Algorithms & Power Systems Architecture:

Using Historical Analysis to Envision a Sustainable Future

Oral History Project

Interviewee: Bahman Hoveida

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***Abstract*:**

Bahman Hoveida discusses his professional, entrepreneurial, and philanthropic experiences. He opens by describing his early work on energy management systems, and eventual decision in 1992 to form a company, Open Systems International (OSI), that capitalized on the advent of microprocessors and focused on development of applications for monitoring and control of power systems. He notes that his company sought more flexible products for the power industry. He mentions that he sold the company in 2020. He explains his early interest in gaining practical experience following his academic education in electrical engineering and power. He was especially interested in using much lower cost microprocessors with much higher computing power to solve complex problems such as optimization. He describes some of the skepticism and discouragement he received when he started OSI. He speculates that the naysayers were comfortable with the status quo and describes some of the arguments that were later proven wrong. He talks about bringing a few utilities on board as customers

very early on. He discusses the process of starting a new business and the combination of common sense and entrepreneurship involved. He notes that OSI never brought in outside investors. He offers an anecdote about the Y2K bug and OSI's approach of first auditing the company's internal software, then making support available to all their customers throughout the night as the year turned from 1999 to 2000. He explains that the restructuring underway in the power industry while OSI was a new company provided opportunities to grow the business. He encourages young engineers interested in entrepreneurship to identify problems of any size in the market and design and sell solutions for those problems. He describes the range of scientific projects in which the Hoveida Family Foundation invests. He discusses the emerging challenges in the power industry, and the great potential around using machine learning tools to solve those and other problems. He emphasizes the value of collaboration between engineers and other math and science specialists. He speculates on the future of power systems, the continual discrepancy between supply and demand, the potential for demand-side solutions, and the complexity of operations. He closes with reflections on the individuals, such as Pete Sauer, and organizations that influenced his career.

Note regarding Transcript and Timestamps:

Timestamps appear in the transcript but may not align with the recording. Pauses and interruptions may have been removed, and the overall length of the recording may be reduced.

Transcript:

Julie Cohn (00:00:49):

This is Julie Cohn. I'm conducting an interview with Bahman Hoveida on October 29th, 2024, online. Sairaj Dhople will assist with the interview as will Daniel Molzahn. Mr. Hoveida, during today's interview, we are especially interested in your work on energy management systems and software for the power industry. But first, we'd like to ask you to tell us about your educational background and your professional trajectory.

Bahman Hoveida (00:01:50):

Thank you, Julie. I'll tell you a little bit about myself. By training I'm a power system engineer, electrical engineer with emphasis in power systems. Graduated with a master's program from University of Illinois in 1981. And no, I was not classmates with Edison. A lot of people ask me if you were a classmate of

Edison or Tesla? No, I'm old, but not that old. But after graduating I wanted to work for the industry. So, at the time I joined a company called Harris Controls that built energy management systems, which were hardware and software, essentially, systems. And later on, that company was acquired by General Electric. So, that technology is within the GE Digital Grid organization right now. And then, there was only a few, handful of companies that did that kind of work.

Bahman Hoveida (00:03:22):

And one of them happened to be Minneapolis. I later joined Control Data, Energy Management System Division, here in Minneapolis. And I worked there for a few years, then joined the consulting ranks. There used to be a company called Energy and Control Consultants. They had an office here in Minneapolis—and later on they were acquired by DMV KEMA, and of course, Control Data was acquired by Siemens—and realized there was an opportunity in the industry for a better mousetrap. A lot of the energy management system technologies at the time were quite complex. They were based on mainframe or minicomputer technology. We saw the advent of microprocessors at the time, and we kind of questioned, how come no one is thinking about a more flexible product on microprocessors? And that's when we started our company Open Systems International in 1992, we started developing, essentially, applications for monitoring and control of the power system including transmission, distribution, and generation.

