Oral History of William H. "Bill" Joyner, Jr.

Interviewed by:
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Douglas Fairbairn: OK. My name is Douglas Fairbairn. We're here at the Computer History Museum in Mountain View, California. It is November 3, 2014. And I'm interviewing William Joyner. Can I call you Bill? Is that the normal way to address you?

William H. “Bill” Joyner, Jr.: Sure.

Fairbairn: Bill Joyner. And Bill has a very long history in electronic design automation field. He spent several decades at IBM and then with the Semiconductor Research Corporation and so we're very interested to hear about his story and his perspective on the electronic design automation, the EDA, as well as the semiconductor industry along the way. So Bill, thanks very much for joining us, and delighted to have a chance to capture your story.

Joyner: Thanks. It's great to be here.

Fairbairn: So we'd like to just step back to the beginning. Where did you grow up? What was your family life like? Just sort of briefly give us a background of how you came to be into the technology business.

Joyner: Yeah, I've been trying to think about the history of that and trying to remember some of those pieces. But I grew up in a small town in the mountains of Virginia, Luray, Virginia, between two mountain ranges.

Fairbairn: Is this Appalachia?

Joyner: It's north of Appalachia. It's in the Shenandoah Valley of Virginia. My father was in the hotel business. He got out of college during the Depression and I think the job he got was as a desk clerk at a hotel in Williamsburg, Virginia, and ended up sort of staying in that business – he was a motel owner. And my sister and I grew up mostly there in the mountains.

How this developed I'm not sure either, but I was planning to go to the US Naval Academy. I had a congressional appointment. I think one of things that impressed my parents about that, it was free. But I didn't pass the physical. And my mother, also a William & Mary graduate, along with my father, said, "OK, sorry that didn't work out, but just promise me there's one school you won't go to." And that was the University of Virginia and that's where I ended up going, in the engineering school.

Fairbairn: So growing up, there was no technology background in your family?

Joyner: There was no technology background in my family. My two children didn't go into technology areas either. So I guess I was the discontinuity.

Fairbairn: You were the exception, huh?

Joyner: Somehow.

Fairbairn: What about teachers in high school or anything like that? Did anybody?

Joyner: We had a sort of very primitive science program at my high school. It's a small high school. We didn't really have a labs or anything. We had some teachers who were good. I think the teacher who was one of the most influences on me there was my Latin teacher, who was not a scientist either. But her idea and I think the whole idea of study of Latin was just rigor, very rigorous. You have declensions, you have conjugations, you have to translate, you have to know how to say these things.

Fairbairn: Sounds like a Latin teacher, yeah.

Joyner: She was definitely. We always joked we thought she looked like Julius Caesar because she had the white hair and was very, very strict. But I think she did have a big influence on me for that. It's hard to say why I ended up going to the engineering school.

My father was always, "You need to go to school. You have to be in a profession. You need to do that, you need to be in a profession." Long after that, I thought maybe law, medicine, or something. But for some reason I think I thought engineering school was going to be a neat thing to do. I liked physics and math in high school.

Fairbairn: So you at least enjoyed the subject matter?

Joyner: Yeah, I did enjoy that.

Fairbairn: But your parents had both graduated from college. They had both gone to college.

Joyner: They both did go to college. They both went to William & Mary. My mother was actually a Latin teacher early when she'd gotten out of college. And I think my father struggled with languages. His story he always told was that to graduate he needed a 75 in French, which he had to take, and apparently got a

74 and convinced the teacher to give him a 75 if he promised never to take French again. So that's how he was able to graduate, according to him. That was his story.

Fairbairn: So they were at William & Mary and so that made University of Virginia the enemy?

Joyner: For some reason I don't think of them as enemies right now, but my mother sort of did. And University of Virginia then was thought of as a sort of a place of debauchery and parties and things like that. But that's where I ended up going.

Fairbairn: Was there ever any feeling of, gee, I want to get out of the country, I want to get out of the woods and out of the mountains, or is that not so much?

Joyner: Not so much. I think this was only about an hour and a half away from my home, although I don't remember, as I did with students I know now, I don't remember going home very much. I was there and it was sort of a whole new world to me.

Fairbairn: Yeah, I bet it was quite a change.

Joyner: It was a lot of different people. Well, most of the people from my high school didn't go to college. Some of them went to the service or into business, into agriculture. But I think I was the only one from my class that went to Virginia.

Fairbairn: Interesting. So you're off to University of Virginia. What year was that?

Joyner: 1964.

Fairbairn: '64. OK. So you had already decided to go into engineering at that time?

Joyner: I decided that for some reasons that I can't quite reconstruct. But I decided to go. I decided to go to the engineering school. I had some arguments with my father later on about that, because about the middle of when I was an undergraduate I was tempted to still study mathematics but go into the College of Arts and Sciences and the so-called “pure” math department. And my father, I think he goes back to, "You need a career. Mathematics? What's that? You're not going to have a career with that."

Fairbairn: Engineering is a job.

Joyner: Well, I think I ended up doing some of the similar things and studying some of the same things that I would have anyway. But I remember this discussion with my father in 1966 or something.

Fairbairn: So was this electrical engineering or what engineering did you get involved in?

Joyner: Well, I ended up, when I started, I had some tendency to want to go into nuclear engineering. They had a small reactor there at Virginia. And I think sometime around then I got more interested in what probably now would be called computer science. There wasn't any computer science.

Fairbairn: No, not back then.

Joyner: So my major was something called engineering science, which you had to take courses in electrical, civil, aerospace. So I don't think it trained you to do anything. My father would have been horrified.

Fairbairn: I was about to say. That doesn't prepare you actually for any of those jobs, does it?

Joyner: I don't think it does. But it was a background that was interesting, because took some of that. I did take some classes in the College of Arts and Sciences in mathematics.

Fairbairn: So you refine your interests as you went through college? What was the process there?

Joyner: I think some of this had to do with getting a job when I was an undergraduate in this computing center, which was in the basement of a building where I think they taught biology. So this was, as you remember, just this big room full of tape drives and big processors and everything that fits right now into something very small.

But there was one professor there named Ed Storm that was teaching things similar to computer science there. And I recollect him being some influence. He was doing, I think, even some kind of formal methods.

Fairbairn: So did you do some programming in college?

Joyner: I did some programming. I had this job as a computer operator for a while. I think the person who hired me asked, "Well, why do you want this job?" I said, "Well, I'm very interested in computers and everything." He said, "Yeah, but do you need the money? Because we want to give jobs to people who need money." I said, "Oh, I definitely need the money."

So this was something, you're going to be taking big boxes of cards, running them into card readers, mounting tapes. I'm sure I dropped people's cards. I remember tapes where you put a write ring in by mistake and it erased somebody's data. So all these things happened.

Fairbairn: I forgot about write rings. That's right.

