missiles, robots, spacecraft, unmanned aircraft. Did this perspective—perspective that seemed to ignore the traditional manned aircraft—did this perspective inhibit the laboratory’s work on technology for aeronautical systems? And was this a vision that turned out to be correct?

Richey: Well, it didn’t impact our work. You know, these projections are more or less the popular science kind of magazines or futurists, and futurists sometimes are right and sometimes are wrong. But certainly in the area of manned versus unmanned aircraft, in the ‘60s and ‘70s, we knew that the Air Force would not be receptive to unmanned aircraft. The technology wasn’t there, and of course, the Air Force, as always, is run by fighter pilots, and, you know, unless they have a terrifically good reason, they are not going to take the pilot out of the airplane. But, of course, there were missiles. Missiles had been developed throughout the Cold War, and very capable missiles—the Sidewinder, and later on, the AIM-120 missile and other long range missiles—were very good for combat.
But as far as the tone of aeronautical research, these things you mentioned didn’t have much of an impact. The guidance and the direction from the Air Force was pretty clear that they wanted to advance the front of combat aircraft—fighters, and bombers, and maybe even transports, to some extent—with manned systems, with more or less conventional wisdom as far as airplane design is concerned. They didn’t have much of an effect.

Now were these futurists correct? Second part of your question. Well, they might have been. We’re now in the 1990s and 2000s entering into a new era of unmanned aircraft. We see them first of all in the intelligence and reconnaissance area. For example, the Global Hawk, which can stay up for thirty or so hours and beyond normal endurance of a pilot in an aircraft. And you don’t need a pilot if you’re just doing the ISR (reconnaissance) business. So that was something that might have been talked about way back when. Of course there’s been drone aircraft for years, and even the Kettering Bug from here in Dayton, Ohio, was an early unmanned system. So that, you know, some of the things that you mentioned—robots and unmanned—could be in the future, but it’s a long time coming.

Brown: If we could stay on the theme for a moment of the future and certainly technology is always looking to the future, periodically the Air Force sponsored technology forecasting exercises. Were you ever a participant in one of these exercises, and if so, did you regard them as effective?

Richey: I was a participant in two. In Forecast One, which was in the early ‘60s, I was a provider of some information, but not a direct participant. We had people in Forecast One which was conducted on the West Coast, and we would mail them data. This was before fax machines even, and we would mail them data overnight, and they would consider it in their activities out there. A fellow named Al Draper from the laboratory, a real visionary, was on Forecast One. He had to do with primarily the high-speed things of Forecast One.

Cut to the chase in 1986, Forecast Two, and I was the panel director of the Air Vehicle panel for the Forecast Two, so I was a direct participant in that 1986 timeframe. And I’ll never forget when the Challenger blew up in January of ‘86, we were in Washington on Forecast Two, and, boy, that was a shock. And so in ’86, I was the director of the part of Forecast Two that had to do with air vehicles, a group of about eight or ten people, and now we were receiving, now electronically in ’86, information back from the field on ideas, technologies, assessments, analysis, and so forth, to make our projections in ’86.

Now as regard to effectiveness, I think Forecast One was more effective than Forecast Two. Because Forecast One, even though I was a worker-bee and didn’t have visibility of the top leadership of the Air Force, for example General Schriever, there was the backing of the
Systems Command to Forecast One, and there was the backing of the Chief of Staff and the Secretary of the Air Force on Forecast One. And they were going to implement as many as they could of the systems that were forecast. So out of Forecast One came the C-5 and several other systems, and composites technology was promoted by Forecast One.

Forecast Two was a lot more diverse and didn’t have the total backing of the Chief and Secretary. It had the backing of Systems Command (General Larry Skantze was Systems Command Commander at the time) and he had full backing of the programs that were coming out. But it didn’t really have kind of the buy-in from senior AF leaders that seemed to be there in Forecast One. So the lineage of current systems here in 2006, twenty years after Forecast Two, is much more diverse.

However, we in the Air Vehicle panel of Forecast Two, forecasted things like high-altitude, long-endurance reconnaissance aircraft; we talked about solar power, but we also talked about other propulsion schemes, and now you have Global Hawk. We also talked in Forecast Two about short take-off and vertical landing (STOVL) fighters, and now you have the JSF STOVL variant with the Marine Corps, and the Air Force is even considering buying some of the STOVL-type of joint-strike fighter F-35 for the Air Force. It’s still in the consideration stage. They haven’t done it. But some of the things that we forecasted in ’86 such as the high-altitude, long-endurance, the STOVL, and the high-speed missile, we talked about are starting to come to pass. But not so much as a direct result of being in Forecast Two, more from the needs, the development, and the opportunity for systems development.