Bahman Hoveida (00:05:05):

We grew over time. We grew to a thousand employees worldwide. And we had a fairly large market share competing with Siemens and ABB and GE, but with definitely a different technology, a little bit more up-to-date technology, and also better processes to deliver and take care of customers. So, that's the journey I've taken. And in 2020 we sold the company, OSI. So, I'm somewhat semi-retired since 2020—early 2021. I'm still very active in the power and energy field, do investments in startups around energy, climate tech, carbon management, and trying to stay active in various areas of the power systems control, involved with IEEE, and So, forth. That's where we are.

Julie Cohn (00:06:30):

What attracted you to industry rather than staying in the academic world?

Bahman Hoveida (00:06:42):

Very good question.

Bahman Hoveida (00:06:47):

I thought gaining some practical experience to round off the academic education—I thought that was important—to see how, really, the academic theories are applied in practice. So, that's why I joined the industry right after my master's program. I had anticipated I'll go back and get a PhD after gaining a few years of industry experience. But you know how it is. You get married, you have kids, and it's very tough to go back and become a student when you're used to a paycheck and the complexities of married life. So, that never happened. But I've always tried to learn, even in a non-academic environment, and tried to better my skills and learn about new technologies and new principles.

Julie Cohn (00:08:14):

As you were having your industrial experiences, before you started your company, were there particular challenges that you found especially compelling—technical challenges?

Bahman Hoveida (00:08:35):

I think the biggest technical challenges that I saw was the lack of, at the time was lack of adequate computing resources to solve these large power system problems. I mean, this is 1980 the fastest computer probably had less, well, a lot less memory and processing power than your cell phone today. So, that was the constraining factor. How do you solve very large power system network problems, especially optimization, with such limited computing resources at the time? So, that was really the main, one of the main constraints I saw. But then we also saw that, on the microprocessor side, there was a lot of progress being made. Small microprocessors were actually beginning to grow in terms of their processing capability and memory handling.

Bahman Hoveida (00:09:55):

I don't know if you guys remember, but at the time, Sun workstations, Sun Microsystems had essentially announced their Sun MicroStations, which had quite a bit of computing capacity, compared to $,1000,000 mainframes. And this was a microprocessor-based workstation that was probably at the time, I don't know if it was $25-, $30,000, $40,000 versus a $1,000,000 mainframe. And Intel had just announced the 486 chip, which was quite a bit revolutionary in terms of computing power over their 386 family of processors. So, we saw that slowly the computing world is changing, with more and more cheaper processors being available. So, we thought, this is great, now we can attack these complex power system problems using economic, more economically viable processors for utilities rather than million-dollar, multimillion-dollar computer system.

Julie Cohn (00:11:29):

Did you have to abandon some of the assumptions that engineers had been using to program the large computers in order to work with the microprocessors? Or conversely, were you able to translate from one format to the other fairly easily?

Bahman Hoveida (00:11:53):

I think at the time there were standard languages that these applications were written in. Of course, at the time, most power system problems were programmed in FORTRAN, a language called FORTRAN. We were one of the first companies that started developing our applications in the C language. We thought C was a little bit more efficient, streamlined, more portable. It was supported by many different OS's. So, that was one shift that—since we were starting to develop applications from scratch, we had the luxury of selecting the right language to use. And I think C was a good language for us because it allowed us to be portable across different operating systems, including—at the time, if you guys remember, there was a company called Xenix, which was a UNIX- like operating system; later, on UNIX and Windows; and later, on Linux. So, these applications would really easily port or compile on all of these different platforms. So, that was really the change that I saw that we had to make.

Julie Cohn (00:13:49):

I'm curious to know if your colleagues or perhaps competitors observed what you were doing and either dismissed it or tried to compete with you directly in what you were trying to accomplish?

