Barry Boehm
Oral History
Interviewer: Leonard Kleinrock
Date: 11/20/2014

     Barry thank you for joining us here. But we want to do in this interview environment. Sixty seconds. Very young that. That allow those great be accomplished. So many years. So let's begin by jet engine. Very quickly. Here. Please if the today. As we know so much what you don't get back to that. OK I'm Barry bang my. I joined Rand Corporation in one nine hundred fifty nine I've been that General Dynamics down in San Diego for a few years and worked on rocket trajectory them and things like that and. Basically did engineering programming for for the deal of time. And I think. You know Rand was a pioneer in various aspects of computing like having the Johnny at computing. Computer in the don't act opens. Opens. Software systems off. You know one of the early interactive thing. Than and then some of those got DARPA interested in sponsoring research at Rand and so I do that came things like. The the graphics program the the rand tablet to where you can do. Natural. Handwriting input then. And the like and. So one of the things that Rand was interested in was people trying to use this. This. DARPA technology to do useful things and. So I had this program that calculated the. The trajectories of rockets and there are a bunch of engineers that flew rockets out of mountains or off airplanes and things like mad Rand was always doing these wild studies about. Different ways of doing things and. So we decided we do an interactive graphics. Version of it where people would use the rand template to enter the parameters of the model and. So this turned out to get me more familiar with with a lot of the rand reset of the are preserved that the brand was doing. Included and a lot of the graphics work but also and included and started to include things like networking and when Paul Baron got involved in the looking at packet switching and then various ways of. Primarily in. Addressing defense problems with Rand was basically working for the Air Force. Originally but eventually it got to working for DARPA's Wow. And so what one of the big concerns that. The Air Force had was survivability of command control and communications and. If you had a bunch of of. And in this particular case the. They were employing a bunch of Minuteman. Missiles and. These were being connected by a regular kind of wires and things like that and and basically it was fairly easy to sever the of the communications and disable a whole bunch of the. If if your rockets were were sufficiently accurate so I got very interested in what Paul Baron was doing and. And doing a companion project that was looking at. Taking Minuteman command control configurations and trying to use packet switching to see how could you do and after writing techniques that would keep it. Survivable in as he went along and you know this was one nine hundred sixty six. And so we we did a bunch of things that. That. And again you know there were people. Who were and had Rand doing. Artificial intelligence and Fagen bomb would come down every summer and be a a a summer consultant and the like and. And so we started looking at adapting writing them than that and that sort of thing with that how can you learn from the traffic that you're seeing what's happening in the rest of the network and. And that sort of thing so. So again this was some DARPA technology and AI that was influencing the how we were looking at had the running algorithms and the like. So you know that went off by in and was militarily. I think it

started around one thousand nine hundred fifty four but I could be wrong on that. Dan and I think a lot of it had to do with the will swear and Keith uncle for in particular. Being involved in in a number of the Defense Science Board studies and and things like that then and thing other there are some technologies that Rand has that that of the look like they could be valuable for DARPA and. So. You know computer graphics was not one of those and. So people like Ivan Sutherland were interested in adding Rand. Do things that were. I think the most unique thing Rand had at the time with the tablet. So. So he was interested in seeing what can you do with three hand kind of things and not just character recognition but the looking at the. Digital sampai build than and the like if you're looking at a defense. The configuration you know it would have the ways around and. And that sort of thing. So I want to contact. Now. Well. A ventilator. Yeah I had the. It went to I forget the the. The sequence of the when paler and and. Yeah. Originally Willison and and Keith were talking with look lighter. So that it went back at least that far and I never did and I know I don't I've read stories of of them about what is the influence was in things like that but that's about it. So you back with I understand by. How much interaction. And so on so fundamentally I was trying to put this interactive graphic version of the rocket trajectory program man. And. WILLIS And he said yeah you ought to go back and talk to the people that are doing graphics and. So he mean an appointment with so that I went other Len and. And sent me to look at what they were doing at Lincoln Labs with with interactive graphics so. So basically this was a really good perspective. So we did come up with a maybe burgeon that was called graphic rocket. Then than it had with use by the ran into nears. And they found that they could get their work done a lot faster and explore more options per day than then than they had with the batch processing that we were doing in that they could visualize the trade off so we would come up with the range payload tradeoff curves and things like that so. Sold the business that got the DARPA interested in the fact that it was being used for things that help people analyze rocket trajectories and rocket mission them and the like. We was directing which would think knowledge. Graphic. Interactive. Application. Guy. Well what what happened was that we we found that people wanted to reconfigure the the. The program and in various ways. And. So what we basically came up with was it was a Dewey builder and in the river there are people that want to do use it for medical problems them and has anything that had different league wage and that could evolve and. And the like and then so. We build a system called Pogo for program where you had a graph of. Operations and and. This got used for economic application then medical applications and other defense applications and and the like and. So it was the. It was it was interesting to do it that early stage in the game. One of the problems was that the. All of this. Required a dedicated three sixty model fifty it fifty dollars an hour though it wasn't the kind of thing that you could. Commercially go out and and sell them. I did get involved with the sort of industrial graphics community at that time. People would love Boeing and Lockheed in all of the places were doing computer aided design with interactive graphics and. I think they were been benefiting for about from a month to the DARPA technology while you interact with ocean. Graphics. No Not really no. You know I have after a while the I'm I went away from doing the graphics things and. Became the director of something called the Computer Systems Analysis Group. So this was doing more of these command