There was one negative example which came out of Forecast Two, and that was the National Aerospace Plane. I was on Forecast Two panel, as I said, and we forecasted that eventually, a single-stage to orbit space plane could be possible. But we put it somewhere around 2025. This is 1986 now, because we knew the difficulties of the technology. And, well this caught the idea of General Skantze, and in ’87 and ’88 then, he instituted the N-A-S-P, or NASP program. And he and I had some conversations about this, and I said, “General, keep in mind that we forecasted this would be around 2025,” particularly because of propulsion and materials and other technologies just wasn’t going to be ready. And single-stage to orbit is a tough nut to crack. Everything has to work just right, in a finite size airplane, to be able to take off horizontally, go into orbit, return, land horizontally. That was the aerospace plane concept. So I said, “General, you know, it just isn’t there.” And he says, “Keith, don’t bother me with details. We’re going to do this.” So I said, “All right, sir, I will support it to the best of my ability.” Well, as you know, three or four years later, reality had set in, and the NASP was cancelled, and it was unfortunate. So we’re still dealing with some of the backlash of things like that.
Brown: The future never quite turns out to be what we expect it to be, and on many occasions, the Air Force has been surprised at how events have unfolded and requirements have developed. A particular example is the conflict in Southeast Asia, the Vietnam War. That conflict created unanticipated demands for the Air Force. What was the effect on laboratory programs, the consequences of this conflict, and did it demand new technologies?

Richey: The main conflict and the impact of the Vietnam was in the area of survivability and particularly due to small arms fire and new surface-to-air missiles. You know, it was a war where the airplanes in some cases had to get down pretty low to see the targets and to identify the targets for close-air support of the ground troops. And like Iraq, you know, there wasn’t enemy here and friendlies there. It was a guerilla type warfare. So they were down in the area of small-arms fire, and if you throw up enough bullets, you can bring down an airplane. So we saw an increased emphasis in the laboratory on hardening aircraft and armor and redundant systems, so an airplane could “take a licking and keep on ticking,” as we used to say. And so that, even if it took small arms fire, it could come back and be repaired. And that was one impact.

The other impact was that in North Korea, North Vietnam, there were pretty capable SAM sites, and so that we saw increased emphasis on defensive systems and other systems for the missiles that were working against the guys going in to Hanoi. That kind of spun back in my case to the case of the F-111. The F-111 first flew in 1964 with the Vietnam War going on in Southeast Asia. And they wanted to get it into operation as soon as possible into the Vietnamese theater. And so there was quite an accelerated development of the F-111 as a tactical system. It was designed to replace the F-105. As I said before, it had terrain-following radar, so it was to provide survivability by very high speed. The original design was even Mach 1.2 on the deck. It turned out that was a stretch, but the idea was to go very fast at low level to avoid the defenses, and that was partly as a result of the Southeast Asia situation, in a more general sense, the Cold War, if you will. But the F-111, then, had to go through quite an accelerated development.

As it turned out, it had uncovered, for the first time, a serious inlet-engine compatibility problem. In other words, the inlet was delivering distorted flow. It turned out to be time-dependent distorted flow to the engine, and the engine would stall (compressor stall) during maneuvers, even during hard accelerations, and during supersonic flight. It was kind of like driving a car, and it just quits on you. And it may restart in a few seconds, but, you know, it really gets the attention of the pilot when one or both engines quit. And so there was quite a push for several months, about eighteen months, on improving the characteristics of the F-111 inlet system.
It turned out what they missed was the fact that the flow coming into the engine at the compressor phase was time-dependent. It was unsteady. And the evaluations as to what flow distortion the engine could take were based on time-average, steady-state descriptions of the flow. But in fact the flow was unsteady, and if the flow would only be distorted at a peak high enough for the engine to make one revolution, as far as the engine was concerned, that was a steady state, and it would stall. And so what we were missing, before we got into it, was the fact that the flow was unsteady, and we had to put instrumentation at the compressor face to describe the unsteady flow distortion.

Once we did that, then we could say, the engine is stalling about where it should stall on its distortion margin, and so we just have to work to beat down the unsteady part of the flow and make it more smoother overall, with not as many peaks and valleys of distortion. But we were kind of in the dark. We were looking at something that was going on, but we couldn’t see it, because the instrumentation was too slow. So when we put in instrumentation in the airplane, both in wind tunnel tests and flight tests, then we discovered that the real distortion that was important was over a fraction of a second. That’s compared to a steady-state operation.

