



**Mr. Larry Lynn
1995-1998**

Interview: December 8, 2006

Interviewer: Can you tell us your name and describe your tenure at DARPA?

Lynn: My name is Larry Lynn, and I was at DARPA from 1995 to 1998.

I: What attracted your attention to DARPA?

Lynn: Well, that's a very difficult one to answer because I worked with DARPA back in the early '60 when DARPA was still a child organization. I was involved in the ballistic missile defense until it was transferred to BMDO and I had friends in DARPA in the '70s. They asked me if I'd come to work with them, but I wasn't interested at the time.

So, I never was interested in going to DARPA until, oh, the end of the seventies, at which point I was in OSD, and Bob Cooper then asked me to come over and be his deputy. I'd known Bob for a long time and welcomed the opportunity and got to know DARPA firsthand.

I: When did you get the call to be Director?

Lynn: Well, at that time, I was in OSD. I was the Deputy Undersecretary for Advanced Technology, and had come in to create the ACTD program. OSD is about a two-year tour. I knew there was an opening at DARPA, and once you've been there two years, you desperately want to escape (chuckles) and find something more interesting to do.

And when I knew there was going to be an opening as DARPA's Director, I went and talked to Paul Kaminsky, who was the Under Secretary at the time. The primary issue, I think, in his mind was how to preserve the ACTD process if I left it, since I was the creator. And, eventually, we came to an understanding that I would do both for a while, while somebody else transitioned into the deputy undersecretary position.

I: What kind of an organization was DARPA at the time?

Lynn: Well, it was almost ten years to the day from the time I left, and the thing that startled me most was I knew most of the people. I recognized them, which says that they had all been there 10 or 15 years. I felt that that was an important aspect of DARPA—that the turnover and the fresh ideas came in all the time. I strongly believe that the health of DARPA depends a lot on the turnover of people and the ability to bring in fresh blood every year. So, 20 percent turnover is unhealthy in business, but very healthy for DARPA. That was the one thing that startled me most.

The other, I guess, was the size of the organization. It had gone from what I knew as about a \$2 billion in constant-year dollars to being close to \$3 billion by the time I came back in 1995, and that struck me as dangerous. The staff has to build up in order to handle that. When an organization becomes bigger, it becomes more bureaucratic. Now, whether \$3 billion was the danger point or \$2 billion was anybody's argument, but I went about trying to reduce the budget. It was unusual for anybody to try to reduce the budget, and I succeeded in getting it back down to about \$2.2 billion. Of course, all the program managers thought I was crazy because they could have made good use of that money (chuckles).

Those were probably the two things that most struck me when I walked back in.

I: Most of the people you knew, but had to eliminate? Ouch!

Lynn: Well "elimination" is a funny word. ARPA had a longstanding policy—it was unwritten—of high turnover, but in the intervening ten years it somehow was slowly forgotten. There had been several Directors and a lot of people, and people began to hang in rather than go off about their business.

I think that struck me as particularly unhealthy, and so I made it a written policy at the time. A lot of people took it seriously, and we helped a lot of people find jobs. Some people felt that they didn't want to leave and weren't going to leave and I couldn't make them leave, and that was true. So, I think since the time I left, I know that both Tony Tether and Frank Fernandez believed in the policy and have slowly tried to restore the notation policy.

I: Were there any sort of written ground rules? For example, I understand that the Directors made it their policy to try to bring two new people in per year.

Lynn: No, but the policy was that at the end of four years you ought to think about finding a job, and be gone by five. And if you take that, it says 20 percent of the people have to leave every year. It doesn't work that smoothly, of course. Somebody comes in, works for four years as a program manager, becomes an office director, and you don't want to enforce that. So, if you move up, then you ought to extend that some more, but even the office directors and the Directors ought to keep in mind that fresh perspective is one of the arteries of DARPA.

I: Cutting the budget—how did you do that?

Lynn: Fundamentally by working with the Congress and the Pentagon just trying

to keep down the number. Every year—at least at that time—the Congress subtracted about a quarter of a billion dollars and added about a quarter of a billion dollars, usually adding slightly more than they subtracted, and so there was a continual growth. Congress typically gets upset with the Services and then uses ARPA as the means of punishing the service, so the budget builds up.

Aside from getting the organization too big, you also worry about getting too big a fraction of the science and technology budget of the Department, because then you build up animosity with the Services, and that's not a healthy structure.

I: With the peace dividend, weren't budgets being cut?

Lynn: They were on the basic defense budget—the productions, procurement, and so forth.

But the science and technology stayed pretty much the same. What was happening was a larger fraction of it was shifting into DARPA and away from the Services.

I: This ebb and flow relationship that ARPA and DARPA have had with the Services over the years—what kind of relationships did you encounter?

Lynn: Well, it goes up and down all the time, and of course the Services are not monolithic. Nor is ARPA, so it depends on the individual you're talking to and the time period. I can recall back when I first went to ARPA in 1981. I was friendly with the Chief Scientist of the Air Force, Dr. Bernie Kulp, and one day Bernie told me—and he was dead serious—he said, “The world would be a better place to live in if ARPA went away and I had its budget.” (Chuckles.) And that was typical. Most people didn't articulate it that way, but that was typical of the attitude the Services had at times.

Sometimes—oftentimes—they'll look at the ARPA budget and work hard to figure out how to use it for their own service, because, of course, ARPA works for all the Services and does whatever it believes is of greatest value at the time. So, there's a benefit for any service that looks at it and tries to figure out how to get ARPA working for them. And they do that.

A good example is the arsenal ship. Mike Borda was the Chief of Naval Operations at the time. He wanted to build a ship as close as possible to unmanned, and this was back in the days when a carrier had 5,000 people or more. I guess it still does. But he believed they couldn't get that built in the Navy, and so he came to me and asked me to help him.