Bahman Hoveida (00:14:07):

Yeah, of course. There were a lot of naysayers at the beginning. I mean, that's—when you start a new initiative, instead of encouragement, you get a lot of folks in the industry that try to discourage you if you're trying to try a new idea a different way. So, we got a lot of discouragement, but we were steadfast in the direction we were on. Later on, I would say it took our competitors 10 years to realize that they need to develop a more open product that runs on open operating systems like Unix. But I still think they're using FORTRAN as their main language for all the power system problems. And the reason is they have a lot of legacy source code that was developed essentially in mid '80s, early '80s, that they carry. I mean, they didn't have the luxury of starting from scratch. So, I would still think that we were probably the only one that used C and later on C++ as the primary language to solve power system problems.

Julie Cohn (00:15:57):

Let me see, at this moment, if either Sairaj or Dan wants to jump in to ask further questions related to this, before I go on.

Sairaj Dhople (00:16:06):

Yeah. If I may, Bahman, I want to take you further back, and see if you can offer some comments on why power engineering? Was this just the hot topic of the day or was there something about your life experiences that nudged you towards specializing in power engineering?

Bahman Hoveida (00:16:26):

I think in the '80s, or late '70s-'80s, electrical engineering was either power or was communications—and maybe power electronics somewhat. There was not a vast array of disciplines that may be taught today in schools. And to me, electrical engineering was synonymous with power. And I really enjoyed the field. I thought utilities are a great industry to work for or work with. They used to be very solid organizations. So, that's why I chose power. And I enjoyed the power program at the university. And of course, Pete Sauer was a big motivator that motivated me to stay in the power program. Financially we were also able to get an NSF grant, I guess, So, that had something to do with it—that I could get a scholarship in power. So, all of that culminated in me studying power, and I don't regret it. I think it was the right choice.

Daniel Molzahn (00:18:17):

Sairaj, if you don't have follow-ups on that, I did have another question, Bahman, based on what you had mentioned, which was: you had mentioned that there were naysayers to this open deployments, open developments—when you were first coming up with these ideas for OSI—what was their argument? I mean, maybe in hindsight, it seems like, well, this is very clearly a good direction to go, but I'm trying to think of at the time, why would people say that that's not an appropriate direction to move it?

Bahman Hoveida (00:18:48):

Yeah, I think—a lot of naysayers were the consultants in this industry. There's the customers, there are the suppliers, and there's a level of companies, individuals, that call themselves consultants, that—they advise customers when they're trying to procure a system. They were just old school. They really didn't have the vision. They would use an argument like, "if a GE or a Siemens or ABB is having such a difficult time delivering these systems, how can a small startup be able to do it?" So, they use the—I would say—the failures of others as an excuse that, "no, this is such a hard problem to solve that no small startup could overcome." So, I would say part of it was ignorance and part of it was the status quo. They're used to a status quo.

Daniel Molzahn (00:20:09):

But it sounds like not very technical arguments against it.

Bahman Hoveida (00:20:14):

No. I mean, the technical arguments were, well, I mean, they're used to running these things in mainframes. They really didn't understand microprocessors or virtual operating systems, the way it handles memory. They were claiming, for real-time processing, that some of these microprocessors did not have the right clocking—some bizarre arguments that—I think we've proven them all wrong. So

Julie Cohn (00:20:49):

I'm curious, what do you mean by clocking?

Bahman Hoveida (00:20:52):

Like in a real-time clock that—because in building real-time systems that need essentially—for data acquisition—let's say acquiring data from the field you need very precise clocks. And they were claiming that Windows machines did not have that for whatever reason, or Windows OS did not have a deterministic clock. To be honest with you, I did not understand exactly what the argument was, but that was one of the things.

Julie Cohn (00:21:35):

But I find that interesting only because of—timekeeping was such an important feature of early power systems.

Bahman Hoveida (00:21:44):

Yeah.

Julie Cohn (00:21:46):

It was a device for keeping frequency within a narrow range and also a device for keeping generators turned on, if people used them. It's kind of interesting that even in the 1980s or early 1990s, that was a topic that people continued.