and control kind of studies and got me into the networking and Minuteman kind of that working with Paul Barrett as well you know what are we talking about now. Or this is this is the still around sixty six I'd say. Now it was leaning means. This guy with me and. I think it was it was primarily. Paul Baron and myself and. There was some other people doing command and control things or the guy named Jack Craig that was involved. There weren't that many people really doing. Networking studies that there were some other people who were writing programs for PA and Joe Smith was one of those. My wife Sheryl X.E. go. Wrote one of the fourteen but humans of the pallbearer and theories of the like the one for he was doing some packet switching. What he was going hot potato routing at the time. So when you call and you see any means. I mean. Implementation post implementation. I remember some of them. And. And nothing with a B.B. in people and. Unlike gun. And I remember some of the. Some of the decision the the the the the. Look like they were sort of questionable. You know. They were building something that was the tightest possible inner loop. But you couldn't get into it to Mitchell What was going on and that sort of thing so you the one and make sure that there was a way to measure and learn and all that sort of thing so you were probably involved in that one. Well. So maybe that would be sixty nine. Leni before that. And you. Go. There was this series of meetings where Larry Roberts would come out and he was trying to come up the learning curve one you know what. What always Paul doing what was he finding where. Problems and and I have things like. What Paul with calling privacy. Came up in those and. You know one of the volumes in his series is called privacy and precedents or something like that. And so it was saying Aha How can you. Guard against the people. Tapping in the are minimal and command and control system or whatever it is and then finding out what the typology and what the the of the commands were to let off a missile and I have that sort of thing so. So there was a bunch of discussions like that that. You know Larry Roberts was interested in all sorts of aspects and. Paul had been interacting with the eighteenth tee and trying to get them interested in the literary one of my why weren't they interested this looked like something that was a natural for them. But basically they were comfortable making a lot of money with the traditional way of doing things and. Yeah right. You mentioned elements of security. I think what we think may she's attacked. Any for me. Action. There was a little of work that the will if wear and rain turn and how Peterson were doing some. Architectures for security protection and that sort of thing and. So those got didn't do what to what Paul was picking up in them and saying you know what. What are the kind of of of services that they have a secure system on a ham and again coming up with the auditing and authentic case and encryption and various ways that you could make the thing more secure. This were. Because the latter you never. Yeah. And so you know I don't think that. What the. I think what. Rain turn and help Peterson was doing was being done on a project ran the in the Air Force part of a random. But I did it with definitely something that the V. A pall that was getting thought about and and terms of how I would you put these kind of networks together. What additional services they would do you want to have to make it secure. How long were you involved. Playing. I mean it's like elements. I think probably in man. Nineteen seventy I stop working on it because I got to sign to lead a on Air Force mission analysis. That was called C.C. IP eighty five and it was basically a thing. What are the information processing implications of their force

command and control by the time it gets in the mid one nine hundred eighty and soul who have this got me. Working full time as basically an Air Force employee. And going to bars the Colonel's them and things like that and finding out them. And visiting the Strategic Air Command headquarters in the Tactical Air Command headquarters and I said I am Mountain Air Defense Command headquarters and the like and see what. What technology where they currently using. Where where the where were the strains on it. What were the kind of capability they wish they had but they didn't have them alike. And. The original. Thought Was that what they needed was a faster computer. But you know when we went. Keeping you from doing everything that you'd like to do it was more software it was getting in their way and. Who has the harder do. Took longer to build them they expected did add bugs that were hard to find and man. People would would build it and find that it was wrong and it was hard to modify and then. And the regional A They were using machine language which was with a very hard modify and. Then they went the unique languages like jovial that. That were non commercial and man. That was hard to find your VO programmers and and the like so. So up to the. The study primarily can. Concluded that the limiting factor on on Air Force command and control them one hundred eighty S. was going to be so I am software and. The or for to be doing more research and how to build software more reliably and them out of the building more rapidly and how to determine you know what what the real requirements were so we will hit we didn't get into a little bit of the aspects of software in the networking. Area and. And the security area and. Did come up with a an error for a software research program and. So I had at that point. I did have some meetings with the. The to the primary. Two star general who was the was running the supervising the study. General Chapman and the other one that was doing command and control and meeting with with Larry Robertson thing I here's what this study is saying and here's what. What we want to be able to do with software and saying you know what what are you doing at that wind. That would help. The Air Force. Do a better job of building in the book. This is fighting with a dolphin. Secular. OK it it came later. That was more. Seventy four seventy five. This was me and. Yeah basically what happened was that an after doing this study I wanted to do more. And I also this of one of the things that we did you do is have the pen companies do special small studies fourth. Some of them were saying you know what. What are we going to do with this blaze what are we going to do with pass computing what are we going to do with better software and. And some of them had some data and it was interesting to try to analyze the data and. So at one point. Tried to put all this together and summarize it in a paper the. Appeared in the animation in the seventy three and. And all sorts of people got interested in that. And there was a. A workshop. But I had the Navy Postgraduate School in the late seventy three that. Involved and. Bill Whitaker who was the lieutenant colonel at the time and became a colonel and was sort of the. The Air Force leader of the our eight a nested. So. So this. More chop was called the high cost of software and think what what could we do to improve it. Then one of the things would be better programming languages and. So that's really what got a to start it. So you know on the op interaction. Life investigation. Not necessarily in fact this so often the critical issue. Guy you know in the way in which these resignations. Play. Freehand. Yes. Yeah. I think give the. They were giving this mother leading people in the optimum and pretty much of a free hand which. In a way it was sort of