Building a ship was an interesting, obviously big expense, but an interesting thing to do if your goal is to minimize the number of people. And so we started on the arsenal ship, and this was a case of the navy trying to make good use of ARPA.

Unfortunately, when Borda died, the anti-bodies got it. It's oftentimes blamed on the Congress, but it wasn't all the Congress' fault, really. They were executing what came from the Pentagon.

I: The relationship between the Secretary of the Joint Chiefs, the Services, and

ARPA—you worked for the Secretary, isn't that correct?

Lynn: Well, of course everybody does. There are lots of different views on that. Mine are different than some of the current views. The original ARPA worked directly for the Secretary. Over time, it was unsustainable, though the Secretary is often interested and his support is essential.

For example, during my day, Bill Perry was the Secretary. He's a technologist of some depth and was interested and listened a lot to what ARPA was doing and would follow through, and give support. But I never thought of myself as working directly for Perry. I worked for a combination of the DDR&E, who was Anita Jones at the time, and the Undersecretary, who was Paul Kaminsky. I had no hesitation in going to see the Secretary, but, nonetheless, those were the people I felt the compulsion to keep informed.

I: Stepping behind the wheels—how does one manage something like that?

Lynn: Well, again, that's highly personal with each Director. Until Tony Tether came along, I was accused of being the worst micromanager. (Chuckles.) I don't believe I actually was, but that was the reputation I got, as does he. You manage it in different ways. What you should do is stand back and look at what your role really is, and your role is—first and foremost—to protect the Agency itself. Don't let people do things that get the Agency in trouble and stand a chance to kill the Agency. That I always viewed as my primary function.

Second was to at least exert some top-level judgment and oversight over all the programs so they were not just people's hobbyhorses, but they really had serious intent—and so make some judgments on the programs. And, thirdly, to stay a little bit out of the way and let the program managers do their thing.

In general, you bet on the good people. I've never done the math to find out, but I've always felt that probably 20 percent of the program managers had 50 percent of the money, and that was because I was betting on the program manager. If you have somebody you have confidence in, you're willing to give them a lot of free rein. If you have somebody who you don't really trust and don't have high respect for, then you kind of parcel it out and watch closely.

I always felt that one thing ARPA has is a lot of flexibility in its budget, and one of the ways you get that money flexibility is to kill something. So, if you came in with a great idea that I believe warranted \$100-million of expense, the only way I could get that \$100 million is by going out and slaying programs that are using that kind of money and taking it away from them.

So, in order to keep a little bit of a rein on things, I periodically ran through all the programs and—typically every six months—listened to all the programs and gave them each a score 1 through 5. Everybody knew it. The office directors all knew the rankings, and 1 meant that if you really need more money, I'd give it to you. Five meant if I need more money, I'm going get it from you. It struck me as a useful way of keeping people going on their toes.

I: The technology reinvestment program—where was that?

Lynn: I really didn't have an awful lot to do with it. It was Gary Denman who preceded me and the guy who lived with the TRP. When I came in, TRP was on

its way out. Really, my only relation to it was keeping it neat and clean as it folded its tent. I really didn't have much impact on it. And it was viewed as a highly partisan project. The Republicans viewed it as a way the liberals were robbing the Defense Department, and the liberals had an obviously different view. So, it really was politicized in the Congress.

I: Republican Congress came in, killed it.

Lynn: Well, that's where the "D" on "DARPA," comes from, too, of course. It's the same thing. I don't remember the schedule, but I lived through the transition, and the "D" has no effect on DARPA except in the political world.

I: So, the way to manage the budget was to transition different projects out of ARPA. Was that part of the consideration?

Lynn: What you're always trying to do is to move projects. No project is of value if it *stays* at ARPA. Eventually, it has to get to the operating forces or to the people who have responsibilities in the Defense Department. And so the question of transition is a continual one every Director struggles with in one form or another. It's not a question of getting more money, because you budgeted to finish this program to some level, and then you want to stop and transition it to somebody else, and that transition process is very difficult and very much depends on the people and the interactions of them.

But there's always a tension. ARPA wants to demonstrate the feasibility of an idea and stop, and there is usually some more that has to be done; the Services don't want to do until it's proven.

I: Part of the relationship-building with the Services?

Lynn: Yeah. And a typical way to do that is to sign an MOU—a memorandum of understanding. Unfortunately, a lot of those things get abrogated and don't stand up. But a typical way to do that is to start a program. DARPA agreed to take the lead for the first three years and provide initial funding. Say, 90 percent DARPA, 10 percent service, going in—and as it begins to mature, 90 percent service and 10 percent DARPA, and then DARPA falling off. That's nice in theory. It doesn't always work in practice.

I: Sounds clean.

Lynn: Right. You can draw a lovely curve.

I: The personality of the Director—what they see shapes the direction. What did you see were the needs, the context?

Lynn: The first three months I was there, I tried to sit back and understand what all the issues were, what was important, and where I wanted to go. During that time, of course, the organization, the people, and the programs sort of stayed constant, wherever they had been left by Gary. During the process of doing that, I put together a list of things I thought were sort of the ten most important drivers in each of the technology and the systems areas.

And the ones that come to mind are the transitioning of UAVs. That's one

that's been going on for 40 years, and I had been working on it in the Pentagon and thought that it was important to carry forward. I think the exploitation of information in one form or another is on the list of virtually every Director in recent times. At that time, we called it "comprehensive awareness," and there was a fair fraction of the budget that went into what amounts to signal and information processing.

There's always an airplane or two in DARPA, and that's important. Probably the external thing that drove most of our thinking was the Bosnian situation at the time, and was a real need to improve the communications and the information exploitation for Bosnia. ARPA jumped in and put together a system, so that was driven by the external world.