Bahman Hoveida (00:22:06):

Yeah, I think that was the argument that, since you need such precise time and—for time synchronization and what have you—some of these microprocessors did not at the time possess this precise clock, which I mean, you could always have satellite clocks that provide input into your process. But anyhow, that was the argument.

Julie Cohn (00:22:41):

So, oh, I'm sorry, Dan, did you want to jump in?

Daniel Molzahn (00:22:47):

Oh, sorry. I was just going to ask, were there other infrastructures or other applications outside of electric power that were moving in the same direction, and you could use as a kind of benchmark or examples, or was power engineering really—and OSI—kind of the pioneers, not just in the energy industry, but sort of more broadly?

Bahman Hoveida (00:23:13):

I think slowly, some of the process control companies, for instance, for power plant control or let's say water network control, I think they were slowly moving towards cheaper microprocessor base. But at the time, we had no idea what else anybody else was doing. We did not use them as an example. We just thought here's a power flow application that we have written, and we can have it run faster on a computer, on a 486 chip, than, let's say, a utility was able to run it on their mainframe. So, we did not really get any sort of, I would say, any sort of example. We did not seek any examples outside the power system. We just kind of, by trial and error, decided that this all made sense.

Julie Cohn (00:24:35):

Did you have a utility that was already on your side with this process, or did you have to find one?

Bahman Hoveida (00:24:43):

I think very early on we were able to get a few utilities that had just completed buying a multimillion-dollar energy management system that used, let's say real-time—I don't know if you're familiar with Gould SEL, S-E-L? Gould used to be a computer system company. They used to have probably the fastest real-time processors. They were, I would say, minicomputers. There was a company—Westinghouse used to be in this business. So, they used to build their architecture on these real-time minicomputers that were expensive. Their hardware was several million dollars, and they had just finished implementing one of these multimillion-dollar systems, and they could not get their applications, their, let's say, network security analysis applications—your basic contingency analysis, state estimation, power flow—they could not get those to execute in a timely manner on this very large, essentially, hardware investment that they had made.

Bahman Hoveida (00:26:12):

So, we approached several of these companies. We said, let us just offload these applications for you. Why don't you just—let's use these, our, applications running on a, let's say on a 486 computer, and we would do data exchange with your existing control system. And for a fraction of the cost. We had a lot of early converters that liked the idea, that it made sense. We started in '92. By '93, we had two or three customers that we had signed up to receive our software.

Julie Cohn (00:27:07):

Was it, oh, Sairaj, go ahead.

Sairaj Dhople (00:27:10):

Bahman. Can you take us through the decades, as it were, and tell us a little bit about periods of growth and periods where things were not looking that great for OSI, just in terms of, let's say, number of employees, number of customers you had? How did you manage running a company over 20 years, through those years? If you can.

Bahman Hoveida (00:27:35):

Very good question. I think, when you start a new company and, I mean, any startup—we did not have access to capital. We did not even know that you could have VCs that could invest, which was actually a good thing. The company was always bootstrapped. We won a contract, or we expanded our sales, then we went out and expanded the organization. So, from the first three-four years, we were roughly 20, 25 people—employees. Then every few years there was a, I would say, a step jump into a next plateau.

Bahman Hoveida (00:28:34):

So, maybe every five years we would jump into doubling or tripling the size of the organization, as our revenues grew and number of customers grew. So, I would say in year 2000, our revenue was $7,000,000. And we had roughly, I don't know, 45, 50 people all the way to, when we sold the company, we were about a thousand employees and revenues of about $160 million. And I'm proud to say we were profitable every year we were in business, because we were very frugal. We did things right. We did not overcommit ourselves or over-hire. And that helped us manage the finances. And the best thing we did was that we did not bring any investors into the organization. Because there are horror stories out there, startups where they bring VCs into their organization and they lose control, and they lose essentially ownership. And we did not do that. Although there were a lot of people that were interested in investing, but we, essentially, every few years, we would decline for any sort of investment.