So with the problems with inlet-engine compatibility, after ’66, ’67, the Air Force turned around and said, “We can’t afford to have those kinds of issues again in a new airplane system, so we need increased emphasis in the inlet-distortion research.” There were also some problems with the drag of the F-111 in the backend, and the Air Force said also, “We can’t afford to have these kind of drag problems of the nozzle system in future aircraft, so we need to do some research in that area.” So in the late ‘60s and early ‘70s, then, the Flight Dynamics Laboratory and the group that I led emphasized almost exclusively transonic, supersonic, up to Mach 2.5, kinds of propulsion integration issues, and we dropped out completely of anything hypersonic. We dropped out of anything else, because that was the need of the systems. Driven by Cold War, driven by where the Air Force was going in the development of the F-15. The F-15 inlet development was based on what we had learned in the F-111, in the fact that McDonnell was then able to develop an inlet system for the F-15 which was pretty much trouble-free, partly based on analysis of time-dependent distortion developed by the Flight Dynamics Lab.

Brown: Your remarks on the problems of the F-111 inlet and the ultimate success in resolving the Air Force’s concern about the technology base for future systems, raises a question about transition of technology into products and the issue of identifying a customer for the technologies of the laboratories. From your perspective, who represented the customer base for the Wright Field laboratories – were they the program offices, the SPOs, the contractors, the user, the operational command such as Tactical Air Command, Strategic Air Command—can you enlighten us on the customer base of the transition issue?
Richey: Well, the customer for the advanced technologies we were developing would have been primarily the people in the Aeronautical Systems Division at the time who looked into the future, the so-called Development Planning, or XR organization, within ASD. The SPOs were pretty much interested in their day-to-day problems. If they had an issue, like in the F-111, then the SPO engineers and the lab engineers would work together to address the issue, and that was the case of the F-111.

For advanced systems, when we were working on advanced inlets and nozzles and aerodynamics and so forth, we would work quite a bit with the development planning organization. A fellow named John Chuprun, a world-class designer, a good friend of mine, would work with us and say, “This is the kind of systems we’re considering for the future in the Air Force, and here’s where we need advancements in technology and can you guys help us to push those areas?” It might be performance or weight or cost or whatever it was, and so we were taking a lot of our cues from the people in the Aeronautical Systems Division, the airplane business of the Air Force, that were looking in the future. We in the laboratory were looking at the components of the airplane, but they were looking at the total system, and they gave us signposts that we would try to develop our technology for.

The other customer was the using commands, the Air Combat command, for example, and we would go down and talk to them from time to time and try to get their encouragement of our projects at the senior level of the Air Force, so that when Air Force budgets came up for review, we always wanted to have the commander of Air Combat Command telling the Chief of Staff of the Air Force, or the budgeteers, “This is important stuff and you need to keep it up.” So we wanted them in our corner, and we wanted to try to be responsive to their view of the future. And of course the combat commands such as Air Combat Command or Strategic Air Command always had their future operations shops, requirements operations divisions, which to some extent looked in the future also. It was primarily wherever in the Air Force we could find somebody that was looking at the future, we considered them our customer.

End of Video Tape One

[on audio file only]

Brown: At this time, we’ll take a break for a few moments before we resume the interview.

Richey: All right. }
Brown: Dr. Richey, the knowledge and skills of individual specialists in the laboratories are critical for advancing technologies. How did the Air Force laboratories recruit and maintain a competent workforce? And do government policies promote the objective of maintaining this competent workforce?

Richey: Well, the recruiting, of course, depends on the budget of the lab, and there are cycles when there are more resources available for recruiting. There’s times when the resources are not available so the recruiting pretty much goes to a low level.

Let’s talk about times when there is ability to recruit. There was such a time in the early ‘60s. There was another time in the late ‘60s, and another time in probably the mid-‘70s, and then later on in about the mid-’80s. There were cycles of staff build-up and recruiting. I would be involved with recruiting trips to universities. We primarily would present to the graduates the ability to take on responsibilities earlier on by working for the government laboratories, to be involved with something that was cutting edge, number one. We explained that it was applied research in most cases. They wouldn’t be, you know, white-coat laboratory-type people. For instance, those students who had kind of an interest in design, a broad background of aeronautical work; we explained to them early in their career take a broad look at the field. Whereas if they were in a company, they might only see that company’s aspect, a fairly narrow view.