It became apparent that biological warfare was rising to the level of a lot of concern, and the DOD had very little capability in biology, so we started a heavy, hefty biological program. Those are the things that come to mind immediately, but all of those—the signal processing, the biology—were essentially new.

I: The opinion was that big weapons systems were becoming less of a problem. Biology was becoming the greater threat.

Lynn: Well, I don't recall saying that (chuckles), but the way ARPA got into the biology area was primarily because there was a small contingent of doctors—maybe four medical doctors—who were part-time DARPA PMs and part-time still in their medical professions. They were there, so that we had just a little bit of biology knowledge—enough to be dangerous, but not enough to do much.

At the same time, Richard Danzig was the Secretary of the Navy, or Undersecretary, I guess. He was a very articulate spokesman for the problems of biological warfare and spent a lot of time on that and brought the people together to try to educate people in the Defense Department, and I was one of his "educatees," and got a good view of the seriousness of that problem. One of the docs who were at DARPA at the time was a very entrepreneurial program manager by the name of Sean Jones, who really created the program, helped educate me on top of what Danzig had taught me.

I: At one point, didn't you even go to Russia?

Lynn: Yes, we went with a team of about six people, I think it was. Let's see. We went with Sean Jones, Jane Alexander, George Whitesides from Harvard, and a guy from the Salk Institute. I can't remember his name, though. Alexis—he had a Russian last name and spoke Russian and Andy Weber. So, the bunch of us went. We started in Novosibirsk at Vector out in the Siberian plains and then went to a number of the institutes around the Moscow and St. Petersburg areas.

Our intention was to try to both understand where they were at that time and to get them involved in our research programs to, if you will, get them off the street.

They were poverty-stricken, in general, and we went with the intention of letting lots of contracts. The Russian government got into the middle of that, and we had some difficulty getting money to the institutes we were trying to work with,

but there was lots of interest and lots of capability.

I: Responding to a Soviet technological surprise—here we are trying to learn from them. Ironic?

Lynn: It's certainly ironic, but remember, the Biopreparat—the Russian acknowledged “nonmilitary,” biological warfare programs, I say “nonmilitary” in quotes, because there clearly was a general in charge—employed 50,000 or 60,000 people during the Cold War doing biological warfare, and the U.S. completely closed down and got out of the business of offensive biological warfare back, I think, in the mid '60s. So, we essentially opted out largely for moral reasons. We had opted out of the whole biological warfare and were competing with a 50,000-strong effort on the other side, so we had things to learn.

But probably more importantly—and some of that we didn't learn, of course—was to get the people under control; get the expertise. You've got 50,000 people who were essentially unemployed, or down to very small numbers and not very well supported. So, any reasonable scientist who can't get any support and can't get any food is likely to go off and be interested in a job in places where you don't want him working.

And that was our concern. We really wanted to build up a program, and there was also a State Department program to do the same. It's part of the cooperative threat-reduction efforts the U.S. has had going on since the end of the Cold War.

I: Setting the technical priorities for ARPA—what stands out in your mind?

Lynn: Well, the money wasn't necessarily allocated according to the priorities. There's a favorite government attitude: if you pile money onto a problem, you can get an answer. And, of course, that's not true. You have to have the ideas to support the expenditure of funds.

I kept and published a list of ten top systems, or ten top military problems I thought we ought to solve or work on, and the ten top technologies. I've mentioned a few of those. Actually, you have the list.

Well, some of the more important things were biological warfare defense, which was new and I talked about; signal processing or what we called “comprehensive awareness,” which was the exploitation of sensor information to get knowledge; and the Cruise Missile defense was a major effort. We had a major effort that started long before my time that was important and continued and stayed mostly classified for quite a period. It is emerging these days.

Unmanned systems were a major focus. I believe we managed to get the UAVs to go over the top of the hill into use. For 40 years, UAVs, or RPVs, have been popular. Everybody's looked at them. The Army has periodically used them. So has the Navy, but they they'll build a set of UAVs for example, the more recent one at the time was the Hunter. It was built. It had some problems. It was killed. Then they moved on to the next one, so there was never any sustainable program that stayed in so there was a military capability that was widely used.

The Israelis took the technology we developed in the '60s and built a very capable set of UAVs and used them very frequently in their dealings with the Middle East—and very effectively.

We never seemed to manage to get over the hump on that. One of the things I think we actually accomplished in the late '90s was taking UAVs, building the Predator and the Global Hawk and getting those into frequent use. We were lucky to have a war come along where they began to be useful. It was the combat experience that really carried them over the top, but there were enough of them there, and now you see UAVs everywhere. Everybody owns a lot of UAVs.

The arsenal ship was an attempt at an unmanned ship; I mentioned we did at the request of the Navy, the CNO personally. But one of my drives was to get rid of everybody on it. There was a favorite story that a lot of people created and told that we were going to put a man and a dog on there, the man there to feed the dog and the dog there to bite the man if he did anything else.

At some point, we got down to and agreed on 25 people to man this ship—this full-sized ship. And of the 25 people, I believe, and *still* believe, you could have gotten that to zero, and probably should have. But the Navy at least is developing, I believe, a littoral combat ship, which was its most recent vessel and is now down to less than 50 people. So, we're getting there, and one day we will have a several-thousand-ton ship going around with nobody in it.

This has a lot of advantages, and it's an interesting problem, actually. If you don't have any people, then you can make the ship much more survivable. Think, for example, of a ship full of ping-pong balls. Obviously, not the way to do it, but it would be very difficult to sink a ship like that. The Boston Whaler is a good example of that, if you're familiar with it. It's a plastic-covered, foam boat that you can actually cut in half and still keep afloat.

