



TRANSCRIPT

Key Conversations with Phi Beta Kappa

Alfred Spector: Envisioning the Synergies between the Liberal Arts and Computer Science

In this episode, Dr. Alfred Spector offers an optimistic take on the evolving relationship between the liberal arts and computer science. Reflecting on his career experiences in creating a company, working for Google and IBM, and now diving into economic modeling, Spector provides a fascinating account of the evolution of computer science both inside and beyond the academy.

Fred Lawrence: *This podcast episode was generously funded by two anonymous donors. If you would like to support the podcast in similar ways, please contact Hadley Kelly at hkelly@pbk.org. Thanks for listening.*

Musical interlude

Hello and welcome to Key Conversations with Phi Beta Kappa. I'm Fred Lawrence, Secretary and CEO of the Phi Beta Kappa Society. This podcast features conversations with Phi Beta Kappa Visiting Scholars who spend one academic year with us. They travel to up to eight Phi Beta Kappa affiliated colleges and universities, partake in the academic life, and present a lecture on a topic in their field. Lectures are always free and open to the public. For a full schedule and to learn more about the program, please visit pbk.org.

Today, I'm happy to welcome Dr. Alfred Spector, Chief Technology Officer at Two Sigma, a firm that uses information to create different forms of economic optimization. Dr. Spector spent eight years leading Google Research and five years at the head of IBM software research. He is a tireless proponent of the importance of computer science across all

disciplines, and often presents on societal implications of data science.
Welcome, Dr. Spector.

Alfred Spector: It's great to be here. Thank you for having me.

Lawrence: So your interest in computers really developed during your time at Harvard, coming out of your interest in economic modeling.

Spector: Right. So when I got to Harvard, I was interested in journalism and I thought I would do economics. And economics required some math, and the math had some programming, and I got really interested in the programming, kind of forgot about the economics, and then went on with computer science. But I've had in the back of my mind, how do we apply computing to economic modeling? And that's something that we'll pick up again on that in my career later.

Lawrence: And then you moved on to Stanford and got your Ph.D. working on the possibility of building computer programs on large scale networks. Tell us a little bit about that.

Spector: Right. So we always knew that as fast as you could make a single computer, if you put a lot of computers together, they would be even faster. And furthermore, if you put a lot of computers together, they would be more reliable, because a single computer might break, but if you had many of them you'd have some redundancy. So what my work at Stanford was is how do you get computers to talk to each other, if you will, if you allow the thought that they could actually talk? Could they communicate with each other very efficiently and easily? And I wrote a thesis on that topic called Remote Procedure Call. That's the term we now use. How do you invoke a procedure from one computer to another? That's something that happens all the time. When you're on your browser today, effectively you're invoking a procedure on a server when you actually go buy something.

Lawrence: And whereas that idea of computers talking to each other, as you say, is pretty common-sensical to us today, this was pretty early on in the process when you were doing your work at Stanford.

Spector: It was fairly early on in terms of thinking broadly about how this would be used over the long term, particularly to gain high performance computing.

Lawrence: Tell us a little bit about the beginning of your academic career at Carnegie Mellon.

Spector: So at Carnegie Mellon, which is a great computer science research university, as well as now having a tremendous undergraduate program in the field, there was a really good group of people that looked at the systems aspects of computing. I worked with a fellow who eventually became the head of Microsoft research, interestingly enough, and we worked together on how do you develop reliable high performance computer systems that would be shared by lots of people and also that would provide new capabilities that people didn't have before? We worked on a system called Andrew there, which created the first largely scalable file system that could be used by thousands, eventually almost a million people, to share information. It looks very much like Google Drive or Dropbox, etc., many, many years later. We were there very early.

Lawrence: And then you moved from the academy and you got a tenured position at Carnegie Mellon into industry. What was that transition like?

Spector: So in my field there's been quite a bit of fluidity between academicians and the startup and technical world, because computing is quite valuable to the world. And also, sometimes it requires a lot of scale to go build systems. It isn't just a programmer in a dorm room, it requires a lot of people. So I had ideas at Carnegie Mellon, which we had demonstrated at our university and at quite a large number of others where they were in use. We thought we could scale those ideas far more broadly and maybe create technology that would be the standards on the Internet, that would allow for this form of what we would call distributed computation.