unfortunate V because they they wanted to use a waterfall model of defining ADA and and getting all the requirements right. Before you. Let out. Contracts to design to the requirements and things like that. And as a result the the sequence so process took a long time to mature and. And they didn't do and he prototyping. So that when the we said yeah we would like to have the a to do. Pass king so they can do a better job of concurrency and non-determinism and things like map and we want it they have the generic so that you can. Basically do. A general definition of what your computing is supposed to do but then you could. Instantiate the generics and say. In this case this deck. State vector is going to be seven and by seven rather than six by six or something like that. And now. So. But they didn't really look into what would happen if you tried to do past scene within this to generics. And when people started. The first compiler they would start doing these combinations and by and had it to the whole computer to trying it we think. Come. He searched for. I think. I think it would have been. Better to have tried to involve the the whole community and. And so it was primarily something that was being driven by programming language experts. And so if it had more people that were saying you know we're going to have to build command and control systems out of this stuff and we're going to have to put it on supercomputer is and things like that they. They might of done more. Prototyping in thing up. Yeah. Let's try to write an Ada program for the command center. Processing this in this places them are things like that we know making wine that allow me to interact. Maybe joke. Action. That's sort of the way it was you know it was direct interaction. It was not structured. So you know. Basically what happened was the idea it took the. How about for years to get the requirements right. And by that time. People started using C.N.N.. And then it became. Really the replacement for Fortran and jovial that. That that the commercial world was doing and. So. Unfortunately it was definitely a lot more or. Semantically strong and then see what the good. Me. Do a lot of bad things with with a C. program and a lot of the heater. Type declarations of them things like that that would avoid that. But. One of the things that. That happened was that. More and more of what. Idea the was was relying on included const props. And most of the cops products had bindings for C. and they didn't have any bindings for Ada and. So. So it was with the you had to do more custom programming needed to get an Ada program not mention some of the funding sources. Wow. Yeah for you mentioned. It. What he was charging affidavit was. Sure so I had egg again when one of the people that the got involved that was trying to get them or the community involved was Larry's ruffle and. He was at DARPA. Yeah. And. So up and. One of the good things about DARPA was that it did it relied on the services to be its agents in contracting and basically they chose agents that were doing complementary research and want to do and use this is a channel to get DARPA research into the service of and and get the services do. See where technology was going a little bit better and do more cost effective research themselves. So. So that that. That was what what Larry was trying to do with the with the ADA and. And he was also trying to do things that said you know we need more than a programming language in a compiler way we we need to support environment for this. And we need to test suites and verification and validation capabilities for it then and that kind of thing so. So he was able to broaden the. The of the and they should have been so. Office. Yeah. He was Program Manager. Oh yeah well. What happened was that didn't have to write

publish this data Mason article. A bunch of companies said yeah we're having a whole bunch of software problems and. Had asked me to come and give talks and and couple of talks lead to job offer has and. I really wanted to see if I could get more opportunities to really address the problems involving and software in the biggest software product that ran with five people and you could really study it for me and ran so. So I ended up taking a job at T.R.W. was the director of software research and technology. Seventy three game. Finding follow you. While we ran didn't have any of the ADA. Funny. But eventually. What. What I was supposed to do with the director of software research and technology was to. Do the best possible job with that with the T.R.W. independent research and development funds and so we. We did some experiments with the with the with with some of the irony fun. But I was also expected to. For every dollar of T.R.W. funds go and find three dollar the of government research funds to to beef up what we were doing. You. So basically in this case it was the the army and it was basically. They wanted an army secure operating system and they wanted an army secret database management system. And so we got the contract for building those in Ada and. This gave us the experience in in. You know what what. What you had to do with both ate it and what you had to do with security. Down. Though. Oh that was that again got us involved in. The the DARPA work and security and you know people like Ralph London that were doing. Formal methods and the are improving and then he was a Mose to them and can't remember when the Orange Book came out. But it was this thing with that basically said if you want a level three hear it a you have to have a mathematical definition of security and have a mathematical proof that your code satisfy the definition. Unlike film. So we got involved in. But to their people. Dop are funded people doing that kind of has. Yeah yeah. And but most of the fun in this particular case frame came from the Army. Where we started to get more. ARPA funding was in the software support environment. Area. While. At that time. Bill Carlson and see if trucker were doing the national software work and. Period I mean you had built something called the file for productivity system. Basically. Included something that that and help. The the whole of the various tools in Iraq or a. It did had a master database of all the things that he did. This was something that low open a who did that after he graduated he came to T.R.W. and helped us build the. The software productivity system. So Steve Cochran Bill Carlson were interested in this. And some other people like Tim Standish and had her by and were doing some really good work and software environments and. Lee Auster while who came to Irvine about that time. Han. So we came up with a concept called Arcadia which was sort of the next generation. National software works kind of thing. That would involve having the the master databases and up and trying to tap into various other our protect knowledge ease my K.-I and think you know what. What can you do. To analyze all of the things you're putting in the master database to to detect the inconsistency is or anomalies and and that kind of interaction. Yeah. Yeah. Yes for the mechanism. And had it off tomorrow. Yeah. Yeah basically they they would assign a program manager to them and original A It was the was. Carlson and the proper Steve went off and did other things. And Bill Carson. Rotated out of DARPA So the people that we started working with the most were Steve Squyres and Bill sir less so now. This is nineteen eighty seven eighty eight. And I know that. Eighty six eighty eight. Yeah. It was the right interaction among. Yeah. And. And I got us involved in a number of other