And, I believe the arsenal ship should go in that general direction. If you don't have people onboard, you don't have to have open spaces, which is where the fires go. And there are lots of advantages to something like that.

On the other side of the coin, those are some of the things on the list for military problems that ARPA was setting up to solve during this time. There were also interesting technologies that supported military applications—obvious examples are the information technologies ARPA has a long history in, and battery power, which is one that remains a problem today. ARPA's been working on that one, now for at least 10 or 15 years and made some progress, but it's evolutionary. What you really would like is a box with lots of power in it that takes the place of some of the batteries.

The micro-electrical mechanical systems, or MEMS, came along during that timeframe and reached maturity, and building very, very tiny systems on a chip. The ability to build mechanical systems with MEMS, electronic systems in the customary way, and optical systems, all on the same chip allows you to think in terms of systems on a chip where you have whole problems solved that way. And you begin to see those even in consumer electronics today. Those are the ones that come to mind.

I: Systems of systems.

Lynn: Certainly, there are lots of those.

I: How do we maintain continuity in a project that takes 15, 20 years to develop?

Lynn: Well, typically, the ARPA Net is probably a good example of that. The ARPA Net was started by one person and spread out and became the lifeblood of several people. Each step of the ARPA Net—or any other program, for that matter—is typically four years long. It's a project with a set of specific goals to reach at the end of some period, like four years. It doesn't mean you can't repeat that, or go to the next phase. In fact, most programs, if they are successful, demand another phase, another four years. And that can go on forever, and it has in many, many areas.

There are probably more areas that have gone on than those that have disappeared along the wayside, but the point at ARPA is everything is project-oriented. Each program manager should have a set of goals he's going to reach within the next four years. Very well-defined and very measurable, and usable, if that's the goal.

The next program manager that comes in will typically be given existing programs. If these programs are good, he'll nurse them along and become the champion. If they're bad, he's probably going to neglect them, and they'll fade away, and that's not a bad process. And it doesn't happen without overall supervision, but you don't let a good project die just because you don't have an interested program manager.

Some ideas come up again ten years later. A good idea that couldn't be achieved at one time oftentimes pops up again later. And one of the things you notice is that nobody remembers why it failed. So they don't hesitate to try it again if they think they can do it, and so eventually these things come around. The lack of institutional memory is not all bad.

I: The mechanical horse?

Lynn: That sounds like the hexapod that was high on Ivan Sutherland's (Carnegie Mellon) program to build. It was this thing that looked like a horse and walked more or less like a six-legged horse. There are some interesting ideas, and some of those are not obvious why anybody's doing them, but there's been a lot learned about the whole issue of robotics and mechanical walkers. But they all contribute to the store of knowledge, and sometimes they're worthwhile, and some of them are crazy. Sometimes they are very hard to kill.

I: The relationship that ARPA has with universities—how do you maintain those?

Lynn: Well, obviously, they want their programs to go on forever, and they bring a lot of pressure on ARPA to continue forever. And there's a very useful tension between the two. The information technologies are probably the primary example. There were four or five obvious universities that received the bulk of the funding in information technology over the years. Anybody can name the five top universities. There are good ideas elsewhere, as well, and so, again, the ARPA-project mentality interferes because the university would like 50-year

tenure, and ARPA wants to be able to renew or review at the end of four years—or, numbers like that.

And so you see the most recent incarnation is a complaint from the universities that ARPA is withdrawing the funding, demanding classification and so forth. There's a whole series of complaints, some of which are based in fact, and some of which have to do with just ARPA's unwillingness to make a commitment to anybody for the long term, other than the projects.

The National Science Foundation and other such organizations fund grants that are enduring, but there are a lot of complaints by the universities, and yet, I believe that ARPA does it pretty much the right way. If the university has a good idea and wants to pursue it, then they ought to get that funding from DARPA. If all they want to do is to keep working on what they've been working on, with no end in sight and no goals, then it's something for NSF. That's not for DARPA.

I: Is there a tension, or coexistence between basic and applied research?

Lynn: I don't think so. Basic and applied research are budgetary terms. They apply to the 6-2, 6-3 definitions. ARPA pays some attention to that, but the programs usually transcend the definitions of 6-1, 6-2, 6-3. But the truth of the matter is that ARPA works across the span of the three S&T budgetary areas and tries to make it a continuum, rather than worrying about dividing it into separate pieces.

I: There are also immediate needs that ARPA would want to jump in on. Is that, for the most part, true?

Lynn: Yes, and it's never clear what research will lead to. And, yet, most 6-1 funding—that is the funding definition of research—is in the Services. ARPA has a small piece, but never has had a big piece of 6-1 funding. On the other hand, DARPA has never been reluctant to pick up something that is fundamental and that any research scientist might describe as research, and so there's a little dichotomy between the budgetary and the scientific.

ARPA's view is that it doesn't really matter, and has never taken that too seriously, although they're required to in the bookkeeping, of course.

I: I was thinking of the UAVs as an example.

Lynn: Well, the history of the UAVs is one of cultural anathema, not technological. UAVs were built when I was invited to come to DARPA back in the '70s—this was, like 1972. One of the programs going on at DARPA at the time was UAVs—several different kinds. The Army picked up and tried to build the Aquila UAV in, I think it was the late '70s, and it was sunk by piling on too many requirements—the usual problem the Services sometimes have in acquisition. And it was a program that grew and grew and grew until it crashed—not literally, but financially.

And there have been a whole sequence of other programs, and the real problem with all of these has been no user really wanted them. And so, unconstrained people at ARPA—scientists, not generally military, though some

military people—could easily look at these and say, “There's got to be some value in being able to sit over the enemy at a thousand feet and see what he's doing.” The military had a lot of difficulty doing that. They preferred to go in a helicopter or a manned airplane. So there was the cultural acceptance issue.