Joyner: Yeah. You had to put the write ring in. And this was a Burroughs B5500. And there was an on-site engineer who was responsible for that. I think his name was Ted, as I recall. He was from Japan and didn't speak much English. In fact, the only English words I remember ever hearing him say was when something wasn't working. It's not working, not working. He'd look. But he'd always say, "Cold start." And then you'd--

Fairbairn: Reboot?

Joyner: Reboot now, you'd say. Reboot. So we'd end up doing that. But it had the old chain printers and card punches and even paper tape readers. People would still then come in with paper tapes.

Fairbairn: So you made it through college. And you said there was one particular professor that was influential?

Joyner: There were two. Ed Storm was one of the professors there. Bill Wulf, who later sort of rose to fame in the National Academies was a graduate student then. And he was one of the teachers that I had too. So those are two that I particularly remember as having some influence.

Fairbairn: So you got a degree in engineering sciences in '68?

Joyner: 1968.

Fairbairn: And what was the next step?

Joyner: Well, I was applying to graduate school. I think my father had given up then that I was going to be an engineer or a lawyer or anything. And I had gotten more interested in things that's probably nowadays would be called formal methods, proofs and theorems. And I'd applied to several schools and ended up going to graduate school at Harvard in the fall of 1968.

Fairbairn: And what was your major there?

Joyner: Well, it was still pre-computer science then, so I majored in applied mathematics. And just like when I went from a small high school to Virginia, going from Virginia to Harvard was another big transformation. Everybody is smart. Much more diverse population of students than there was when I was at Virginia.

I think the reason I'd gone there, they had a few faculty who were in programming languages, formal logic, and things like that that I developed some interest in when I was an undergraduate. So off I went. I think I'd never been to the north before. I don't think I'd ever been there, so I got up and went – drove up there.

Fairbairn: Hadn't been much out of the state, huh?

Joyner: No, I hadn't been too much out of the state.

Fairbairn: So you arrived at Harvard. What were some of your experiences? What did that path look like?

Joyner: I ended up there with an adviser who had graduated not too long before me who ended up them being there as an assistant professor for just a short time and went then to work for BBN, Bolt, Beranek, and Newman there. I still had this, in the back of my mind, this idea of proofs and theorems and how do you do things like automating those kind of things.

And I ended up working with my adviser and in particular with another professor who was in the graduate school of Arts and Sciences in the philosophy department. He was a logician. So this became very fascinating to me to think about logic and how would you prove things automatically and so forth.

So in fact, there was a person who was on my committee for a while who didn't think much of this at all. I mean, when he read my thesis proposal and then thesis, he'd gone on sabbatical to somewhere in California. So he wasn't on it. But he wrote a scathing letter which I think I still have that says, "This thesis belongs in the philosophy department. You face none of the issues of computer science today," and on and on, because it mostly addressed decidability and sort of the big thing then was computability. If this takes exponential time or polynomial time, how are you going to do this? Well, that's not what I'm addressing. I'm addressing decidability, which was interesting then. I was lucky that he had left before I had my thesis defense.

Fairbairn: So what was your thesis on? Describe it a little bit more.

Joyner: It was called Automatic Theorem Proving and the Decision Problem. And there were sort of two parts. But the thing I was working on there, and I had a colleague who was a graduate student there was working on sort of the other side of this, and that is if you have formulas and first order logic with quantifiers for all, their exists, and so forth, that's generally undecidable. You can have a proof procedure that will find a proof if it exists, but if it doesn't, you'll never know. It will just go on and on, perhaps because it's undecidable.

But there were certain classes of first order logic that are decidable. And what I tried to do was map these classes of decidability and show how you could do that using what then were called resolution-based proof procedures, things that were designed and could be run on automatic machines, could be run on computers. I had several classes of these formulas that you could show how you could make this resolution theorem proving process a decision procedure. It would either say it's true or it's false and produce a counterexample. None of this involved actually writing computer programs to do this, even though that was being done then; people were doing that. It was mostly in the theoretical computer science sort of area.

Fairbairn: So as you were finishing up your thesis, what year did you finish and wrap things up?

Joyner: 1973.

Fairbairn: So you made good progress.

Joyner: I made pretty good progress. There were some discouraging years. There were years where I said, this is never going to finish.

Fairbairn: I think every PhD student says that.

Joyner: I think we all have that. I had a couple of summers I worked at MIT Lincoln Labs outside of Cambridge there. And not really in that area, in information storage and retrieval; I was looking at storage and retrieval systems. So I still remember some of those things too. By then I was married. I had a young daughter.

Fairbairn: So then you needed a job.

Joyner: I needed a job. My wife was supporting me. And then we had a baby. She was working for Harvard. So I did need a job. I had a scholarship from the National Science Foundation for a while. But yeah, then I felt, "Now I think I need a job," yeah.

Fairbairn: So you wrapped things up in '73, did you say?

Joyner: Right.

Fairbairn: And what were you looking for at that point?

Joyner: I had my defense then. I remember looking at some academic possibilities as well as industry. I remember having interviews at the University of Texas at Austin and what was then the new Information Sciences Institute in Marina del Rey of USC.

And I think what influenced me is that there was a person who had come to talk to graduate students at Harvard from IBM. And I talked to him, I think, two or three times, because he would come, he'd talk to people who were early in their studies or later and everything. So it sort of felt comfortable talking to him. It wasn't that far away from where we were. By then we'd been in Massachusetts for five years.

And turned out I got an offer to work in his group where they were working on things that were actually related to my thesis. They were working on program correctness. Back then microcode certification, it was called. And we ended up going to New York, going to Yorktown Heights.

One story I remember. My wife and my daughter took me to the interview there, I remember, for that. And my daughter's pediatrician had said, "You know, if you're going to work for IBM, you've got to be in a white shirt, tie, suits and everything." And they waited for me in the lobby at the Watson Research Center. And my daughter, who was three, I think, at the time, saw people walking around in flip-flops and shorts and everything. She said, "Mom, I think daddy has the right clothes. I think he'll be OK. I think this will work out."

Fairbairn: Hopefully. So you ended up working at IBM for 35 years.

So one of things we wanted to focus on was your work in electronic design automation. But how did you get to that path? What were the things that lead you in that direction? Any major accomplishments, things that you want to highlight there.

Joyner: Well, the first job I had was working in a group in this microcode verification group with two or three other people. And the idea there was, can we use some formal technique, some what we call symbolic simulation techniques to show the correctness of microcode? In fact, even now I think when people say we want you to show the correctness, they mean we want you to find bugs that we didn't find. So it was interesting.

We worked on a small spaceborne computer designed by IBM for Huntsville in the Defense Department. And we actually used some of these techniques to find errors in the microcode. But we could never have good communication with the people who were actually designing this.

We had a rudimentary principles of operation manual that we tried to formalize in a sort of a language that we developed based on, if you believe, a combination of LISP and APL is hard to start to think about. But every time we would have a confusion, we would write to them and say, in such and such an instruction, is this what you meant? We never got responses from them. But each time they released a new principles of operation, they just incorporated our language into it. So we assumed that maybe--

Fairbairn: You were having an impact?