So we would tell students, “Come to us for five years and get the broad view. At that time, if you want to go to an industry, fine. You go with our backing.” But in many cases, they got so interested in the broad view and the idea that they were guiding technology, guiding large contracts, and guiding teams of researchers within the lab that they would stay.

Paywise, we always told the engineers, particularly in the ‘60s and ‘70s, you might start out a little bit low, but after five or ten years, you should catch up with your peers. So as far as the development was concerned, the environment was relatively good. The policies that upper management would put on were not particularly onerous. I think in most cases, the engineers understood that there were budget cuts, there were issues with promotions that wouldn’t always come when they were wanted, but they enjoyed the work. And we would oftentimes, when I was Chief Scientist, meet with other chief scientists and we could walk about “psychic income.” You have fiscal income and you have psychic income. As long as we can keep the total of fiscal and psychic above the fiscal with opportunities outside the lab, we will be able to retain our people and be able to keep them motivated. So we as leaders, chief scientists, would
work to create an environment that was conducive to collegial research, to
dual work, and to the idea of making a contribution that they couldn’t make
in another industry.

Brown: When you visited a campus on a recruiting trip, were you
interested in recruiting specific specialists, specific knowledge
backgrounds? Or was your objective simply to get the best qualified
person whatever their interest?

Richey: It was more the latter. We would hire in to engineering
specialties, such as aeronautical, electrical, mechanical. I would have
been mostly involved with the aeronautical engineering graduates. So we
would particularly emphasize the top-level schools across the country.
We knew that we probably had our best chance of recruiting if we stayed
in the Midwest, because, it’s difficult to get someone to move from the
West Coast to the Midwest, with all the bad weather and everything. But
certainly there are many very good aeronautical universities in the
Midwest—Purdue, Illinois, Michigan, Ohio State, Case Western—within
five hundred miles of Wright-Patterson. So we would go to those
universities and recruit the highest G.P.A. we could, the top of the class, as
near as we could, and try and induce them to, as I said before, come to the
lab. As I said before, we’d also then discuss with them the opportunities
for graduate study, part-time or full-time, so if they wanted to pursue their
educational career further, that the Air Force was very interested and
supportive in advanced education.

But we didn’t look for someone who had a particular skill, at least
when I was recruiting. I think later on, they might have recruited more for
people who were coming out of the university with a computational fluid
dynamics background or something like that. But in general, when I was
recruiting in the ‘60s, and ‘70s, and ‘80s, we said “Bring good people in,
then we’ll train them.”

Brown: The work force in the laboratories is an interesting combination
of military and civilian personnel. Can you please describe the reason for
this arrangement? And did you regard it as an effective way to staff an
R&D organization?

Richey: I always felt that the mix of military and civilian was good, and
that the military, particularly the military leaders, fellows who’d been in
an operational command, perhaps even combat, could give us some good
insight, some good guidance. We didn’t expect them to be the brains of
the outfit, necessarily, but we appreciated their leadership, we appreciated
their experience and I think, they were effective in helping to guide our
research. In most cases, they were in the management chain and so they
were good advocates with the users, the people in Air Combat Command,
the officers at Systems Command. And we always said that if we’re going
to visit a using command, we need a “blue suit” with us, who would talk in terms of operational needs and leave the technical details to the civilian engineers. We were probably at least eighty-five percent civilian, fifteen percent military. I think even now, it’s even less that in military, but the leadership, I think, is good.

The down side of it is that the leadership, for example at the lab director level, would change quite frequently, so that you had change every eighteen months or so. So you had a change of leadership style or a change of leadership point of view, but in the end, you could average that out, and we kind of worked through it. Sometimes a project would have difficulty if a particular lab director didn’t like it for some reason or another, but we’d kind of put those projects in the bottom left-hand drawer, as we called it, and then bring them back out when another director came in and we thought we could sell it again, so we kind of kept the corporate memory. But I think, overall, it was beneficial to have a mix. I don’t think all military or all civilian would either be a good idea.

Brown: The laboratories at Wright-Patterson Air Force Base have a heritage that goes back into World War I, the foundings of McCook Field and the Engineering Division, and that results in a culture with a very long memory, and certain unusual characteristics, a culture that is perhaps different from what you would find anywhere else. How would you define the culture of the work environment within the laboratories at Wright Field?