I can remember going to a seminar in the late 70's or early 80's at Langley Air Force Base, where there was a lot of discussion about the value of UAVs. And, I can recall coming away wondering if we were ever going to get past all of this. It wasn't necessarily that the pilots were worried about their jobs, but it just couldn't catch on.

The Israelis demonstrated the value of UAVs in the Bekka Valley several times and convinced people that what really made it was the Predator.

The Predator was derived from the AMBER program that was run at ARPA in the early '80s. The program was very successful, demonstrated the ability to fly for very long periods with the same kind of performance as Predator. It became the GNAT-750. The intelligence community used a few of them, but the military never really caught on to that. Predator was then built. The actual Predator was not a DARPA program. People think it was an ARPA program because it derived originally from there, but it was put together by the Navy RPV Program Office. A very aggressive program manager in the Navy who put a development program together had it on a 36-month contract. Bosnia broke out, and it went out in the middle of its development contract. It went to war and was quite successful.

People were looking at the imagery as it was relayed. I can remember standing in the Pentagon, looking at the real-time Predator images in Bosnia, and that began to capture people's attention.

When Predator and Global Hawk both came into the most recent Iraq conflict, when we invaded Iraq, they both played major roles in the surveillance there. That began to bring them right over the hill. As late as 2002, I was still wondering if we'd ever make it on cultural acceptance of UAVs, but I think they're there now.

I: Did the whole idea begin with Johnny Foster?

Lynn: Oh, I suspect it did.

I: Because he liked to fly model airplanes?

Lynn: He always did. He still flies model helicopters. That could well be.

My earliest connection with UAVs was Kent Kresa, who I think was director of STO at that time. That's one of the offices at ARPA, and he's a close friend. Every time I saw Kent, he talked about how there were going to be UAVs everywhere; that every soldier would have an UAV. Now, this was back circa 1972.

Well, his vision was good, but 30 years too early.

I: Classic ARPA.

Lynn: Classic, yes.

I: Does it ever amaze you how far we've come?

Lynn: Probably not. As you live with it, it's like watching your children grow up. If you take a snapshot every five years, then it's horrifying as to the rate of change. On the other hand, if you see them every morning at breakfast, they look about the same every day. And it's the same with the technology, I think. If you stop and think about what things were like when you began to work—and for me, that's a half a century ago—then it's amazing. I can remember buying, probably in '64 or '65, one of the very first hand-held calculators: the HP 35. I gave it away to somebody who collects old weapon systems. But it had essentially no computing power. And then you compare that with the machines of today.

I: Cell phones, GPS?

Lynn: All of those things, yes.

I: GPS came from DARPA, too.

Lynn: The transit satellites started at DARPA. The Navy picked them up, and DARPA stayed out of it after that for a long time. So, I guess you can say DARPA was involved in the early days of GPS. The Navy and then the Air Force did most of the GPS work.

During the early '80s, one of the DARPA goals was to take a GPS receiver, which at that time was probably \$100,000, and to shrink it down to \$5,000. I can remember that was a very ambitious goal, and we got it down to something like \$10,000. And then, of course, when Desert Storm broke out, all of a sudden it began to be mass produced and get to what you have today.

I: The reason for the formation of ARPA was to prevent another technological surprise. During your tenure, did that apply? Did you "have to think very far into the future?"

Lynn: Oh, you mean—was it still a goal?

I: Yes.

Lynn: Oh, yes. Yes.

I was trying to think whether there was any technological surprise, and I can't recall one. There probably were, but avoiding technical surprise certainly remains the charter today. I think if you talk to any of the Directors, you'll find that it was high on everyone's list to prevent technological surprise and to be in a position to deliver technological surprise. And the latter is a lot easier. You can do that unilaterally. Preventing technological surprise takes two players.

I: What do you mean?

Lynn: Well, the adversary has a stake, has a play. They have an opportunity to go to technological surprise.

I: How does one see that far into the future?

Lynn: Well, primarily you're trying to exploit all of the technologies that might

change the military equations. For example, MEMS—what can you do with MEMS? What could the other guy do who has the option to do the same things, at least on a global scale? So, what can you find to do with MEMS? You don't really have to think in terms of technological surprise as much as what you can do yourself in a unilateral sense to, if you will, exert surprise on the other guy. So, you explore all the possibilities for military capabilities out of all the various technologies.

You think of what your own people know, what we could do as a weapons system. For example, power generation with a generator that's built out of MEMS, guidance of small aircraft with MEMS, and creating very adaptive mirrors. There are lots of things you can imagine you can do, and if you explore all of those, you'll find which ones you believe can be militarily useful, which means you now have to watch and see if the other guy did that, or if it's available in the stores, for example.

I: Industries have R&D. Does DARPA feel competition?

Lynn: I don't think ARPA should care. If it goes into industry it's still accessible to ARPA. Think of GPS, for example. ARPA managed to get down to \$10,000 for a GPS receiver. If it goes into industry and gets built on a wide scale, now you're down to, well, you can almost get it with pocket change.

The same thing is true of everything else. If it's something that you really want to use, you want to protect it from the bad guys. That's not always easy, particularly if you get into the mass market and build a lot of them. So, there's a set of tensions there, but there's no sense of competition with industry.

Recognize, of course, that ARPA doesn't do anything itself. It hires somebody to do it. It has no facilities, no laboratories, so it asks industry, or academia, or the government laboratories to do whatever it is, and sits on top of them so they do what the ARPA program manager believes is the right thing. But ARPA doesn't do any of it themselves, so there's no sense of competition.

The only time you get into a competitive environment is if you've dealt with one industry and want to go competitive on building some aspect of it. Then you get into intellectual property and other issues of that sort.