Joyner: Maybe we were on the right track, maybe we were having an impact. But during this time, I had a colleague, John Darringer, at IBM who had come from a different background. He was a real electrical engineer. He was from Carnegie Mellon. And had started thinking about synthesis of logic and looking at what IBM was doing there.

At that time in IBM you did a design which now we'd probably call register transfer level language design, a programming language-like design. And then engineers did an actual circuit design. And there were static analysis techniques then to try to show that these were the same. But engineers asked, "Why are we doing this twice?" and so forth.

So my colleague, my friend John, was starting to look at, is there a way we can do that then automatically? Can we have synthesis of logic from a description down to the gate level description that then we'd hand off to physical designers and see if that can be used to speed up the design process and to get the design correct.

Fairbairn: So before you get onto that. So you were mentioning the work that you were doing in sort of formal correctness or formal verification of microcode. I mean, that's still even today a hot and new topic in design automation space in terms of formal verification, and especially with software going into real time things like driving cars and other kinds of things.

Do you see the work that you did 30 years ago, I mean, was there some impact in terms of IBM's progress in that area? Do you see your effort as a one-off or did you help sort of shape the direction of where IBM went then?

Joyner: What I think is interesting is even now I'll see related things. There was a talk this morning here at the ICCAD, the International Conference on Computer-Aided Design, that sort of combined both of those things. It was a person from Bosch who was talking about electronic design automation in automobiles, self driving and things.

And one of his charts said, now that verification effort is 80%, which is one of the highest numbers I've seen, and design is 20%, verification is 80%, and it's a real concern in automotive, I think. Doesn't this have to be correct or everybody's going to crash? But I think it's interesting to me that some of that initial work we did on verification, even going back to my graduate work in theorem proving, it's funny to see things that are related to that still going on today. Every now and then I'll check a paper that arose from my thesis and see how many citations this has. And it was interesting, because last time I looked a couple years ago, there were 100 or so citations. A lot of them had happened within the last five years before that. What have people found?

Fairbairn: All of a sudden it's a current topic after all these years.

Joyner: I think so. But verification, you're certainly right. Verification. Some of the things we were doing evolved into some of the formal methods. And I think that was something that most people thought, oh, this is great, this is formal, but it's never really going to work. We're never really going to use it. And now it is being used. There's certainly products there that companies are selling. And they're hiring verification people to do them. So I think there's certainly been progress.

Fairbairn: You can slip right back into a job there if you wanted to.

Joyner: Perhaps so. But there's been progress not only in that, but in having techniques that don't have to be run by specialists, that can be used by designers. So I think that's been a real thing.

Fairbairn: A few tens orders of magnitude more computing power to do the work with, right?

Joyner: All of that. Yeah.

Fairbairn: All right, so you started work with John Darringer. So was he working in the same department or you just happened to sort of meet one another and start collaborating? How did that come about?

Joyner: He was working in a related department. And it was interesting that our second level manager had gone on sabbatical. She was working in Armonk. And the acting manager taking her place was sort of giving us free rein to look at that and work on that.

So I think coming from sort of a more computer science background, he was coming from an electrical engineering background, and we started to look at previous efforts in logic synthesis, how they succeeded, how they hadn't succeeded and what could be done to make this successful. And really to try to work hand in hand with the real designers, people who are trying to do chip design then and see how we can make this useful.

Fairbairn: So I'm sort of intrigued in listening to you what you've done. It doesn't sound like you've done a huge-- at least at that point-- that you'd done a huge amount of computer programming yourself. Is that correct? Don't mean to step on things, I'm just trying to understand where your contribution lay.

Joyner: A lot of the programming I'd done then is a lot of it was done when I have the summer jobs at Lincoln Labs. The summer before I went to graduate school, I worked for the Navy in a shipyard in Portsmouth, Virginia. I remember then one of my tasks was to write a program to fit every vessel in the Navy into the optimal floating dry dock. And we had specifications of floating dry docks. I didn't know what a floating dry dock was. And so forth.

But the interesting there is I worked on this program, and it was pretty straightforward to find the optimal floating dry dock, the one that was available and stuff. But this was in IBM 1130. And the only print device we had was the console that was there. So I had another student who was there for the summer. We'd work on this program and we started it printing and it would print all the rest of the day. So we'd put on hard hats and try to walk out on submarines and things like that to see what was going on.

Fairbairn: While it was printing out.

Joyner: While it was printing. It printed all afternoon. We did that. And then at IBM when I was first there, in this microcode verification, microcode certification project, is quite a bit of programming then. Mostly then in LISP, as I said. LISP was used to do the programming, and APL was used to do these descriptions of a memory or register file or things like that.

Fairbairn: Yeah, I just wanted to get clear on where the activity was. So you started working with John. And tell me about how that evolved. Then I'm particularly interested in the work that you did. When did you start working with him and how did that relate to the evolution of logic synthesis outside of IBM? And what was your collaboration with some of those people, if any?

Joyner: I think John was sort of trying to put this effort together around 1978, something like that. And as I said, I think we wrote a paper that appeared in the 1979 Design Automation Conference. There were not only other groups outside that were working on synthesis. There were a couple of other groups inside IBM that were doing that. Bob Brayton from IBM was there working on synthesis.

And there was a group in IBM Poughkeepsie, part of the electronic design automation area, that were working on some efforts in that area too. There's some funny stories about them. But outside of IBM, I remember being on some panels back with Art DeGeus. This was before the foundation of Synopsys, when he was working for GE.

Fairbairn: He was GE in North Carolina, right?

Joyner: He was. He was in North Carolina then. So yeah, I remember being on a panel long ago with him. I think Art, Bob Brayton, Alberto Sangiovanni-Vincentelli. We were all talking about this. What about automatic synthesis methods and different approaches?

Fairbairn: So within IBM, you said there were several groups. Were they all kind of following a similar strategy where they'd focus on different aspects of the problem? What do you remember about that?

Joyner: Our approach was an approach that's still, I think, still a big part of the IBM synthesis effort there called local transformations. In other words, we weren't trying to put everything into standard form or disjunctive normal form and then apply logic simplification techniques. We were saying, well, we need to apply some transformations here that would maybe reduce unneeded inverters, maybe would replace three input gates by four input gates. Would move logic around in an attempt to-- about the only goal then was we have to make this smaller, we have to make fewer gates, we have to make fewer cells.

Fairbairn: So it was optimizations verses synthesis, is that a--?

Joyner: It was synthesis. But I think the whole idea of just doing the synthesis in terms of an arbitrary set of gates was based on this register transfer-like input language, which was pretty straightforward. So the whole idea was, how do you simplify this in terms of just the logic design?

And then following that, today, what you'd call technology mapping: how do you go from this to a particular set from some cell library or something like that? So that was the thing we'd worked on there. Some of the other groups in IBM were using some different kinds of transformation. Some of them used Boolean minimization and other techniques. They were sort of-- of course we thought ours was the best. I think they thought theirs was the best.