things that. Like what what what I read awful was doing he he put together a program called starter for software technology for adaptable reliable system and. So in this case. He was the trying to do all of these other things like saying you don't you need more than a programming language you need a software support environment. So Arcadia was a candidate for a software support environment as part of the Stars program and Ada was part of the Stars program. Actually you know on that no those were the two main things. Again one of the. Difficulties was that the bill that a current day fishery were in charge of of the. And Vironment program and then they wanted it to be a no I went for a to programming and. Again this was unfortunate it would have been better if it were more language independent and. A lot of the things you do at the front end in terms of requirements an architect you're good traceability and consistency checking and the like are really. The. A to type declarations help. But. But they're there more when you get into the programming and then when you're doing the architecting. And the like. You know quite a few. OK. So again and some of them. Larry dreadful was was the lead. There was a. A really big. P.-I meeting that within the rally or Chapel Hill North Carolina. Which at this point. But. But basically this. This brought together. Everybody that was getting. Either ARPA or made your. Research funds from from other. From the services and also some people from industry. Basically were building environments like we were here W. and I.B.M. was building environments and lucky Martin was building environments and. And that's what I think so. So yeah he was saying out we we want to do a better job IT requirements we want to do a better daven architecting we want to do a better job but programming and testing and configuration management and qualities aren't the only thing then. And all you people have stuff that brute. To bring to the party and we want to try to make sure they get done consistently and and synergetic lay and. So this was a weeklong workshop where people would go off and break up groups and address this kind of problem that kind of problem and report out on them and things like that. So. There were there were a couple of similar kind of things but this was one that sort of covered the whole whole field of. How do you want to support software the best way possibly can. And. Some of the other things we're getting passed on to. Some of the other program managers like Bill fearless So we we would have the. Arcadia meetings with with Bill's hairless and then say here here's what we're looking at in the in terms of architectures. Here here's what we're trying to do in terms of sign in or operability of tools that were designed it or operate with each other that. What what kind of architectural mismatches were there and then how come to resolve the you through wrappers or connectors or. Various kinds of mediators and the like so. So so and and you know Bill for less would have the P.R.I. meetings where we where people would get together and and and. Tried to see you know. So. So you know. At that point they were sponsoring work on on architecture is they lock em up with Stanford. And they are all in the Mary saw it that kind of e-mail and the like and each of these people had some very powerful ideas but they they wouldn't really in our operate. To know our benefit from each other go on with this. You feel that. This life. Time. I hear. It was. Compared to doing work for the for the Army or the Air Force it was wonderful. You know. They basically they they gave you a lot of freedom there there weren't monthly reports that you had to fill out the said what to do last month and what are you going to do with next month. And the like that nobody ever read. And.