Richey: Well the culture, I think in my experience, was favorable. We worked with a lot of very good people. We had good leaders in the Flight Dynamics Laboratory, where I spent basically all my career, at the branch and laboratory level. Some commanders were more effective than others but they all were good leaders. And I think the culture was generally favorable. We didn’t feel like we were oppressed in any way. We had enough resources for our in-house research, for contracts, for travel, for participating in professional societies. We were able to go to conferences and symposia when we needed to. Promotions for the most part came when they were deserved. We’d go through periods of time when they would try to, you know, count things that didn’t need to be counted as far as promotions were concerned, but we eventually got back over to the point where we had kind of a mentoring process, where senior people in the laboratory would kind of informally mentor, or take under their wing, some of the younger engineers. I was fortunate to have people like Mr. Philip Antonatos as my mentor, and Mr. Al Draper as one of my other mentors. They were senior leaders at the division level in the Flight Dynamics Lab, and we would go with them and interact with the lab commander. And even if the lab commander changed, they knew that when either Mr. Antonatos or Mr. Draper would bring us younger engineers along that it was for a reason, and they would listen to us.
think the culture was good. It was collegial. I don’t recall any particularly oppressive or negative environments.

00:10:39 Brown: Let me ask you to shift your perspective from internally within the laboratories to the outside world, and particularly to higher headquarters and the Pentagon. Through the decades of the Cold War, several men served as Secretary of Defense, were remembered for initiatives that changed how weapon systems are developed and acquired. Did the office of the Secretary of Defense have a particularly significant influence on the Air Force laboratories, and do you regard any particular secretaries as having been effective?

00:11:18 Richey: Well, a lot of that was above my pay grade, as you might say. You know, we would see the budgets go up and down, and of course that was somewhat dependent on the Secretary of Defense support of technologies. I think most of the Secretaries of Defense were favorable to technology, but a lot of them wanted to have more of a near-term return on the investment and push the technology bar back to more of a near-term approach, say ten years out versus twenty-five years out, something like that. So there’d be some changes and some perturbations as the secretaries changed. I never met, myself, with the Secretary of Defense, although in the case of the F-111, we knew that Mr. McNamara was extremely interested in the F-111 and was being reported to on the F-111 every Saturday morning in the Pentagon, with a program that was called “Project Icarus,” which is a mythological character whose wings were made of wax and melted when he got too close to the sun. So it was kind of ironic that the F-111, which was having problems of flight, would be called “Project Icarus.” But we saw the influence at that level of Secretary McNamara on the engineering work at the contractor and then our support of that problem with the F-111 in the ’66, ’67 time frame. I have recorded some of this in a Systems Engineering case study for the F-111 that I did a couple of years ago, and I gave you a copy of it, Squire.

00:13:02 Brown: Thank you. So your professional career covered not only decades at the height of the Cold War, but you were there when the Cold War came to an end, an end that seems, in retrospect, rather swift, rather abrupt, beginning with the withdrawal of the Soviet forces from Eastern Europe in 1989, and finally the political disintegration of the Soviet Union in 1992. Did the Air Force anticipate the collapse of the Soviet Union and the end of the Cold War? Did you personally foresee the end of the Cold War?

00:13:43 Richey: No, I didn’t foresee it personally. You know, I would follow the news, but I was surprised that it really did happen. As far as I could tell, the Air Force didn’t communicate to us in the lab one way or the other whether they were surprised about that or not. But it changed the impetus
of research to some extent; we were involved in '91, '92 in the First Gulf War, and that had a lot of impact on the lab budgets because the Air Force needed more money to fight the war, so there was a decrease in both people and fiscal resources in the laboratories. And we used to call the ‘60s and ‘70s the “Golden Age” of research in the labs. In ‘91, ‘92, of course, with the diminution of the Soviet Union and the Gulf War, less emphasis on research, there was significant manpower cuts in the early ‘90s, and the Wright Laboratory—five directorates here now at Air Force Research Lab—was reduced by about a third over that time frame. And during that time, I was Chief Scientist of the Wright Laboratory (five directorates) here. Later on I was Director of Plans and Programs for Wright Lab, and from ’95-’97, Director of what is now the Air Vehicles Directorate, at that time Flight Dynamics Directorate. And so we were under quite a bit of pressure because the Soviet Union had disintegrated, we were in a war with Iraq and other issues in Southwest Asia and so we were fighting the battles of budget and personnel. Morale was good at that time, but we at the senior leadership level (I was a leader at that time) had to really advocate our laboratory and advocate the research we were doing and sometimes had to adjust to rather significant personnel and budget cuts. And on occasion, I would visit the commander of then Air Force Wright Aeronautic Laboratories, AFWAL, at his home on Saturday afternoon and get my point of view across.