But we had a lot of discussions about what was better and discussions over whose mission was to logic synthesis. We were in the research division. And IBM is a big company and there were other people. I remember one meeting when our manager at that time really came to our defense. Because we had a meeting with some people who had come down saying that we should stop working on this because this was somebody else's job.

Fairbairn: EDA group?

Joyner: This was this other design automation or EDA group there. And I remember coming down and they said, what are you doing? What's going on? This is our mission. And our manager at the time, after that, he said-- they told us to stop.

And he said, "Look, we have about four people working on this. Just four people here. They seem to be working with people who are designing IBM products who really need this tool. So I think we're going to keep doing it. I don't think we need to stop." It was one good thing about being defended by management there. Because we were in the research division, we weren't--

Fairbairn: Research always needs good air cover to kind of keep itself going and on track. So were these other groups working with other IBM divisions? I mean, did everybody sort of have a practical bent to what they were doing?

Joyner: They were all definitely very practical. They were working with other parts of IBM, some of them working with the same parts we were. I think there were some people who had worked on maybe synthesis or verification techniques earlier. And I think one of the things we wanted to do right was really do in a way that was going to try to get used by the design community.

One example is there was a language that IBM was using called BDL/CS. Now this has been replaced by Verilog or VHDL or something. And there was a language BDL/S. This was the cell level connected description. And I think previous people, even people from research in IBM, they said, we'll help you, but you should describe this in this language and we'll give you this language, something different.

And they said, we don't want that. We have a language. One of important things for us was to actually work with the people doing design and take the input they gave us and produce the output they wanted. And I think that was the sort of one key to the success of this.

Fairbairn: So was this your focus for quite a long time? Were there other things you got diverted onto, or was this really what you were--

Joyner: We did that for quite a while. Thinking about it, I've often thought it's similar to the building of the Alaska Highway. Because the Alaska Highway was built in the Second World War because there's a fear that the Japanese would attack Alaska. And the Japanese did attack Alaska, in fact. But you get the impression that the surveyors were only a couple of days ahead of the bulldozer. So that's one reason the Alaska Highway is constantly needing to be repaired now.

And I think we were sort of a short way away from designers. We were actually working with designers in the early stages of doing the IBM 3090 who were using the tools as we were fixing them and correcting errors and getting them ready. It wasn't a product with a manual and everything. We were mostly just working directly with them. And I think that's one reason it worked. But I would get calls at home and my manager would get calls, you need to fix this, this is not working, we need to get this out tomorrow. So we worked on that for quite a while.

Fairbairn: So you started in late '70s, '78?

Joyner: I think '78 or so. I think in '82 or so is when this was really being used for large parts of the IBM 3090 machine.

Fairbairn: And was there reluctance in the beginning? Did they realize they had a big enough problem or were you able to show that you could really help them early on such that they became strong partners?

Joyner: There was reluctance in the beginning. I think both there was a reluctance saying yeah, these guys from research, what do they know? And this is not going work. And I think a reluctance which you see sometimes in other areas now that this is an art. This is a skill I have to do this design. And I don't think it can be replaced by some automatic tool. And digital design, of course, now none of these designs can be done now at all without automatic tools. I think in analog there's still some ways to go.

Fairbairn: Analog has held on for a long time, despite many efforts to automate the process.

Joyner: We a lot. We would go up to Poughkeepsie, I think, once a week and talk to the designers and work with them.

Fairbairn: So you mentioned early on that you had had this panel with Art DeGeus and Alberto, people that were working on it from the outside. Did you do more collaboration later on? How did that evolve? There's always this challenge in EDA when you're doing internal work and then the outside world starts to catch up and so forth. Can you tell me what that path looked like? Did you stay ahead? What was your experience there?

Joyner: There were various attempts, I think because this was very much being used within IBM, but there was, if is so good, why can't we sell this? Why can we make this a product? So there were some efforts to do it through internal IBM sorts of channels, even though IBM wasn't really selling tools like that. There was a deal with some company whose name I can't remember that did that.

Fairbairn: Yeah, I remember. Booledozer? Was that being sold? Did they make an attempt to sell outside?

Joyner: Yeah, there was an arrangement with Synopsys at one time in which there was a deal in which they got the rights to use. Whether it was Booledozer or pre-Booledozer, I don't quite remember. But there was an arrangement. I remember a big meeting. Chi-Foon Chan came up and we had--

Fairbairn: I remember something, like there was a third party I didn't remember.

Joyner: There was some other thing before that.

Fairbairn: So did eventually your activity gain steam and you grew your department? Was it transferred to EDA? If it was going to be an essential part of the development process for your systems, it must have attracted quite a bit of attention.

Joyner: It did get moved. Not really moved into EDA, but there is a substantial group in the EDA part of IBM that was doing this, supporting this, developing it. Still with some core group of people in the research division who worked very closely with them.

Fairbairn: And you remained part of that core group to push this technology forward? Is that correct or did you move to something else?

Joyner: I was part of that for a while, I think sort of following the Peter Principle or whatever. I was made a manager of several groups, including synthesis and I think some of the people doing test and people doing physical design. I did that for a while. I had some different jobs then in IBM that were really totally unrelated to that. I worked on the staff of the director of research for, I think, about 18 months.

One bad thing about that kind of job is nobody cares what your schedule is. You have to do this. The good thing about that is if you're not there, somebody else will do it, because it has to be done right away. So that sort of gave me a perspective on a lot of different things, especially in the research division, and how that interacted with other parts of IBM. And after that I worked for a couple of years. I was the manager of technical recruiting where we were, at that time, trying to propagate -- the research division hired a lot of people with PhD's. And we had an idea that the people with PhD's could also be useful in other parts of IBM. The director of research and I would go and talk to different other parts of IBM and tell them that this might be something important to you.

One barrier there was a lot, today probably even more so, a lot of the PhD's in engineering and science were not US citizens. So to get them hired in other parts of IBM, there was additional work that had to be done. We told them we knew how to help them with that and do that. So I did that for probably 18 months and also got another job as manager of that group and other things like the library, safety, and contracts. How I ended up there, I don't know. Very interesting.

Fairbairn: How long did you stay with the logic synthesis activity?

Joyner: I think I got another one of these other jobs around '85 or something like that, maybe in the late '80s was working as a manager in the technical area in what we called research operations doing that. I came back then into the technical area sometime after that, probably in the early '90s.

The safety department, which I was manager of, that scared me to death. Because I went to see the safety manager one time and he had several files in what that now we'd call the inbox. How one of them doesn't say the building's on fire or something? Said, oh, I know where everything is.

I'd go to these other seminars and they'd say, if OSHA comes in and does an inspection, your lab director will be arrested. I said, I don't think I want to be a part of that. I was missing some of the technical things, still in EDA. So I ended up going back into EDA.

Fairbairn: So you went back into the technology division?