Fundamentally the. The the way that the that you were incentivized to make progress was that these P I meet. And the I'm meeting that everybody was supposed to do a demo of what they done since the last P I mean the the the the the standard story was you're only as good as your next demo and so when people do a demo they go home and relax for a while and Whoops another P.I. meeting is coming up with their or invent some new things to to demonstrate. Then. So it was something that gave you freedom to just sort of reflect for a while but then. Based on the reflections. Go and work real what really hard to come up with a good demo for the next be I mean it was a quote fresh paint and official in your mind. You know when when when I got there and ran the offices as a good management practice and. You know you would find that. Besides the P. I'm eating the you you do site visits and. But you do try to give people a couple of months notice that I'm going to come by into a side because it then give them a chance to work hard to demonstrate something good. That's going to. You into the mission. Now that you. OK so. So basically I think out and Jack Swartz was leaving as as the. The. Office director. And basically. I think partly through Steve's wires and Bill fearless. The. They suggested me to Craig feel that the candidate. So I went and had a couple of interviews with with Craig and. And you know. One of the things that he had been concerned about was the jack forth with a tremendous mathematician a deep thinker but he was also a micromanager. He basically. Wouldn't approve something until he had thoroughly analyzed it then and the like and. And in a lot of case it wasn't the mathematical correctness that the VI's looking at the in the eye and the like it was here it's six and them. And the like and. So he was in the process of of. Reducing the the in the DARPA investment in AI and this. Fortunately he didn't do it by the time I got there and. So what I did was to pull a bunch to the Feigenbaum. Then the rod readies and then the like together to say. You know what does a good rationale for thing you know I did what are the benefits that I have is providing and will justify not just keeping it where it is but. But increasing its IT support and told me they came up whether a bunch of good rationale than. And Craig field was OK it saying you know let's let's put the money back in the air. And the other was was really trying to delegate more. And say OK. Fundamentally we will have competition for funds in that they are in the the office only get so much. And we know the DARPA has this web thing that that says every year you stop doing twenty percent of the work and then gives you twenty percent of the budget to go do things and and. So everybody will have to come up with with a good rationale for what they want to do. And. One of the other really good things about DARPA was I said and. So this was information science and technology it was basically. It's still as Board of Visitors. And so you know people like. George Howell Meyer and Feigenbaum and run ready and the like would meet for a couple of weeks in the in Woods Hole and go through investigating some new research direction. And and. This was preceded in general by I think couple thing that would happen in the spring where people would do a first got it down what. What the talent isn't promises of of this research direction were and some questions that ought to be discussed at Woods Hole and. So through that I had been familiar with with the criteria and that basically says. What with the problem you're trying to solve. How the being done today what are the short falls and how it's being done today who cares. How much is going to cost what are the risks and now. So we basically use the high on our criteria to evaluate people's proposed new

projects and. So. And in a lot of cases. What I would find is that the things they were proposing. Had a good rationale. But then they would get some proposals from P.I. is that the were doing things that looked better to Bam And then what we put in the proposal and so. So I didn't want them to just sort of stick with what they've proposed and but the occasional lad become surprised that. Steve Cross had said he was going to do this and now he were doing that and no. And it turned out been a lot of cases the doing that was something that had spectacular results. So I don't know you're familiar with the dart. Project. It was something that was using the AI people to do. Constraint based planning for transportation planning for. D.O.D. logistics and mobilization and deployment and. And all that kind of stuff and. What the the the D.O.D.'s main way of doing this was something called the time phase force deployment documents that said Yeah. We have so many transport planes we have so many ships we can call on Fed Ex if we need them and then and things like that. And basically one of these to be fitted for doing a particular supply mission took. Four days to to produce and. So what Stephen and Winston and M M M I T and some of the people that. And Carney were able to do is to. Come up with a constraint based planning thing they could do it in three hours rather than three days. And this was in one nine hundred ninety one. Which is when desert field came and. D.O.D. had to get half a million troops over the Middle East stand up. One of the things they did was confiscate all of these researchers Sun workstations that could could run this the start programs so that they could use it to more rapidly. Do the tip feds and get the stuff over to the mentally and. They did replace the Sun workstation it. But. But again it's the kind of thing that if you gave the program managers. The more leeway they they could find hype. I pay off kind of thing. Well. Yeah I'd lay down. Well yeah I said mention they the only two. Pieces of training I got and becoming another office manager. The Been talking to Craig fields he said the other there are only only two primary things that you need to. Keep at the top of your list and one is that if you succeeded one hundred percent of your project you're not doing your job. So we were supposed to fail. The lot of cases and it. But basically if you failed you were supposed to do some kind of failure rationale that you know was there a missing technology there and that Goldman. Try to mature more rapidly or was it an architectural problem. And where they're better architecture that might have that made it go better and that sort of thing. The second piece was his suit is one sentence. Principles of ethical behavior which basically said. Whenever you make a decision just think about the possibility that that decision will be reported in tomorrow's Washington Post. So this is this is really something that makes you very careful about of oid conflicts of interest or over promising on things and the like as. Simon. Well. One of the other things the that I inherited was the of the of the Larry draw for of Bill Whitaker's Stars program. And. At that point it was still trying to do everything in an ADA and. So what we ended up doing was saying we're we're going to. Change what the the three. Prime contractors that we're building a to environment. Were. Boeing and Unisys and I.B.M.. But it was the I.B.M. federal systems of isn't it wasn't by B.M. Toronto who was building commercial support in Vire so that we basically said. If you want to stay in this program you're going to have to team up with your commercial suppliers and build something that they will be willing to sell. And. In in two years we want to have. We will. We will identify an army and navy in an Air Force program that will use your environment and