It's the basis of cloud computing. So we created a company, myself and three students, called Transarc, and we pursued many of those dreams. Some of them were very impactful, some didn't work as well, but overall it turned out pretty well. We got acquired by IBM and a lot of what we did became an important part of a fairly major IBM product.

Lawrence: Transarc then winds up getting acquired by IBM.

Spector: Right. That was quite a change for me to go to a very big company from a company of a few hundred people, and I was fairly quickly managing more like a couple of thousand of people.

Lawrence: So, tell us a little bit about that transition.

Spector: Well, IBM was the world leader in transaction processing, which is the technical domain of taking lots of inputs, like from a bank or an insurance company, and then processing those against a database to keep a record of what's going on and to return results to users. Even airline reservation

systems, booking a seat on a plane. They had been the leader in that for a long time, and I found myself leading a lot of that work at IBM when they bought me. They moved me to do that. So it was quite exciting because I was quite young and I was not just doing a startup in that domain, but now kind of running the largest software organization in the world in that domain.

Lawrence: But you must have had a lot more autonomy at Transarc than you could in IBM. Was that a difficult part of the transition?

Spector: One of the things that I learned is that very big organizations have systems in place that constrain what you can do. They have reasonable reasons for that and not so reasonable reasons for it. At a startup, you just do what's right. There are no systems particularly in place. You think about what is the right thing to go do, and you can go do it. I do remember a call with the Chief Financial Officer that worked in my area and he said, "Well, you can't do that." And I said, "Well, what do you mean you can't do that? This would be better for the company, better for the customers, better for the shareholders. We should just go do that." He said, "Well, I agree with you but you can't do it." That was pretty surprising to me.

Lawrence: And then famously you became the first Vice President for Research and Special Initiatives at Google.

Spector: So Google was a great company when I joined. That was back I think in 2007, and it was already doing very well. The mission of Google, to organize the world's information and make it universally accessible and useful, is a great mission. It got a lot of attention and it was really making the Internet far better. But Google was interested at the time and sort of growing and improving its ability to do the core research on which the future would be built. And I had had experience doing that at IBM. For a number of years, I had been a tenured professor and had done good work in distributed systems, which is a basis of a lot of what runs the Google plant, these large network systems of many computers, so I had a good background to go do that. So it was fun. It was really a great gig to go and help a bunch of really smart people organizationally and maybe in terms of goal setting and in terms of recruiting, continue to build that capability to innovate.

Lawrence: Now, some of the things that you were involved in at Google are the things we most think of now in terms of breakthroughs in technology. And by we, I mean people, not experts in computer science but on the consumer end of this. Speech recognition you were involved in, right?

Spector: Right. So when I got to the company, the company had made bets in translation and speech recognition, notably, and there was a thought that the existing ideas that had percolated, in fact partially from IBM, also partially from Carnegie Mellon, in those domains, would work if they were scaled up at the "Google scale" using very large amounts of data and large amounts of processing, and they would work, and the company had started to bet on those. So I inherited those projects and was able to lead them to a production use. By the time I left Google, if I gave an academic talk, which I did quite a few of, and asked people in the audience, "How many of you use Google Translate?", 90% of the audience had used the product.

Spector: The product has continued to grow and it's become superhuman. No human can translate across, I'm guessing somewhere 50, 60, 70 different languages, from any language to any other. There are humans that can do better from any single language to another one, but not in that breadth. And the quality has gotten good enough that it's very useful, even if I'm sure there are people at language departments that may be listening to this that will cringe when I say it because it's not as good as they can do, it's very useful.

Lawrence: We still have a language requirement for Phi Beta Kappa. Members of Phi Beta Kappa have to have reached a level of intermediate proficiency. Call it a comfort level, not fluency, but a comfort level in a second language. So not putting you on the spot here too much, but if you were meeting with my, what we call the Committee on Qualifications, which decides which schools get chapters and don't get chapters, should we dispense with the language requirement because Google can do translating at a superhuman level?

Spector: Well, I think we have to break this down into two parts. So one is do we need foreign language capabilities in order to get around in a foreign country or to read a book or to find access to information? Clearly that's declining, right? Whether it's gone to zero, I can't say, but it's declined to some extent and it will continue to decline because clearly translation will improve. Translation improved rapidly even a couple of years ago, again, using neural network technology and it became much better, just recently. So, I think one of the things is going to decline in importance. However, in understanding culture and understanding the world and being a historian, being an educated person, I think understanding and reading directly the literature and being able to be part of another culture, it's still an important part of education. Should every Phi Beta Kappa member be required to do that? I guess I would say probably not, but many should.