Joyner: This was all in the research division, but I went back into the research groups there and was a manager of a couple of other areas there and for a while was in charge of, for our design automation area, in charge of getting support from other divisions. The whole idea was we need to bring money in. So we would say, we'll work on logic synthesis. We'll work on your physical design problems. But you need to give us $X amount of money.

Fairbairn: So you're working on getting support from the operating divisions for research activity.

Joyner: Exactly, trying to get support for that.

Fairbairn: So what were the specific things you worked on? Was there any particular project or activity that sticks out in terms of where you were able to impact IBM's approach to design?

Joyner: There was a group -- I wasn't part of the group -- but one of the groups in my area was verification. And there was a lot of intense work there in Boolean equivalence checking. And a program called Verity. Andreas Kuehlmann, who later went to Cadence and Berkeley in software verification, was the manager of that project. They had a lot of good people that, again, I think part of his success was working with people in other parts of IBM.

They had quarterly meetings in different places, once to Germany and the Hudson Valley and Minnesota. So that was something I really-- there was talk there also about, can we make a product of this? Is this something we can sell? But ended up mostly just being used internally. So that was still going on then. It's still being used, I think.

Fairbairn: So I see you were doing the other thing. I'm just looking down your resume trying to sort of guide things. Throughout this activity, you were heavily involved in outside activities, a Design Automation Conference or other technical conferences. Were you sort of an IBM outside guy as well?

Joyner: Not so much then. A lot of that happened once I went to SRC, which was in 1998.

Fairbairn: So let's talk about when you were manager of design verification activities and focus then.

Joyner: Yeah, was what I was mentioning some before. We had a project called Verity that was doing Boolean equivalence checking between high level and lower level description. Back when you first started synthesis, one of the requests from the designers then was, well, if you're doing synthesis, then we don't worry about correctness because this is correct by construction. But we were still never quite sure of that.

And there's still a need, still certainly today, there's equivalence checking and a lot of verification kinds of work. There I was more of a manager than actually doing the work. We had, as I said, Andreas Kuehlmann and Florian Krohm and a bunch of very smart people who were doing that and getting that used in all sorts of parts of IBM. I think one of things happened later there was another kind of dispute within IBM of whose mission this was.

Fairbairn: Must be common. Any company as large and diverse as IBM is to sort out whose mission everything is, right?

Joyner: Well, you wouldn't want to have more than one person working on something.

Fairbairn: So when you first began this effort in synthesis in the '78 time frame, there was very little of significance going on in the outside world, and certainly nothing of a product of nature. By the time you get into the 1990s and so forth, a whole industry had grown up outside. Can you comment about any of the discussions or trade offs that IBM was making in terms of internally developed tools versus outside acquisition?

Joyner: I think even then, one of the discussions was, how does IBM differentiate itself? Is the use of internal tools or specific tools that are going to work directly with IBM or probably even people who were developing those tools who work closely with them, is that going to give an edge? Is that going to give an advantage? And I think the feeling then was yes.

There's certainly a lot more use of vendor tools now in IBM than there was back when there weren't any vendor tools, of course, but even when IBM was developing some of its own tools and using some vendor tools. But there's still a notion that an internal EDA effort was important to help get better performance, get better time to market, and to get better designs.

Fairbairn: Being one of those outside vendors at the time, it always seemed like IBM's approach and focus and terminology and everything was so different than what existed in the outside world that just from a sort of practical interface point of view it was somewhat difficult to penetrate IBM. Independent of the quality of the tools on either side, IBM's approach was just different and was not one that typically outside vendors focused on. Is that something you found as well?

Joyner: I think that's sort of true. And even when we'd have discussions with the outside or even at conferences and everything, we're saying a different language here. We're saying, is it chips or dies? People were using SPICE. IBM had something called ASTAP that was a similar tool. So yeah, there was sort of this whole different terminology.

Fairbairn: So in general, IBM was convinced that maintaining their design automation effort was still a major or still a significant contributor to their success and competitive advantage. And there was never sort of a major switch to, OK, we're going to shut down a bunch of activities and use outside tools or anything like that.

Joyner: I think gradually more outside tools were used. But still in the research division, there's the design automation group and several subgroups of that. So there's still, I think, that realization in IBM. I don't work for IBM anymore, but that's the case. I'm pretty sure that's true.

Fairbairn: So you were charging along. You were working as a member of this design verification group through '98. What happened then? What was the transition then? That's when you moved over to SRC. Is that correct?

Joyner: Some people had come to IBM in Yorktown to talk about. IBM was a member of SRC, which is a nonprofit consortium of semiconductors manufacturers and suppliers that supports university research. I used to describe it as like Robin Hood. We get these rich companies, they give us money, and we give it to poor faculty members. I'm not sure whether the companies are still rich or the faculty members are still poor, but that's sort of what we try to do.

Fairbairn: Good model, anyway.

Joyner: And I think I got some interest in that at the same time things were happening in and my personal life. My daughter had gone to school in North Carolina, almost over my objections, because I'd gone to Virginia.

And when we had taken her down and my wife said, well, this is a nice place. We should think about moving here. And our daughter said, well, you can move here, but not until I'm gone. And she ended up going to graduate school. So she was there eight years. She was there until 1996.

Fairbairn: What was she studying? Not technology.

Joyner: Psychology.

Fairbairn: Psychology, OK.

Joyner: Which she claims is a science, but I'm never quite sure.

Fairbairn: So she completed a PhD?

Joyner: She did. She completed a PhD in psychology, in child development.

Fairbairn: So '96,

Joyner: When she left, this was about the time. '97 or so was when we were talking. People from SRC had come to see if IBM should get more involved in SRC. I became one of the members of the technical advisory board for what was then called design sciences.

The SRC's main focus then – design was a smaller part of that. The focuses were materials, devices, back end, packaging. But I found out that SRC was looking for assignees. They populated the SRC space with people who were assignees from the member companies. The members then were IBM, Intel, Texas Instruments, AMD. And I ended up talking to a fellow Ron Gyurcsik, who was the director of design sciences. In fact, I think '97 or so I ended up talking to him at the Design Automation Conference. It was either '96 or '97, but the DAC was in Anaheim.

I remember talking to him. Ellen Yoffa was my manager at IBM. And she was going back and forth and saw me talking to this guy for a long time. When I got back IBM, she said, "I know what you're going to talk to me about." But she was very, very supportive of having me go on assignment to SRC. I was supposed to work for this fellow, but in the interim he had left. He, I think, at that time went to Cadence. And so they offered me the job he had as director of design sciences.

And it ended up being very good. I was still working for IBM. I moved to North Carolina where my wife had thought was an interesting place to go. And the job at SRC was then and still -- some of the neat parts of that are working with a lot of faculty and students. I'm getting older, but the students are always young, always energetic, always full of ideas and everything.

Our funding comes from these member companies and we solicit research proposals from faculty members for research that the members feel is going to be helpful to them. In my case in the area I'm in now, it's called CAD and test rather than design. The design split into a CAD and test area and a circuits and systems area.