Sairaj Dhople (00:30:19):

Just a follow up on that. Did boom and bust cycles in either Wall Street or just the power industry at large, the Y2K bug—I mean, you saw all of this as someone who started your baby. Like, how did you navigate everything that was external and affected your company?

Bahman Hoveida (00:30:46):

Yeah, the Y2K is a good example. We essentially made sure we did an audit of all our software; make sure we are handling the date processing properly. And then, from a business point of view, we told our customers that we are going to be—from 10:00 PM till 6:00 AM—our entire company will be available in case you run into any sort of issue or problem. You can call us; we can help you recover. And we invited almost two-thirds of our employees to come in, and that gave a peace of mind to the customers. They liked the idea that, hey, there is a company that can support us in case you run into trouble. From a catalyst point of view, the Y2K actually created some opportunities for us to—because there were customers that were replacing components of their system because of Y2K. So, that created a little bit of surge in our sales. Because we had other components that we were selling. It wasn't just the power systems analysis applications. We had alarming, we had historians for data capture that relied a lot on dates. So, we were able to sell some of those applications.

Sairaj Dhople (00:32:36):

That's an interesting story. Thanks for sharing that

Bahman Hoveida (00:32:39):

Yeah.

Julie Cohn (00:32:43):

Along those same lines, your company was born as the power industry itself was undergoing a fairly profound restructuring. And I wonder if that ended up being beneficial to a newcomer in the control field, or more challenging because decision-making wasn't as centralized in some areas of the country, other kinds of effects?

Bahman Hoveida (00:33:13):

I think the restructuring provided some new opportunities because all of a sudden, even though some larger utilities were merging, there was a lot of newcomers, a lot of renewable companies started forming. So, all of a sudden, we saw our customer base increasing. And we came up with some new products for generation management, for instance. All these new entities were popping up all over different markets, like ERCOT or PJM, which needed automation to manage the generation assets. So, we had a product that we could implement right away. And these companies wanted a product yesterday, because they were just forming, and they couldn't wait a long time. So, we were able to deliver these systems fairly fast. So, I would say deregulation and restructuring actually helped us quite a bit. It also created—I mean—the separation of distribution from transmission also separated, or created, some new needs. All of a sudden, instead of one system for generation-transmission-distribution, we were dealing with three different entities that needed to buy their own systems. So, I would say all in all it was a good thing.

Julie Cohn (00:35:04):

Did you have to dovetail what you were offering with different market structures in different parts of the country?

Bahman Hoveida (00:35:12):

Yeah, usually, I would say, the rules were fairly similar. I mean, all we did was we acquired data from the power plant, and we had a generation control algorithm to control the generators based on the market signal. We did not have any sort of trading applications, or we did not participate in sort of, any of the trading aspects of these generation companies. It was purely monitoring and control of the generation. And the most part, you had a signal that came from the market that we had to implement and react to and control the generator. So, overall, I think the rules were fairly uniform. A few, tweaks here and there. I mean, ERCOT was a little bit different than, let's say, MISO. So, yeah.

Julie Cohn (00:36:25):

Was that happening in different increments of time as well? The day-ahead market versus the order timeframes, or is that not relevant to the kind of generation control algorithm for—

Bahman Hoveida (00:36:43):

Are you talking about the time increments for like receiving

Julie Cohn (00:36:47):

Receiving the signal and then responding.

Bahman Hoveida (00:36:51):

Yeah. I think some markets were, at the time, they were 15 minutes, I believe, and eventually got down to five minutes. And as of recently, I haven't checked, but there's even shorter increments of time. But yeah, there were those idiosyncrasies between different markets at the time.

Julie Cohn (00:37:21):

Go ahead, Sairaj.

Sairaj Dhople (00:37:25):

Bahman, how comfortable or uncomfortable were you making business decisions with your analytical, engineering mindset? And did you rely on experts to help you navigate those types of waters? Or did you feel adequately equipped with a master's degree in electrical engineering to steer such a company in the direction that you did?