Lawrence: So, is this kind of discussion that we're having the kind of thing that would go on inside Google or were the discussions more technological, "We can make this happen, so we will make it happen."

Spector: At Google, I think we had a very bright group of people that were thinking always about the implications of technology. Now I'm not sure we always understood them fully. To the extent that we could, we tried to do things that were beneficial. So we were well aware that there was a potential negative that people would, instead of using a Latin trot to go do their Cicero translation, they would just be more easily able to do it. But on the other hand, we did feel there was an overwhelming benefit to allowing people to search for information in French that they couldn't otherwise see and then translate it into English and that that was the real mission of the company and would be beneficial.

Lawrence: You've now returned to economic modeling, which is what you said got you started in computer science in the first place at Two Sigma as the Chief Technology Officer, and it's described as "a firm dedicated to using information to undertake many forms of economic optimization." So, tell us what that really means.

Spector: So, we're very interested in our firm and how we can use data to help firms and optimize what they're doing. We started out in the investment world helping people that had money to invest, invest that money well so that the value of their portfolios would go up. We'd been very successful at that. So the firm has had a long history of being a successful investment manager, but we've diversified beyond that. We're looking, for example, at insurance. We're looking at can we make it possible for people to get insurance for their small business very efficiently, with very low overhead and with the right pricing of risk, and maybe even be able to reflect the risk back to the firm so that they know how to reduce the risk and, thus, reduce problems that they have and perhaps also lower insurance costs? So, it's a broad mission. It's a very interesting one that combines technology and data modeling and data science and a lot of knowledge of finance. I don't have so much finance knowledge, but I have the other.

Lawrence: Let me give you a provocative assertion that was made in the midst of the Great Recession and get your thoughts on it. There were those who said that in part, the Great Recession of '08, '09 was brought about by people who were competent in algorithms and complex systems analysis, but didn't really understand the fundamentals of economics, so that you had people who put data in that suggested real estate prices would continue to go up because tomorrow would always be a little bit like

today. And what never got factored into the equation is what happens when that stops being true. Anybody with basic economic sense would have known that wasn't the case, but the high-level math guys didn't understand that. So, is there some truth to any of that?

Spector: I think there probably is truth to that statement. I think it requires not just blind allegiance to data science to make good decisions. It requires a lot of thoughtfulness to understand what the data means. You can look at this in the economic dimension, which you just did, but you can look at it in the medical dimension. It's very easy to find epidemiological trends which look really strong, that X is associated with Y in the population, and you think you might control X and therefore impact Y in a positive way. It's often not true, and we see that if we look at the continually changing requirements and suggestions that we get on what to eat and what not to eat. Those are often epidemiologically thought through and then we find out, actually, they're not as good as people thought. So, you have to be very careful with data science.

Lawrence: Let's actually talk a little bit about what you've been doing this year as a Phi Beta Kappa Visiting Scholar. You've visited a number of different types of colleges with the program. You were at Denison, a small liberal arts school in Ohio where I was just earlier this week. You were at beautiful Rhodes College near Memphis, Tennessee, which I think the Princeton Review has called "the most beautiful campus in the country." At least they did back in 2017.

Spector: It's really beautiful!

Lawrence: It is in fact a beautiful campus. You were at Valparaiso, which is a faith-based midsize university in Indiana, and you were at the University of Arizona.

Spector: Which is spectacularly beautiful also.

Lawrence: Both Valpo and Arizona in Tucson.

Spector: Arizona in a completely different way, but it's a gorgeous school.

Lawrence: You've been at big schools and small schools, public, private, sectarian, nonsectarian. I wonder what are the similarities you've noticed with the students you've been on campus with and what are the differences?

Spector: So, first, what is probably not surprising to our listenership is that there is an enormous amount of desire to understand data science, to understand computer science and to move in that direction. All of these

universities have significant growth in the number of students that want to be educated in this. Some of them, in fact, want to be majors or concentrators in this area. So, that's pretty universal, I think. That has effects on the students because they're trying to get into courses that are sometimes constrained and trying to make sure that the courses are state of the art, have access to the right faculty. It's also quite a challenge for the faculty because there's so many students in many cases and there's only the ability to grow and hire that's so much, that there's constraints on what they can do.