Sort of at the same time in recognition that design was becoming a more important part of the effort for our members. The members were becoming fabless. They really wanted this effort. So the proportion of working especially going on design has been increasing over the time I've been there.

Fairbairn: As opposed to?

Joyner: As opposed to materials, devices.

Fairbairn: Devices and fabrication?

Joyner: And fabrication. Those are still important, but designer has really grown as part of that.

Fairbairn: So you take proposals from faculty members to be funded? They do research at SRC, or this was funded research at the university?

Joyner: Now, this is funded research at the university. So we don't have actual research being done at SRC. But we developed what we call needs documents based on what the members wants, all member driven. We keep saying member driven. And for example, I think the last effort we made was in test.

So we had the test experts from the members, we had several meetings. We said, what are the targets that we want to be able to submit proposals on? And we solicited the proposals. The members select which ones we'll fund. And we normally fund three year projects. We try to get the students involved. The members often offer them internships. That's one good way of transferring the technology to the members is having a student go there for the summer.

Fairbairn: Go to one of the members?

Joyner: Go to one of the members and work there. So Ellen, who was my boss when I left there, she said, oh, you know, the university people, they're all going to love you. You're going to be giving them money and they'll all love you. And I called her after three or four months. I said, you know, when we do these solicitations, it's only about 6% or 7% of the proposals that get funded. So those are the only people that love me. All the rest hate me.

Fairbairn: So 94% hate, and 4% to 6% love?

Joyner: Probably it's on the order of maybe 10% or so. I've fielded many calls from people who want to know why they weren't being funded.

Fairbairn: What were the typical size of the grants?

Joyner: Usually not so big in the scope of things. Usually the order of us $100,000, $150,000 a year for a three year period. So maybe $400,000 to $500,000 overall. What the faculty have always said, they want to get the funding, but they like the idea of being exposed to real world problems and having their students look at what's really needed in the world. And that's what our real mission is, to do research. This is pre competitive. It's not work that somebody needs tomorrow, but it's something that the members collectively see as something that's important to them in the future.

Fairbairn: So would the members not only give you money, but give you a design examples or test examples? Other things that the faculty could use in their research to see if it was actually applied to the kinds of problems they were dealing with?

Joyner: This is one of the big efforts we've made. And we've had some success in that. The example I give as a sort of counter example to this is we'll have one of these reviews and after each review, each project is reviewed each year and the faculty member and students will make a presentation, and we'll give feedback. We'll say maybe you should go in this direction, and we'd like this, we don't like this.

But the sort of thing that used to happen a lot is the criticism will be, this is a toy example. Why aren't you working on a real example? Well, can you give me a real example? No, it's proprietary. So we've put in place a lot – some of it the really happens with our help -- we help put in place a lot of non-disclosure agreements between the faculty and the industry.

So they can do the work, their research is still public, the members don't want the details of the examples to be known. So most of our members are able to do that. One of the big ways of doing that in addition to agreements like that is to have the students to work as interns at these companies where they're exposed to what the real problems are.

Fairbairn: How many universities do you work with? And do you continually get proposals from dozens?

Joyner: SRC overall funds, at any given time, something on the order of 100 universities. Mostly in the US, but increasingly worldwide. We're able to support work outside the US too and get proposals from a lot of different countries. The computer-aided design and test area, I think we probably now have maybe 65, 70 projects going on at I don't know how many universities, a bunch of universities.

Fairbairn: So how has the SRC-- when was it first founded?

Joyner: It was founded in 1982.

Fairbairn: So it was well on its way when you joined in '98.

Joyner: I joined in '98, right.

Fairbairn: And so what has been its experience over that time frame? Sort of ups and downs? Has it been continually funded? Do you have to defend your work to keep getting funding for members?

Joyner: There have been ups and downs. It's mostly been successful. I think one of our biggest challenges now is when SRC was founded it was primarily US based. The idea was to really support the education of students that could work in the semiconductor area. Then when the feeling was that the US was falling behind in that area in the early '80s, it's now of a more worldwide organization. Back then the members were all large companies; they were all integrated in the same way. They all had fabrication. They all produced things.

Now with the real diversity in the area with fabless companies, with companies doing applications, with foundries, it's more of a challenge to get members and to select the work that's going to be appealing to all of them. Not every member is going to be interested in every single research project, but we want to have enough of a commonality so we can show the members that they're getting-- the argument we use for them is you're getting more value than you would if you invested your own money separately because you're getting this multiplication of having what we focus on, not only the contributions of other members, but increasingly joint projects we have with government agencies that we can get to support the same work, to have our members play a big role in selection, but getting a lot of government funding. We've put in place several successful programs with the National Science Foundation, where they'll give us two to one, even up to three to one, sometimes, matching funding from the government sources. So that's worked out very well. That's been very good.

Fairbairn: But you're no longer with the SRC? You've retired?

Joyner: No, I'm still with SRC. I was on assignment from IBM to SRC. The joke was I kept telling people I'm on the eighth year of a two year assignment. But I retired from IBM, but still--

Fairbairn: Your retirement was from IBM.

Joyner: Retired from IBM, but I'm still doing similar things--

Fairbairn: Still actively involved in SRC.

Joyner: --in SRC and doing that. And I think, as you asked before, I think it was really after I was in SRC that I became more involved in things like the Design Automation Conference and some journal editorships and things.

Fairbairn: It fits very well with your role at SRC in terms of understanding the broad landscape of what's going on.

Joyner: I think it's good in trying to understand things. It's good to come to conferences like ICCAD to get a feeling for what kinds of things are going on.

Fairbairn: Is there any particular project or set of projects that you're particularly proud of or results were exemplary relative to some other things throughout your time? You've been at SRC for 14 year?

Joyner: 16 years, I think, yeah.

Fairbairn: Sounds like overall it's been positive, but is there anything that sticks out in your mind?

Joyner: I think overall it's been positive. I think some of the efforts we've had with the National Science Foundation, which turned out to be sort of hard to get started but turned out to be very worthwhile. One of our new areas has been in hardware security. And we just did a solicitation and funded projects with NSF in that area. And that's sort of a little different from the things we've normally done at SRC, but I think it's an area of growing importance.

So NSF has a big program in that area. We were able to get their cooperation to fund, I think we started about 10 new projects funded with joint support in that area. And there's a three year plan to fund some more of those. Three years ago, in 2012-2013, we were working on a solicitation of what we called FRS, Failure Resistant Systems, in other words, can you take a look at the system level and see we're making things with, when you get down to the circuit scale and below, we're getting variability, we're getting uncertainty, we're getting devices that fail. How can we address that in the whole scope from the system level down or even from the software level down? And one of the catch phrases I think is making reliable systems out of unreliable components. How are we going to work on that?

We had a project before on multi-core, tools for multicore design, tools designed for multicore. So those are some of the areas that I think it's not accidentally that these were all joint work with NSF. Because I think that's been a value we've really been able to bring to the members is that kind of cooperation with the government.