Bahman Hoveida (00:37:50):

That's a very good question. We approached the business as an engineering problem. We tried to apply good analytics to solve business problems. So, I think we did not have to have an MBA to know how frugal you need to be in your expenditures, and where you have to look at opportunities to invest and invest in the technology. So, I would say we—again without anything intended against MBAs. The company did not have an MBA at all. And a collection of engineers, a lot of good engineers might, and I didn't make all the decisions. I hired a lot of good people, good engineers, and collectively these guys were—they had a good business sense. They were not, I mean, engineers are—there are different breeds of engineers. There are those that are deep into the tech and they put their nose to the grind, and they understand all the differential equations that can solve your power flow problems. But there are those engineers that they've had, in their life, some business training or even the way they run their lives. They were shrewd folks. I don't think it was a detriment not to have a businessperson. We just—we always used to say, "do what common sense tells us to do," you know? So, we had no lawyers and no MBAs, we were a bunch of engineers trying to do the right thing, keeping customers happy, employees happy.

Sairaj Dhople (00:40:41):

Well, thanks for sharing that because I, again, I would suspect that a lot of our audience is on the engineering side, So, I think they will take a lot of heart with what you said, that we are sufficiently equipped to make decisions in a broad spectrum of areas.

Bahman Hoveida (00:40:55):

Now, those who, who are in engineering, and they want to try going in a business track in an organization, I think a lot of companies, it helps to have an MBA. And I don't discourage that. I think that's good. If you want to go work for a GE or a Siemens or ABB, if you have an engineering program degree, and then you have an MBA, I think that would open up some new doors for you on the business side of these organizations, rather than on the purely technical.

Daniel Molzahn (00:41:48):

And maybe, Bahman, to follow up on this, and Sairaj, I know you have to leave here soon, So, I might steal one of your favorite questions. But, specifically for students that are interested in entrepreneurship in the power industry—you mentioned getting an MBA and maybe working in the business side of a larger corporation. Do you have any advice for students that want to start their own company or—. You took some time; you worked in industry before going back to start your own company. I know a good number of students that want to sort of jump right in and start their own company or get going immediately. Do you have a sense of different tradeoffs or advice for different situations?

Bahman Hoveida (00:42:31):

Yeah, that's an excellent question. I think entrepreneurship, the number one, I guess, point in entrepreneurship is to have the ability, a person that has the ability to notice a need in the market and try to solve that need. I mean, that's the definition of an entrepreneur as I'm concerned. And in order to see the need, I think you have to have some experience, you have to work for a few organizations and see how the problems are solved or what the unsolved problems are and then look at that as an opportunity. And if you want to have your own startup, try to go out there and try to solve that problem. I would say what gave me the vision was, I mean, graduating from university I could have never been able to start a company or know what the problems are that we need to solve.

Bahman Hoveida (00:43:40):

So, definitely working in the industry for, I would say, probably it was like 12, 13 years before I started our own company—really helped me understand the industry, the technologies that were available, what the needs were, what were shortcomings. So, I definitely encourage people to work, hone their engineering skills, and then those who are interested in entrepreneurship look for problems that are unsolved. And these are not huge problems. I mean, entrepreneurship could be—you could go out there and create a new widget or a new application that solves a small problem, and people can make a lot of money at it. You don't have to—it does not have to be earth shattering. I mean, even small improvements. People have built big enterprises around just offering very mundane, I would say, solutions to some lingering problems.

Julie Cohn (00:45:07):

Sairaj, I saw you wanted to jump in before you have to depart our interview.

Sairaj Dhople (00:45:11):

Yes. So, I do apologize. I have to run to teach. As luck would have it, I'm teaching Newton-Raphson to solve the power flow problem in my undergraduate power systems course.

Bahman Hoveida ([00:45:22]):

Alright.