and and measure how much better it will do in productivity and quality in the line. So owing didn't sell. Support environment. But they teamed with Digital Equipment Corporation which did. Unisys did but they weren't all that competitive so they did a strategic Procter tip with ULA Packard So so basically we were able to get it to be more. In the kind of commercial mainstream. And more likely to be used and sold so so that. That turned out well but. But again it was. It had so much data legacy to it. It was. You know it was it was that never made the the top of the list when when I.B.M. and deck and you look backward were outselling environments and most of the marketplace was gorgeous all that sort of thing. The other thing that. I inherited was the Software Engineering Institute. And again. This was. Another major. And it to do. Where where Dr made a huge difference. Which was that. Basically it was the. The time that the the the the Morris. Worm came in and I messed up. You know. And so when I got there Steve Squyres and Bill Thrillist were working with the S.C. I had to get them involved in building something called a Computer Emergency Response Team. Which turned out to be a super investment because I see I hired a bunch of people who are really good it. At diagnosing things they were funded adequately enough that they could build a network to warn people of breakin than Trojan horses and things like that then they can build an infrastructure that would give people advice on on how to fix the security holes. And that sort of. So. So basically the. The the. The cert and and its services are now about two thirds of the sci's but. It's become something that the part of Homeland Security your. Depends on all sorts of other countries are getting the SCI they help them secure things and I'm like so. So this was another really major breakthrough where a couple of of proactive. DARPA program managers. Found a place to address a lot of these critical security prop. How much. Catalyst. Yeah away it was really the catalyst. Did made a lot of headlines them and at the expose a lot of people that wanted to do things better and. So there was an opportunity for DARPA to jump in there and then to. And it was was doing. Still research on formal methods and then those kind of thing then. And looking at. And supporting some people who were trying to do more secure databases. Management Systems and in the like God but basically. Yeah. No nobody else. Came in at the cradle class level two to really address the problem. So again it was a major coup for dark but to do that. Back question. Reihan had a contract to do some climate that. They spent a great deal of money on the U.C.L.A.. I.B.M. mainframe. Which I found rather interesting. Right about that great. Oh. And it seems to me that maybe the first commercial use of the OP with exploration to that. Money was being spent. They have another location over the nest. You were involved in that although your Where was going on with the large transfer of work and find for us more that works for you know twenty byte wage for you know. Yeah. And yet it was a major. Offload. No I wasn't the where of that particular project. But I was aware that people were trying to. Again the other the Larry Roberts vision was that you be able to do interactive graphics that they might be if you wanted to from here. I'm not going to think abt second thing is you mention security and the reaction of the mob is for help and you know. Was that the first time we saw it. Concerned about protecting the net. Against various kinds of their favorite factions. Be good at not a lot of attention to network protection in the seventy's and maybe you can explain it. I thought about what was the thinking about the need for such network. Protection in the early days before. So the reaction. Coming. You know I think most people

who were using the ARPANET. Where are using it to collaborate with with fellow researchers and and. Basically what he was motivated to slow things down or break into them there are plant Trojan horses in them and and that sort of thing it was yeah everybody want to get their work. Anybody wanted to capitalize on things that were going on elsewhere and tap into the more they help their their research go along so you know when it was when I was there. It was at a time where DARPA and S.F. were of going through all of the. The procedures of transferring the ARPANET into the Internet and then having it run by an S.F. and DARPA would continue to supply a lot of the fun that would improve the capabilities and all of that. But I think. There wasn't a lot of attention that was. Being drawn into looking at what is going to happen if this thing is being used commercially and it's going to be used by. Annie buddy who wants to and then anybody who has a bone to pick with the with somebody and. So it was really just the I did. Getting the technology to work was was was the top priority. And then and. Things like security were sort of second order things that. Well they they became first order pretty soon. I think. Military. I think. My son. Yeah right. You know. So there was concern with the with the hackers from particularly Russia. Could penetrate that and find out secrets and slow things down and. And those kind of things. But I guess I think the the model was was was was different it was it was really trying to guard against the small number of experts rather than a huge number of hackers and. And that sort of thing. And if you could monitor what was going on and then detect certain kind of patterns that the that a small number experts would do that then basically that would address what you thought the problem was that you mentioned transferring and. I would go to high level meeting and basically say here are. DARPA services that we want to make sure are preserved and things like that. But I don't recall getting into a lot of the planning meetings that said you know what what's going to happen when you open this up to the whole world. And that's and. What about this issue. Back. That process. One of the. This was another interesting situation than that. We were getting. Suggestions from the White House staff and suggestions from people like Al Gore than thing. We do we think this is a good thing for the country and and way wow to go forward and doing that and. And so. What one of the things that you wanted to do was to make sure that. And any time you gave people credit for supporting what you were doing you were you were giving the Republicans good credit and the Democrats got them. So there were a couple of congressional hearings that we had. You know basically you would say. Yes Senator do. Goriot you you were doing some wonderful things but does so with the White House staff and then that all of these were coming together and I wonderful way to make this the way over the country. That sort of thing. With those does involve transfers and. You know. The other thing that happens between Republican administrations and Democratic administrations. Is that the. The name of the agency caned is going to Democratic and or the strays and it's ARPA and it's OK to do. Industrial policy. If it's the Republicans that become the DARPA never camp not OK to do industrial policy can. OK. What you know. And the situation has been evolving. Of late. Change. Funny. How. Say. Evolution. I think it did to some extent to lose some of it's the Greens of freedom. One of the really good things that are pay had was was creative lawyers. We had people like Rick done. Who would invent new contract fuel mechanisms called other transactions. You didn't have to follow the D.O.D.. Sets of