Fairbairn: Are the programs that you fund, are these all publicly known? There's nothing secret about what activities you're involved in or who you award to or whatever? Is that correct?

Joyner: We encourage publication. We don't have publication restrictions. One of the values we think we can give to our members is both the selection of the projects, the selection of new work, the direction of them, and the early access to the results.

We have a lot of examples where we'll find something that's received best paper award at a journal or at the Design Automation Conference. Our members have access to that maybe 18 months, maybe two years earlier. When they sort of inspired the work, they were working with them, they got reports which we give to the members. So the work is in the public domain. But it's the stuff we try to give our members, both the ability to direct and the ability to get early access

Fairbairn: I was wondering whether you publicly announce the awards. Like when you make an award on a project, do you announce those awards or are those-- can people--?

Joyner: Certainly the ones we do with the government are announced. And they're not secret. I don't think there's anything repository where you can say, let's see what work is going on. That's one of the values we try to give our members and try to recruit new members is to try to show them that.

Fairbairn: OK, so before we started this conversation, there were a couple areas that I wanted to kind of get your perspective on as opposed to what your own particular contribution was. And given your involvement with SRC and focus on design over the last 16 years anyway, my question had been, sort of in the last 20 years from the mid '90s to now, what has been the major progress and breakthroughs in design automation?

Whether SRC funded or whatever, but just from your active participation in the Design Automation Conference and so forth. If you were to list the top three or four major areas, what would you say the major accomplishments, breakthroughs, focus, whatever has been in electronic design automation?

Joyner: I think a few of them, I'd say, and I think SRC has been involved in quite a few of them, but the whole focus on that design for manufacturing, design for manufacturability, dealing with variability. How are we going to deal with that with the tools? Are there tools we can use when we're at the physical design level or above to still make things that work, to still take advantage of the circuits that the devices are being able to produce?

And certainly quite a few of our projects deal with the whole issue of power, which has become, I think, one of the major challenges. How are we going to reduce that? More than once we had SRC forums or reviews, we've talked about that -- researchers from our companies will say, I'll handle everything else, but somebody's got to handle the power. This is a really big challenge.

I think I mentioned before, I think in verification, I think SRC had and still has back when SRC started, some of the original projects in the '80s were in verification. Ed Clarke from Carnegie Mellon, who's winner of the Turing Award, is going to retire next year. Somebody I've known since we were undergraduates together.

But he was one of the original researchers funded by SRC and is still funded this year. So it's been gratifying, I think, to see not only the good work come out of this verification area, but the fact that it's still now something that's becoming used. I mean, you can walk through the exhibit floor at DAC and you can see companies that are selling products.

Fairbairn: Formal verification.

Joyner: Yeah, formal methods, formal verification. And the thing we've done recently is there's been a great focus on analog. Texas Instruments, as you can imagine, one of our members was very interested in making sure we kept a focus on analog. So with their help and the help of the state of Texas, we were able to set up what's called TxACE, the Texas Analog Center of Excellence at UT Dallas. We recruited Ken O from the University of Florida to be the director of it.

There are about six universities in Texas, but the whole maybe 12 or so universities outside of Texas that are all part of this multi-university center that all of our members have access to and that we're hoping to direct in the area both circuits and tools and test for analog design. So that's a focus that's going to continue, I'm sure.

Fairbairn: So in terms of major developments over the last 20 years, are there some that SRC was not involved in or ones you look back and say, boy, we should have funded more work in that area or something that where major problems or major breakthroughs happened that you weren't involved in. Was there sort of a retrospective of we missed that one sort of thing?

Joyner: Every now and then the members ask these questions. I am trying to think about what some of those are. But SRC has been involved in a lot of things and even at the device area. FinFETs and some of that early work was done by SRC. As I said, the verification work. 3D is something we've had a lot of projects on. I don't know if we were on the ground floor of that.

Fairbairn: Sometimes you might be a year or two late or something getting in.

Joyner: We still have people now working on the test for 3D and 3D design techniques. And some projects where we specifically asked for proposals going up toward the system level and down toward things like 3D. How are you going to make use of all these? Various things at that level.

Fairbairn: In terms of your recent work, are there areas where you've asked for proposals where you haven't gotten any good responses or where the responses are not-- you don't think that there's quality work out there being done yet?

Joyner: I think what's been more of a challenge is looking at-- a lot of times when we've established centers like this Analog Center and several other centers and SRC, there' are solicitations that I think are going on later this year for having several faculty members work together on different aspects of a problem.

In another part of SRC now called STARnet, it's a program bigger centers. It used to be called the Focus Center Research Program. It's funded jointly by DARPA, the Department of Defense Advanced Research Projects Agency. And they've had some success of getting people to work together. But that's sort of not the nature, I don't think, of faculty members. I think people, they want to develop their reputation, they want to develop their work, and so forth.

And so I think that's been one of the challenging things, both in these focus centers and some of the work we're trying to support. We'd like you to work together. Can you work on this? Can you work on this? And can there be connections here?

We talked before back when we were talking about IBM and synthesis about the use by companies of their own tools versus vendor tools. And with some of the members relying much more on vendor tools than they did in the past, they want a path for the tools that are developed by researchers to be used by them. We like them to be incorporated into vendor tools. That's been another challenge that we're continuing to work on.

Fairbairn: The design automation companies, are they members typically or not?

Joyner: Right now Mentor Graphics is a member. And we're actively talking to-- both the Cadence and Synopsys have been members in the past, and we'd very much like to have a stronger component of EDA companies to be part of that. Of course, that landscape's constantly changing. I think Cadence and Synopsys have been there a long time and we'd very much like them to be involved.

Fairbairn: So let's switch gears now. Instead of looking back, let's look forward. We talked at the beginning about Moore's law has not run out yet, but it's getting harder and harder, and perhaps more importantly, it's getting more expensive. And it's not clear what some of the requirements are in terms of further density improvements and so forth.

Tell me what's your perspective on design automation and design in general as we look forward? What are the major challenges and what's your perspective? What do you tell people when they present you with this question? I'm sure you've heard it before.

Joyner: As a little bit of a preview of this panel that we're having tonight at the ICCAD, this was one of the questions. It says, Moore's law is dead, long live EDA was the title. I didn't come up with the title.

Fairbairn: Got to have something that's catchy.

Joyner: We have panelists, several universities and from industry talking about what this means. And most of them, several of them, and I think this is true, paint sort of a good picture of EDA in relation to that question. We can't just now say everything's going to get faster because we're going to go down to 14 nanometers, seven nanometers, even smaller numbers. We know there's an end somewhere to this.

So the question is, can design and design tools be a part of meeting that challenge? We're leaving a lot on the table now because we've relied on scaling to continue going on. And several of the panelists feel that there are real opportunities for that.

I know one of our researchers quite a few years ago looked at place and route. Place and route is an area that has been declared dead I don't know how many times. But we still fund work in that area. He was able to construct some examples of optimal place and route and showed that existing tools, both tools from vendors and tools from universities, were not really getting to those optima at all. There was a lot left on the table. I don't know how much that's still true today.