I: Why ARPA?

Lynn: Well, there is no other such institution. I've talked to people from Britain. I've talked to people from Singapore. There's a lot of desire around the world to emulate ARPA. Other people would like to have an ARPA, and have never been able to get it, so there is no comparable organization I'm aware of anywhere in the world.

It's a very free-wheeling organization. It has lots of characteristics that are important, not the least of which is lots of money. For example, if you take a typical problem or typical technology in a university and fund it at a \$100 K per year, you'll pursue that, and you can go a long way over time in understanding that technology. If you believe that it's valuable in an application, you probably want to put \$10 million or \$50 million into it and give it a very high-impetus attack. You need entrepreneurial program managers. You used the word "imagination."

You need guys who really can imagine and who are unconstrained by the system.

Typical industry people have bottom lines to worry about. They have programs and sponsors they have to worry about. There is no free-wheeling organization like DARPA anywhere that I'm aware of.

So, you ask, "Why ARPA?" It was created to stay on the leading edge of technology for the military and, I think, has proven that that was not a bad idea over time.

I: Are there some problems beyond the scope of ARPA?

Lynn: Oftentimes, there are, of course, programs that get started to try to do something and fail to do it. And so, yes, they're beyond the technological capability. Usually, they can be turned into something useful.

There are lots of cultural things that stymie ARPA in solution of a problem. That is, the transition problems of the Services. I can think of a program, which I won't mention, but it led what the Services were trying to do. It was a good solution, demonstrated all the various capabilities. It was in direct competition with a program the Services started a few years later, trying to retread the same ground and not doing as well. And then it died because it was in competition with a service program. ARPA typically won't fund something that gets into that kind of a bind.

I: Are there problems that come up?

Lynn: Sometimes there are technical problems. Things get tried. There were programs that were undertaken in the early '80s that failed to achieve their goals and didn't transition because they cost too much, or didn't perform well enough. They may have demonstrated their goals, but not adequately to keep going. And they pop up again with a new technology ten years later and can do it, and do it better, and then will make the hurdle at that point.

I: What, if any, is a role DARPA can play in the War on Terror?

Lynn: Well, I think ARPA is playing a substantial number of roles in exactly the same way they've always done it. They look at the problems going on and try to address those problems with the technologies they have available, or can find. So, they are, in fact, doing that. I spent the last two days listening to things they were doing in what amounts to the War on Terror, but not limited only to that.

I: What's going to be the key to DARPA's success in the next 20 years? Or even better, in the next 50 years?

Lynn: High-level support.

My belief in what's going to keep DARPA going is keeping it small, keeping it flexible. Don't let it grow too large. Make sure it sustains the most senior-level support. That is to say, that the Secretary is aware of it and supports it as a function. That has always been the case.

Lots of freedom from the bureaucracies. If ARPA chooses to do a program and it's being done someplace else, don't get the anti-redundancy

warriors out to kill it. As long as ARPA does that consciously, then there's probably a reason.

Keep the people turning over. Keep it such that your budget is flexible, so that you can kill programs and put new ones into being. The people, the small size and flexibility, and the top-level support are probably the most important things. There are several other characteristics that are important, but not life-threatening.

I: The sense of excitement. Does that still apply?

Lynn: Oh, absolutely.

I: Does something come to mind?

Lynn: No, but there's nothing that inhibits that process. The Director has authority over the funds, is obliged to keep the Pentagon informed, of course, but typically is never interfered with, so that if it gets to the Director's desk, he can do whatever it is.

Now, he has to do that within the limits of the laws, of course, but there are very few laws. And Congress is often kindly disposed to giving special authorities to DARPA because, for the most part, DARPA has never gone so far astray that they blew them up.

But I believe firmly that if Tony Tether today sees a great idea coming, he can have it funded from a practical sense in probably a matter of days, and in concept in at least a matter of hours.

I: Wow. Why was Congress eager to keep pumping money into DARPA?

Lynn: The Congress tends to punish the rest of the S&T system by giving the funds to DARPA. Congress occasionally thinks of pork and ARPA works very hard, if given some pork money—typically to make something useful out of it, rather than simply accepting the fact that it's pork and sign up for it and do it. So, the Services, by virtue of their size, are oftentimes disappointing to the Congress. They'll take a program on, and it doesn't go at the pace Congress thinks it should, or it doesn't accomplish the thing, doesn't do whatever it is that Congress sees. Now, when you say "Congress," you're talking about the staffers mostly. The Congress, itself, I don't think, pays that much attention. But the solution to their problem is "give the funding to DARPA."

But there is a continual trend on the Congress' part to put more money into DARPA and less into the other Services. And as I said, that's a bad piece of business. It makes for a bad relationship between the Services and DARPA, amongst other things—aside from getting DARPA too big.

I: What does DARPA pork look like?

Lynn: Say I'm a congressman, and I want to support a particular university that happens to be in my district—surprise. I want to give them \$10 million to do something they wanted to do. Obviously, the university has been to see the congressman and has gotten him to help, and so they will give it to them. You know, pork is the same whether at DARPA or any where else.

They will write into the law that this \$10 million is to be devoted to the research of X, Y, Z at a university no farther than ten miles from ...— and so forth.

They'll write it, not ever naming the university, but writing it in such a way that it can't be anything else. That's typical in these things. There is typically 10 percent of the budget that gets added with pork, and in order to fund it they've taken away some of the programs.

I: What was your relationship with Congress?

Lynn: For the most part, it's a gentleman's society. The congressional members very rarely get involved in any of this. I did have one significant problem that was really a constituent issue, but it was cloaked as criticism of the way I was going about things in terms of an investment strategy.