Spector: At the smaller schools also, there can be some tension I think between the growing CS interests and other faculty members that maybe have some relative decline in the focus on their area. And that creates some complexity I think in the management of the faculty that I think the deans and university administration has to confront.

Lawrence: Well, you coined the phrase, "CS + X" back in 2004 at Harvard, at the Center for Research on Computation and Society, "Computer Science and Another field," "Computer Science and." So, I want to take you through some of that thinking that is a broad, if you will, liberal arts version of computer science, as opposed to just the applied side, and think about it first on campus and then we'll also move out into the broader society. So, tell us a little bit about, first of all, how you conceptualized that when you first talked about it and then how your thinking on that has evolved over the last fifteen years.

Spector: So you may remember back to about 2000, when the bubble burst in high tech. And there was a feeling in society at that point that there were going to be no jobs in computer science.

Lawrence: That was the so-called "dot-com bust."

Spector: That was the "dot-com bust." And you could even go to the Bureau of Labor statistics that would say, oh, things are going to hell in a handbasket.

Lawrence: NASDAQ has a big crash and petrock.com goes under, et cetera.

Spector: But there was another factor and that was people said, "Well salaries in the developing world are much less, computers are available anywhere. There are networks that connect the world together. Why won't all the jobs just be exported? And there'll be low paying jobs in the developing world and there won't be high paying computer science jobs in the developed world, America." I thought this was not true. I wrote a paper

on this for some national academy workshop, I think, on this and said it wasn't the case.

Spector: So, part of what I was thinking was, when I went to this Harvard Center for Research and Computation and Society seminar to present at it, that I wanted to (A) explain to people that things weren't over. That things had not closed down, that the best was ahead of us still, and that's something my mother always said, that was her philosophy of life. And I agree with that. The second thing I wanted to say is explain that it wasn't just for, if you will, nerds, the implications of the field and the necessity of education in the field and knowledge in the field was much broader, because there was a hybridization between computing and every other discipline. And I still believe that to be true.

Lawrence: So give us a couple of examples of that.

Spector: Well, if you look at one of the clearest ones, look at a personalized healthcare computational biology. So, in the biomedical sciences, we need to really understand the human genome, which, if you will, is a kind of a program which dictates a significant amount about us, and we need to understand health and the implications of that specific description of ourselves. What are the right drugs? And how should we gain therapy? And what should we do for ourselves? Same thing is true if we look at the creation of new drugs. We need to understand statistics and data science and understand proteins and how they merge together. And, in fact, we call it computational biology, for example, or medical informatics. Those are two specialized, hybridized fields of computing and either biology or biochemistry or medicine. It's happening everywhere.

Spector: So, in finance, we're an algorithmic finance firm. We're roughly speaking half computer scientists and a quarter mathematical finance people and a quarter other people, and we're a mixture of that together. The advertising industry was not thought of as a computational industry 25 years ago. I'm sure we do think of it that way today, thanks to the growth of the big online advertising firms. So, I think you see it everywhere, even in the humanities. So, I've always been fascinated by what we can learn about language from computing. So, the other part of it is, I think it's true that it's the case that there is this hybridization of computing and every other discipline and that's beneficial to computing, of course, because it's interesting to apply your field to others, but it's really important to these other disciplines because they can make more progress. They can do better biological research, better medicine, more interesting historiography, better economics, better prediction, whatever it might be. That's all really interesting stuff.

Spector: What I thought was really important, though, to also state is that universities should be sure in some way to capture this notion so that not everyone wants to go into computer science. It's a really important thing that we continue to have the great universities that have tremendous breadth and have that scholarship continue broadly across the university, not see a complete specialization in only one piece of where the world is going, and that was something that I've been arguing for. Some universities have done that very well, others I think still have to strive to do that better.

Lawrence: So let's put you in the position to be the Dean of Arts and Sciences, and you're now designing a curriculum. Do you require some basic level of computer science for all students? Do you require all computer science students to take some basic humanities? How do you think about weaving these themes together?

Spector: So, yes to both of those. I would say I believe in a proper liberal education today or even an engineering education today. We should have everyone knowing something about computing, and we can talk about how to do that, and we should also have our scientists and engineers understanding humanity. And there are reasons we'll get to that. We talk about the implications of all this technology, it's even more important that we have students that understand some philosophy and some political science if they're going to help use technology effectively. So, it goes both directions. I think it's very important, though, to note that how you craft this will be different at different universities. For example, I've always liked the idea of infusing computing into other courses.