Brown: From this post-Cold War perspective, if you were speaking to a future historian, how would you describe the significance of Wright Field during the Cold War?

Richey: Well, during the Cold War, I was involved with the laboratories from ’61 up to the end of the Cold War, which we’ll say is 1991, ’92. And so during that time frame, it was in most cases, a robust time of research for the lab, whether it was the Soviet threat or just the need for advancing technology. We were under the leadership a lot of that time from General Bernard Schriever. He was a giant of advocacy for technology, and well-respected by each successive Chief of Staff, each successive Secretary of the Air Force, and when General Schriever spoke, people listened. And he was the one in the ‘60s and ‘70s who really kept technology going. I had the privilege of meeting him several times, and in the ’66 time frame, I was involved in a study on the west coast called Beyond the Horizon. It was kind of a follow-on to the von Kármán study, Toward New Horizons. It was run by General Schriever, and he was such a prince, a brilliant man, and a strong advocate of technology. We’ve not had one since at Systems Command. We’ve had very good Systems Command leaders, but we’ve never had a Schriever.

Brown: As we close this interview, Dr. Richey, is there anything else that you would like to mention, perhaps something that we’ve not addressed
through the questions themselves? Any other perspective that you would like to share with us please?

00:18:33 Richey: Well, I’ve had a great career, and I was very fortunate to have had that career. Good support of my family throughout, a lot of travel, and my wife was very supportive in all aspects of my career with the Air Force.

I think the thing that I get back to in the laboratory is the people, and the people who were visionaries. In the laboratory, we think of Bill Lamar and Phil Antonatos, Zip Zonars, Al Draper, some of the other people, many who have now passed on, who were visionary, who were good leaders, and who encouraged the younger engineers such as myself. We had good lab directors, I think of Bob Barlow and George Cudahay, a very dynamic and somewhat unpredictable man, but always had some good ideas. Brian Dale Ward, who strangely enough, I got along with very well; he was a bit of a terror, but somehow Colonel Ward and I got along all right, and he helped to get me in some of my senior positions, and so we struck it off good for some reason or another. But basically the people; if you think back on your career, the budgets come, the budgets go. The facilities come, facilities go. But if you can have good people, and good leaders who will, number one, listen to their subordinates and advocate the programs that the subordinate teams are going to be pushing, such as the two-dimensional nozzle on the F-22; work that led up to the advanced inlets systems, the advanced structural concepts, some of the hypersonics. Al Draper was a leader, a pioneer in the lifting body research, a lot of which resulted in application to the space shuttle and also to maneuvering re-entry vehicles. Good ideas were advocated, good ideas were supported by the people there, and the budgets would be applied as best they could. Some things worked, some things didn’t, but there was never reprisal for failure. There was always “what did we learn and what can we go from here,” and I think the laboratory was in a mode of taking some risk, that we need to be careful as we go into the future that we’re not so risk-averse that we’re not able to take some flyers on technologies and try a few things that might not work. You know, if we’re in kind of a cost-accounting mind-set that we have to show the application and the favorable outcome for everything, we will not pursue some ideas that would be useful.

You had talked to Bill Bahret about stealth, and that was, of course, one of the keystone technologies in the Cold War. But you know without people backing ideas like Bill’s work up in “The Barn” on stealth, it wouldn’t have come to pass, because Secretary Bill Perry, I think maybe he was Undersecretary of Defense, was an early advocate of stealth, and I’m sure Bill mentioned that, but, you know, it wasn’t widely known. So that you weren’t getting top down direction from the leadership on things like that. But, as I said earlier, in the case of General Schriever, you were getting top-down advocacy and top-down guidance for a broad scope of
technologies, and then he would leave it up to the lab engineers and lab managers and leaders to do the best they could to promote that. So I think the laboratory has to maintain an environment of collegial relationships. It has to maintain an environment of advocating for its people and its programs, and don’t get too wrapped up in organizations or too wrapped up in bean counting and things like that. The laboratory has to remember it’s a technology development organization and everything isn’t going to work. But some things will, and when they work, it’s great.

00:23:14 Brown: This concludes our interview with Dr. Richey. Thank you for your time this morning. It’s been a pleasure.

00:23:19 Richey: Thanks, Squire.

End of Video Tape Two
End of Interview One