That was, I think, the only one I can think of that was unpleasant during my two tenures. For the most part, you're dealing with the staffers. You very seldom deal with the congressional members themselves, and the staffers have a lot of things to pick at.

One of the things they always want is more control. So, for example, ARPA has something like 15 program elements, and each time you have a program element you can't shift funds very easily from program element 1 to program element 2. So the more program elements, or PEs as they're called, the less your flexibility and the greater the staffer's control because you have to go back to the staffer to get around that. There's that kind of tension that goes on, but it's, in general, a well-understood game people deal with because they haven't got a choice. You know, you try your best to keep the staffers informed so they tend to be on your side, rather than the other side.

I: So it's to DARPA's advantage to stay out of the headlines?

Lynn: I believe so. Yeah. ARPA has over the years not gone to the man on the street and asked him if he has ever heard of ARPA or DARPA, and the answer—in spite of the ARPA Net, which is almost always known—is either, "Sure, I work for the defense industry," or, "Never heard of 'em." Those are sort of the only two answers. Most people have never heard of ARPA, and that's probably a good thing.

There is nothing to be gained by being publicized. There are lots of newspaper articles, lots of clippings, but they're not particularly noteworthy. I think the average man on the street probably thinks of ARPA as something he read about six months ago, that it's another one of those government organizations, and he doesn't know any more than that.

I can't think of any good reason why good publicity would be useful to DARPA, and bad publicity certainly isn't. So, I believe you're better off with no publicity.

I: Keep quiet and keep on the edge.

Lynn: Right.

I: What's it like working there?

Lynn: It's fun. That's why you get so many good people at ARPA. They come because it's fun. In a fairly unconstrained way, they can do things they could only imagine before.

I: How did it come to be that you ended up Dr. Cooper's Deputy?

Lynn: Bob and I both came from Lincoln Lab, and so I had known him for—let's see—20 years, something like that, or 18 years, I think. So, we had known each other. I don't know why he chose me, except I was handy—I was already in Washington. He had just come from Goddard Space Flight Center at that time. I don't know why he chose me. You have to ask Bob.

I: Do you remember what was going on at the time?

Lynn: Bob was a busy guy, and he tended to stay to the outside of ARPA. He was also the Assistant Secretary of Defense, so he tended to work the outside of DARPA and leave the inside to me. And so I got to worry about most of the programs, obviously keeping him informed. Bob and I were a good team at the time.

As you perhaps know, when we left DARPA, we jointly founded a company. Now, there was a second Deputy at the same time, Chuck Buffalano who was the third founder of the company. So, we have remained close. In fact, we have a dinner engagement in a couple of weeks.

I: The technological buildup leading to the collapse of the Soviet Union— were they throwing buckets of money at DARPA?

Lynn: No, no. I think the budget was about a billion in those days. It was substantially smaller in the early '80s than today. The Cold War was going full blast. Nobody believed Russia was going to collapse. In retrospect, it was in the era leading up to the collapse, but that didn't occur to anybody I knew at that time, and I don't think it occurred to anybody else, including the intelligence organizations.

It was a fairly stable time, with a stable adversary, our favorite adversary. There was an awful lot of work going on. About a quarter of DARPA's budget was going into directed energy, and another small fraction was going into space technology of one kind or another. And when the famous Reagan speech came up, it caught us all with our pants down. All of a sudden, the SDIO was created, and we transferred all of the directed-energy and its budget, and all the space stuff and its budget into SDIO.

A personal comment and you can find out whether Bob Cooper agrees or not. I think DARPA was probably better off with this transition of major programs over to SDIO. Directed energy had begun to run us out of control. We were spending money hand-over-fist. There was a lot of theology behind the space-based systems, which has been discredited in the meantime, but you were beginning to hold onto the tiger's tail and hoping you could keep up without getting bit. So, I don't think it was necessarily bad.

I: What do you mean "theology"?

Lynn: Well, there are people today who believe you can and should put up a space-based system with enormous lasers and enormous mirrors. There are estimates of the budget that range from \$10 billion if you're a theologian, to a trillion if you're not (chuckles). Nobody knew what the costs were. The things that were envisioned to go up would have required a new shuttle of much larger size and so forth. There was a theology against the Soviet Union that believed all of this was the right thing to do. That's what I meant by "theology." People who believed beyond the point where at least the facts were agreed upon.

The other program we had at that time that fit in the same category was Teal Ruby. I y once said that DARPA works in order to fail half the time—trying to do high-payoff, high-risk programs, and failing 50 percent of the time was a good rubric.

And somebody then asked me, "Give me an example of a failure." And the only one I could think was Teal Ruby. (Chuckles.) I couldn't think of any others because for the most part, failures either quietly slide away because they fail to reach their goals, get terminated in some form or another, or get converted into something slightly different that is successful. So, I don't have a list of failures.

Teal Ruby was a program started when Bob and I were *not* there. It started back in the '70s, was originally a \$20-million contract to put a large telescope in the sky able to track Cruise missiles. That was fundamentally what it was, and as I recall, there were about 150,000 detectors, which was a *tour de force* in those days. Nowadays, millions is the scale. And it was to be a single satellite for \$20 million that would be put up.

Well, I think when we came into DARPA, it had passed \$200 million in terms of the cost of the program, and it was still a ways away. Before I left the Pentagon to go to DARPA, I was involved in trying to kill that program, and the DARPA Director, who was Bob Fossum at the time, defended it and got enough support so we couldn't kill it. And so when we walked into ARPA, Bob was of the same mind. When we walked into ARPA, the first thing was, "What do we do with—Teal Ruby?" And we succumbed to the usual: "There's so much money sunk into it now, we can't afford to kill it." (Chuckles.) It finally died at \$500 million.

I: Things that moved out of ARPA—there was SDI—anything else?