I certainly think there's a lot that can be done with tools. We've tried to always make the point that a big investment in EDA tools is always to be dwarfed by the cost of the next fab. I mean, that's going to be an outrageously big number. So we think that that kind of investment has to go on. Of course, everybody's exploring all sorts of different paths, including different technologies.

I think one of the concerns about moving maybe beyond CMOS technologies is, are we going to go to something there that's going to have the same scaling features that silicon based logic has had over this long period? It's hard to think that that's going to happen. So are these just going to be one off solutions? Or are we going to need to do that? So I think the design and design automation are going to be important things.

One thing that's certainly the case now too is this more sort of application focused notion. We're not building the processors or even small processors that are general purpose. Everything has its own purpose and with a lot of challenges: mobile, etc.

We were asking the speaker this morning, we talked about cars, he was from Bosch: Aren't you concerned about security? Are you concerned around reliability? Are you concerned about verification? If everybody's car is out there self- driving down the freeway, doesn't that worry you a little bit? So I think that's where the verification area is key.

Fairbairn: So not just physical design, but you mentioned very early on your work in microcode verification or whatever. The classic hardware software co-design. Are you funding activity in those areas and is that important space? System level verification as opposed to hardware or software?

Joyner: These are both areas we've highlighted in our needs documents and especially in the verification area. We funded a little bit of work in that, but not so much. The funding is also determined by the members, and they're really trying to focus on things that are going to help them. I think that's a real concern in the security area. We had a workshop maybe almost a couple years ago now talking about bringing together some software and hardware verification people.

And it was sort of funny to me. I sort of figured this would happen. But the software people were saying, oh, we can teach you a thing or two. And the hardware people were saying, almost all these catastrophic errors you hear about are software errors. It's not because this wire gets disconnected or something. Going back to talk this morning, that's going to be the key challenge in automobiles if we're having all this software. I mean, how are we-- I think they're not that far ahead.

Fairbairn: So that's an interesting question. Given that you're funded by these members who are in general semiconductor companies, is a concern that you might miss some big problems because they don't see it as their problem? Existing companies always have a hard time keeping up with the latest trends, just as a general statement, right?

So you have new companies springing up to do even wilder things of mixing biology and silicon, right? And I'm not saying that that or any particular thing. But what about that sort of general question about sort of missing the major trends because your sponsors are all too focused on today's problem?

Joyner: That's a concern. That's a concern the members have. That's a concern I have. I think, in fact, one thing we've talked about, my colleagues is if we really want to attract those broader spectrum of members, is Semiconductor Research Corporation even the right name?

Is that something that's going to say, oh, you're only interested in chips? We do have fabless companies now, but maybe it's more Systems Research Corporation. And we have the whole legacy of our work and our reputation which I think is very good in that area, but we'd like to attract more companies.

The STARnet is something. This has been called the Focus Center Research Program for probably 15 years but then they said, look, we're going to fund this again, which is sort of unheard of with DARPA.

They don't usually want to keep funding the same thing. But they did want to have a new name. That stands for something too, which I can't remember.

Fairbairn: Of course. So I guess when you're talking about really advanced research, typically that is an area where in the past government might have stepped in to fund DARPA or whatever. So is there a possibility you could get funding from government in some of these more advanced technologies?

Joyner: Yeah, well, the STARnet program is funded almost half, I think, by DARPA. And that's looking at things a little bit beyond what we're doing in these the core program where we've got the individual projects. There's another effort called the Nanoelectronics Research Initiative.

Fairbairn: Part of DARPA?

Joyner: That's part of SRC.

Fairbairn: SRC, OK.

Joyner: They get projects and funding from the NSF and from NIST, National Institute of Standards and Technology. Their initial goal was, so let's find the next switch. In other words, if the silicon transistor isn't the next switch, is there another switch? And there was a lot of work and that went on with other kinds of non-CMOS sorts of switches.

They've expanded their role now, since I don't think they found the next switch. But they're looking especially at benchmarking a lot of these new technologies and trying to narrow down to what should really be looked at by companies doing it. So they've gotten a lot of government support on that. And I think we really try to do a lot of work in making sure we have good relations, especially with NSF. And they have constantly changing management and leadership, so we want to always stay connected with them.

Fairbairn: Do you try to steer companies, steer member companies and say, hey, we're sitting here with a pretty broad view. We think this area is hot over here and deserves some extra funding. Do you try to bring that to their attention? Or is that beyond the scope of what you can really do?

Joyner: We do try to do that. More times I think it's in partnership with them where we do that. But a lot of times we'll be talking to NSF people pretty regularly and find out something. Sometimes it's a suggestion that comes from the government: Hey, we'd like to start something in that area.

Maybe it's because their constituents have said that, maybe because they have people with that expertise that they think should be supported. So sometimes it does come that way. And a lot of these dealings with the government are interesting. Because we'll talk about something, maybe we won't hear anything for a couple of years, and then a lot of times something comes back.

And we need to do this. And they have their own rules, their own selection process that we deal with too. It's been very productive and I think very good for our members that we've done that.

Fairbairn: Good. OK, so is there anything we missed in terms of the IBM story or things you wanted to highlight? I wanted to make sure that we covered synthesis as thoroughly as you're able to and anything about SRC that you wanted to highlight or touch on that we didn't get to?

Joyner: Just certainly to emphasize in synthesis that I was one of the people involved initially, but it certainly wasn't any sole effort by me. I think John Darringer I mentioned, was one of the early contributors. Louise Trevillyan.

Fairbairn: Yeah, we do have an oral history from John.

Joyner: I think I've seen that. But Louise and Dan Brand, Alberto and these guys.

Fairbairn: It's just an interesting area since it sort of evolved in parallel, IBM is certainly one of the major forces. I'm always curious. I mean, here at the Computer History Museum we don't necessarily take sides in terms of saying who did something first, but we to uncover the story behind major developments. And certainly synthesis, logic synthesis, was a major transition development in the design industry, starting in the '70s, but really in the 1980s.

And so when I talk to people like yourself who were directly involved, I'm always interested to add to that story and get any additional perspective or understanding of how that evolved and where the pieces fit together or not. Was it sort of the commercial versus IBM very separate? Was there a lot of collaboration? Where there are key ideas that got passed back and forth? Just in terms of developing a complete history in technology, that's sort of one area that I've tried to explore.

Joyner: The whole thing has been quite fascinating and something I've enjoyed very much. The whole development within IBM and what I've done at SRC after that.

Fairbairn: You're really in the, to use an old term, the catbird seat in terms of understanding not only seeing what's going on, but helping drive what's going on. So it's a neat position to be in.

Joyner: I don't know. I think so.

Fairbairn: You think so. After 16 years, you hope so.

Joyner: Continuing going on.

Fairbairn: All right, well thank you very much for joining us, taking time out. And I think it's been a valuable conversation. So thanks again.

Joyner: Thanks, Doug.

END OF INTERVIEW