Lawrence: So what is the essential kind of knowledge that undergraduates should have today about computer science?

Spector: I'm not a pedagogue of introductory courses, so there are people that are far better than this, and I haven't even read the modern literature of what people think. But I do think a certain amount of programming should be part of it. So even though you might not create a program to sort numbers or to look at a maximization problem or maybe match interests across different people or write a little computer game, I think it's useful to understand these very elegant machines and how they work and what they do. So, much like I think learning a foreign language is valuable in that regard also, even if we don't have to use it to get around, I think it's a very useful thing to do. So a part of the education should be on that. A part of it should be on the theory of computing, which was done by von Neumann, Turing and others, that explains some of the mathematics.

I have a music major, who's a daughter of mine, who's taking kind of a computer science theory course, and I'm really pleased. And she likes learning the theory because it's an elegant part of the basis of modern thought. So, I like some of that. That's good. And then I think understanding how some of these systems work today. What happens when there's a recommendation system? Or how does search work? A little bit of that. And I think that can be combined into a course. I think that's probably the type of thing that CS50, for example, at Harvard does and probably many of the intro CS classes.

Lawrence: So we can't conclude without talking a little bit about artificial intelligence. What do we think the future challenges and opportunities, I'll let you talk about opportunities now, the whole area of artificial intelligence presents?

Spector: So, first, I'd like to just say that the Association for Computing Machinery in my area just gave out the Turing Award the day before yesterday to Yoshua-

Lawrence: Named for the great Alan Turing.

Spector: Yeah. Which is our Nobel prize in our field, because needless to say, computer science wasn't around at the time when-

Lawrence: Alfred Nobel set up his prize, right?

Spector: Exactly. So it went to Yoshua Bengio, Yann LeCun and Geoff Hinton, who did tremendous things with so-called deep learning and neural networks that are somewhat modeled on the operation of our brains, these neurons that fire and such. So they've made a big contribution. What I would say is that that's not the complete story about how to do artificial intelligence. We don't know how to create artificial general intelligence. Most computer scientists, like myself, will say eventually we'll do it, that there's no reason that computers can't be as intelligent, as creative and thoughtful and learning as humans are. We don't know how to do it today.

Lawrence: So you talk about being excited by it. One person's excitement is another person's anxiety. Looking down the road in the next year or now decades, are we looking at 2001: A Space Odyssey, where technology exceeds our ability to control it, and we lose control over our humanity? Or do you see a world in which all of this expands our ability to understand and control and direct our world?

Spector: I think first, it's going to happen. There's nothing that will enable anyone to control the growth of technology over time. It's an international world, there's no single governing body about how to do this. So computers are going to grow better, and AI is going to get better, and we're going to apply it in more places, so we have to apply our creativity as humans to make this a world we want to be in. We've always done that. I don't think there's any difference. So people could look at it on the one hand and say there'll be no jobs. On the other hand, we have an aging population and we probably have constraints on the workforce as we get older and we don't want to work when we're 90 years old, and there'll be a lot of us, I hope. So, that's an example of one side of it.

A second is, many of us think that perhaps if you have more computers there'll be fewer jobs. Well, we may be more creative in the jobs we have. Furthermore, we may have opportunities to do things that are new that we couldn't do before. I'm capable of doing reasonably good drawings now with computer technology, which I could never have done because I'm not very artistic. So, I'm optimistic that we can control this, but there is clearly in every technology we've ever created, good parts to it and bad parts. I think there's an immense amount of opportunity to harvest the good in this, given the magnificent machines that we have available to us.

Lawrence: And this is the role of the "+ X" part in the "CS + X." These are the philosophers and sociologists and historians and economists and literature scholars who will help us understand all this.

Spector: I think that's certainly true.

Lawrence: Dr. Alfred Spector, thank you for coming in. Pleasure talking with you today.

Spector: It's my pleasure. Thank you.

Musical interlude

Lawrence: This episode was produced by Lantigua Williams & Co. The episode was mixed by Paolo Mardo. Our theme song is Back to Back by Yan Perchuk. The Phi Beta Kappa producer was Hadley White. To learn more about the Phi Beta Kappa Visiting Scholar Program, please visit pbk.org. Thanks for listening. I'm Fred Lawrence. Until next time.

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