Lynn: No, that was primarily the whole Directed Energy Office, which was largely focused on three programs: Alpha, which was the laser; LODE, the mirror; and TALON GOLD, was the pointing system that constituted the high-brightness lasers. The other things moved out were some of the Strategic Technology Office things that were basically space telescope and things of that sort.

I: The famous Reagan speech. What was it that started the whole thing?

Lynn: That was when he had been talking to Edward Teller and decided to go ahead with a directed-energy space energy that would shoot down ballistic missiles. It was the ballistic missile defense. I think it was in 1983. Nobody knew he was going to do this. It was a surprise to everybody involved. I think it

was Shalikashvili. Who was the Chairman—no, no, it wasn't—it was Crow, Chairman of the Joint Chiefs at the time. I probably got the characters mixed up, but in any case, nobody expected this. Nobody was aware he was going to say this.

And at least half—probably more—three quarters of the people who were technically aware of all the issues did not believe it was feasible or practical. So, Reagan created SDIO, and to the surprise of everybody around.

I: Was there a scramble mode in the Agency?

Lynn: Oh, there was a lot of effort to transfer the budget, identify the pieces. We worked with Jim Abramson as closely as we could to get it there. We disagreed with the directions he was going in, so there was cooperation between the new SDIO management and DARPA, but it was not mutually supportive. We did what we were supposed to do to get the programs transferred and the people transferred including the whole directed energy office.

And, of course, the bookkeepers and the people issues were all major issues at the time, but nothing that had any heartstrings attached to it.

I: Anything send a shockwave through DARPA?

Lynn: No, the budget for transferred programs went with them but none of the existing programs that remained got cut. And, I don't recall what brought the budget back up again, but something did.

I: Always does.

Lynn: It came back up 10 or 12 years later, it was shockingly high to a new Director. (Chuckles.)

I: What were your feelings when you handed over the reins?

Lynn: Well, of course—as I suspect most do—I felt that the programs I put in place and left in place were the right things for ARPA to do, and so I tried to persuade my replacement of that. Some yes, some no, of course. ARPA is a very personal agency, so what Frank liked of what I was doing, he kept. What he didn't like, he declared victory and stopped the effort. And that's not surprising. I suspect that happened to him when he left.

I left as much as I could; gave him information on what I thought was important, what I didn't think was important, which people I trusted most and which I didn't. And it was a very friendly change of command. Ran over a period of several months. Frank was there, and I was there at the same time for quite a while, until I finally appointed myself to go over and work with the Undersecretary for my last couple of weeks, so that Frank could get (chuckles) his hands on the throttle.

I: Did you feel you left a healthy organization?

Lynn: Yes.

ARPA's always been healthy, in my view. I guess there were some times in the Vietnam era when it was a less-than-happy organization, but that was true

of the whole Defense Department in those days. And I was not coupled very tightly at that time.

As far as I know, ARPA's been pretty healthy.

I: A sense of melancholy or relief?

Lynn: Well, I left voluntarily (chuckles), so there was no melancholy. No, I felt I had been there long enough. I am older than some and felt it was time to quit and go back to whatever else I was doing. So, no, there was no melancholy. It was a change, you know. All of a sudden, you go from being very rich with lots of people who will at least listen to what you have to say, to being a lone voice in the woods. That's inevitable any time (chuckles) you leave a position of responsibility. But, no, I had no melancholy. I thought it was time for me to leave, and I left. I had actually announced my intention of leaving several months before that.

I: Looking into the future, what do you see?

Lynn: I think that depends entirely on who the Directors selected are and whether or not they get the full support of the secretaries. I suspect Gates will probably never get around to ARPA, just because he's going to be a busy guy. But you have to know who the Directors and the Secretaries are going to be.

It's actually been remarkable you could keep that kind of pressure on for 50 years. I hope the system is smart enough to keep the process going.

I: Directors from all sorts of areas.

Lynn: There are a lot of smart people out there, and with the atmosphere at ARPA, you get smart people with broad knowledge in charge. The organization will warp them around to being convincing Directors.

I: Are you comfortable to talk about the JASONS?

Lynn: Sure, but having just read the book, I suspect I'm probably more friendly to the JASONS than I read my friends were.

I: What was your relationship with them?

Lynn: I thought they were a very smart bunch of people, and they were useful. I had no hesitation in thinking about problems for them and listening to the results. I believe that during both of my tours, I went through their summer study brief-outs every time. I thought they were worth listening to.

I once made myself a skunk at the garden party with the JASONS when they asked me what I thought of them. And (chuckles), I told them (chuckles) in very candid terms. I thought they did a remarkably good job on physics, some of the physics problems, and deep technical problems, and that they did a lousy job on system design, which they loved to do. They took some slight offense at that, but I think I'm still friendly with most of them.

I: Any specific solutions they came up with?

Lynn: I really don't remember. And they were never finished solutions. They

specialized in telling you this would work, or this wouldn't work, or this might work. So, they were fledgling things rather than finished products, generally. But I had a lot of respect for them and, therefore, didn't cause them too much trouble.

I: Were they still under the Science Advisor's office?

Lynn: But they worked for ARPA at the time.

I: You had direct contact with them.

Lynn: Yeah. I say "worked for ARPA." That's probably an overstatement. The JASONS worked for the JASONS. In fact, one of the tensions is that they do what they please. ARPA funded them—that's a better description. DARPA was the sponsoring organization and funded them, but they managed themselves.

I: Any last comments?

Lynn: I hope ARPA continues to thrive. I think the rules that make it successful are clear to everybody. They've been clear to every Director I've ever talked to, and I hope it continues that way. The other key ingredient is the Secretary, and I hope he continues to understand the value of a renegade organization.

I: Mr. Renegade, thank you.

Lynn: (Chuckles.)