mill standards and they died of the scripts and then. And things like that and. And he was wonderful and if you ran into a problem that. Somebody was claiming that you were disobeying in D.O.D. directive X. Y. Z. could come up with a legal reason why you weren't an order. And that's what I think though. So if it. It. Compared to other defense. Agencies it did did did. Was a wonderful place to have a lot of freedom. But it. It didn't seem like. Some of the degrees of freedom. Were restricted. Like it used to be that. DARPA would pick centers of excellence like carving your MIT or Stanford or the like and then they were going to give you a whole bunch of money and. We're not going to micromanage how much of it goes in the software and how much of it goes into robotics or or or the like but we want to make sure we'll do site visits and see that the thing that we're interested in are still being pursued and I'm the like. But that kind of thing became harder to do with as time went on and more people were saying. You need to give everybody a prequel opportunity to compete for the. All of the fun the DARPA hands on and the like. And I think that the. That. Did. Fraction eight some of the research and reduce some of the degrees of freedom that. That some of the the the larger. It is still researchers organizations have had an in a way this was. Partially true and well in this. And some of the people that were on the the ice that committee were people from Carnegie and MIT and then and the like so there there was there was a little bit of sort of inbreeding that was going on there but. But it was in bringing a bunch of among a bunch of people who were. Category engineering members and leaders in their field and there weren't really they were late trying to improve the field and. And they they would recognise when you know somebody at Iowa State had a good idea that you'd have some fun the most to pursue the idea and that sort of thing. So. But the I did it did lose some of its degree the freedom and then as time went on and I got to be a bigger agency and that sort of. Now the kind of. Yes one for. DELEGATE. Things. You know. This is a man with. I mean when I was a dark for when I was at U.S.C. here and I mean you know I see often OK. Yeah. Yeah. OK. Now. Why do you find. How you for you. The of fundamentally. Does this. Trying to. I think. Balance the the. The tradeoff between doing your own research and collaborating with with the other people on the team. So this Arcadia project that we had. LOL open a toe was was basically doing. The master database part of it and. And. There was sort of a talented and saying oh I want to do this with the master database and remind people in the U. Mass people want to do something different with it. And so. So there were those kind of things where you'd say well. Lois can we figure out a way that you could get some of your goals done but the community goals done. And that we would usually be able to work those kind of things out. So you mentioned what you find facts. So the main thing that you find when you go from. DARPA to you who are city is that the decimal point on your budget moves to the right to places. So it would take me about the same amount of time to get ten thousand dollars of support for a graduate student as it took me to get made a million dollars of support for a program manager at DARPA. So it. It really. I made you. Made you aware that that down the there the whole old boy whole different ball game there. Eventually we did get some. I couldn't do got DARPA research for her eighteen months. And so but. After the yeah. Yeah. And September ninety two I think. And I am so so in ninety four we we became part of the. Software Technology part of the DARPA research program. Done phallus and was the primary. Program manager at the time. Bill for a list was still there for a while

and then he went back to CMU. And so there were some things that we were
doing in. There was a thing called the. Rationale capture. What usually
happens when you're doing the requirements an architecture for a. A
project is that you make some decisions then you write down the results
of the decisions and and then they would be to go into the requirements
and then you would just go off and and buildings from there. And what
you'd like to do is have the rationale for the decisions continue to be
there. And so if you say well. We could have done this project. Faster
and cheaper if we had very used a piece of software that we already had
but it's that the pieces but any code it would be hard to maintain and so
will decide not to use it. Later on in the project if you don't have the
rationale around then you're getting behind him but did you might say
let's go reuse that thing. And cause a big problem. So so so basically
rationale Kaptur with a fallacy. Megaproject that had people from. From
the Arcadia project. The that that I had been part of before I went to
DARPA. The. Layoffs are while you mass and Laurie Clark. Humanise and
Dick paler at her bind and the like got and. And a bunch of other people
that were bringing in perspective then another environment perspectives
and the like so. So again. What what we were trying to do with those is
to. Do research on on on the critical issues in and next generation
environment and and and the particular in rationale capture trying to
figure out. How how can you come up with with better ways of capturing
rationale than writing it down. And so in some cases we would be D.O.T.
people and then we would say you know. I mad we're all X. Y. Z. and then
I wanted to work this way because the simple make the the Navy were
better. Are things like math and and pin that to be the body of in from
our lead to bout the project that you were doing. Somebody wanted to say
yeah why why did. Why do we make this decision. You know what that what
Admiral X.Y.Z. said. Yes. Yeah that. Comment about. One comment about.
Well. It was it was really more the two years before I got back into the
dark dark dark a community. For those two years basically. I could do
things for research for the Air Force or the Navy or things like that and
we did some of that. Oh this is U.S.C.. Oh. Yeah. Shift. Well I as a an
ex DARPA person I could build on DARPA projects or propose and opera
products. And so. So basically I had to find fund elsewhere. When he came
back things got better. You know. But again. I don't think they were
quite as expansive as they were. And the eighty's. OK so. And so way.
Change. You character. The talent. OK. You know I want one thing that. I
learned from. Simon Ramo was that the. The best people and high
technology tended B.P. shaped people. They were very deep in at least one
technology but they were brought in that they could see what was going on
in some of the other technologies and see where they might help them.
And. So I think in a lot of cases we had some really good T. shape people
it and that is stuff that you know people like Bill Fairless will do
things that are really deep in programming languages and formal methods
but but he will also get involved in things that involve Well what
motivates people to do things in certain ways and in the like. And get
into social networking and. And so the military offers is that we had
and. Steve Cross and Eric mythology were again. Deep in in a particular
technology but also having all this. Army and Air Force experience and
being able to. I relate it to all of the other thing they knew him. There
the other is that the people tended to come with an agenda. And there was
something that they felt was. Could be improved. You know it was Eric
with all I had was the it was basically. Well he was also involved in

what we were doing in robotics and the like but he was very interested in. And then coming up with better ways of building product lines across the Defense Department rather than building. Dividual stovepipes where you'd reinvent the wheel several times and. So he came up with a program called the mains this effects offer architecture that. Basically said you know can we come up with a a an architecture for software in the missile domain in the command and control the main on the ship domain and the like and. And did and do create some technologies a really improve people's ability to reuse things and become part of the O.T. reuse in there to the same line. Another is really leadership that fundamentally. I found that sort of scary would be there. That basically I'd come in in the morning and I'd spend the morning getting briefed by the smartest people in the world in various technologies I think so all that much about their technologies. But somehow or other I need to do. Make sure they didn't go off to wild and in some direction. And the program managers were similar. Yeah. Here is this the. Air Force Lieutenant Colonel Steve Frost telling John McCarthy what he ought to do about a I have to go off. Yeah. But. But basically they had the chutzpah to be able to do that kind of thing and. So you know what were some of the other. Things you know. Well again. They they were people that had an agenda and were were committed to it. But. They were collaborative. And so again you know we had a bunch of off sites where we would get the whole office together and say. What what what going with how can we benefit from each other where where the new challenges and opportunities and things like that and. And a bunch of. Birthday celebrations and Christmas parties and things like that where you do you try to get the everybody together. And a lot of things where young people would get together and do things out of the office and. Thank you so by way summer. Second. Very successful. The. Cry. This is so funny. Help fix it. You know I think you know. One of them really was the reduced bureaucracy. Basically. People could get a good idea and and be funded within a month and. That doesn't happen anywhere else in the O.T. that I know of and. Other ones are I think. The tradition of of rotating in and out. Is important that basically. After about four years you you. You had a chance to simulate what your previous The predecessor had done. Stablish your own program get them moving in the right direction and. And and be reasonably satisfied that the agenda that you came there for was was as of now part of that ARPA strategy and things like that and that it was time to go off and do other things and. So. So I think. You lose something in and institution live Maria that way but. But you get fresh new ideas the. The weds that basically says you know your program is going to start decreasing and and. After four or five years it's going to disappear and. So all of this is a way to make sure that you don't get locked into a think this thing and GEND and just put it when there's a whole bunch of new opportunities coming. And yeah I'm now the chief scientist of the System Engineering Research Center that D.O.T. have them that. And yet we have five million dollars of core funding and basically we're using a wedge strategy that's a. First we're going to give you five years the first two years are full funding and then you go down twenty percent. And then after five years well I had. When they when you lose twenty percent. You can be part of the pool that's proposing new thing. So you can keep your agenda going in various way. But I think that's something I ever did from DARPA that. That was really a good practice to continue. Like you. Right. Oh I think this was the very thorough coverage of some notes I don't know whether I. I think

we did go into critical mass that he was fundamentally most or in S.F. they they never do anything while they do. Megaprojects. Yeah yeah. So it so again. What one of the challenges that you. You frequently have with. When and you know before we got core funding for the circuit we were doing individual products for individual services and and the like and. Basically they would last a teen once and your Ph D. student would all of a sudden be out of fun and. So. So what we've done with with the core funding is make sure that the up programs go on for five years so people can get a Ph D. well while they're on the program. And that's the kind of thing you could do it dark with that there was enough critical mass of the funding and enough duration of the funding enough opportunities to continue it. And are a new kind of initiative to keep people getting their research done so. So I add that that's the that was a major thing that DARPA did. And it continues to do pretty well. We've done a little bit about the. The strategic partnerships with with the services and the agencies but again this is something that. Work they stream way well in most cases that. So with with them that there ARE put a huge amount of money in it that at first and it was integrating networking technology in a virtual reality technology in a number of other real time technologies that you had to worry about and just and. But they had a deal with the army that said Yeah. As we ramp down you're going to ramp up than you're going to ramp up even higher than what. You're going to build a whole facility at Fort Knox where you can have two hundred virtual tanks and then put people through virtual battles and things like that. So the. Classified agencies are basically when we did image understanding and speech understanding a natural language understanding and the like gob. We would make a five year deals with them that said Yeah. We'll do the bulk of the funding at the beginning but will work on your problems and but as things go on your budget good figure and ours get smaller. So well that kind of thing with the various accessible kind of road. And I don't know how much of it goes on now. OK good. You know. Yeah yeah sure. Yeah. Thank you very much.