Sairaj Dhople ([00:45:22]):

So, I just want to leave with this one question, Bahman, and both Dan and I have benefited tremendously from being involved with the IEEE-PES and we are quite excited to see all the initiatives that you have been supporting. Can you say a little bit about the philanthropic angle to your life as it stands now and where you see this contributing value to the next generation?

Bahman Hoveida ([00:45:54]):

Yep. Very good question. When we sold the company, of course, we always were thinking about paying back to the community, to the organizations that really helped us get to where we were and makes us successful. So, we started a family foundation, Hoveida Family Foundation, that was funded as a result of the sale of our business. And we chose scientific causes. We said we want to be able to help any sort of scientific cause out there that essentially deals with science, somehow deals with science—academia, science, medicine—and big emphasis on power systems as well. So, we've been doing a few initiatives.

Bahman Hoveida ([00:47:09]):

We did one initiative for Pete, and—too bad that he passed away—but he knew that we were doing the initiative, So, he was still alive. We funded a chair, a distinguished chair in power systems, at the University of Illinois, which, they've had an issue filling the position, yet they have not found someone to go in and fill, I guess, Pete's shoes. So, we've set that up. We help with the IEEE Power System Foundation with some scholarships for students that study power. That scholarship is available through IEEE. And then a few different initiatives with the likes of Mayo Clinic. We funded a scientific program. They're trying to use AI to detect pancreatic cancer. One of the biggest problem is, of course, pancreatic cancer is detected late stage, and almost 90% of the cases are fatal.

Bahman Hoveida ([00:48:44]):

But they have this wealth of information from all the patients, for years, including x-rays. But humans cannot process all that data. So, they have an initiative to be able to detect early warning signs So, they can detect pancreatic cancer early, applying deep learning and machine language, and essentially processing all this massive amount of data. So, that sounded interesting to us. And we essentially funded that research at Mayo and a few others. Every year we kind of look at either academic or other scientific causes, and we try to donate, I guess, or start an endowment. We've supported some PBS programming of NOVA, you may have seen our name on as sponsors, and a few other scientific shows that they've done.

Sairaj Dhople (00:50:12):

Well, thanks for sharing that, Bahman. I'll leave you in the very capable hands of Julie and Dan, and I'll go back and teach Newton-Raphson. Thank you So, much, Bahman.

Bahman Hoveida (00:50:20):

Excellent.

Julie Cohn (00:50:23):

Dan, did you have another question you wanted to ask at this point?

Daniel Molzahn (00:50:29):

Yeah, maybe some follow up on what you were just saying, Bahman, with these philanthropic initiatives. So, you have this sort of vast experience in the power industry and computational methods and your own personal background and expertise. And clearly there's some of the things you mentioned with IEEE-PES, where that experience is directly applicable. Some of the things you mentioned were maybe less directly applicable, or obviously applicable, like deep learning for pancreatic cancer. I'm curious, how did your mindset or experience that you built through the years working at OSI and other organizations, how did you take that into this new stage of this philanthropic effort? Is this a future for power engineers—is that we should be spreading out and solving all the world's problems?

Bahman Hoveida (00:51:20):

Yeah, I always have thought that all the world's problems are better solved by engineers than politicians or other disciplines. You know? Because when you apply logic, you analyze what the problem is and you come up with a range of solutions and you apply the solutions, see which one works the best. I really think that the cure for cancer is an engineering solution. It'd be a combination of an MD engineer that's going to solve the—the cure for cancer. So, I think, I mean, there's enough problems in power, in the power engineering. These are great times. I mean, I wish I was just going to school right now. There's So, many good technical challenges with the new energy transition, the implementation of renewables, decarbonization, all of that provides a lot of challenging, interesting, I would say, by challenging I mean interesting and challenging, problems for the new power system engineers to work on. And on top of that, there's this other dimension of data and using data, massive amounts of data that we gather, to apply computer methods, machine learning, AI, whatever you want to call it, to analyze this massive amount of data that we can obtain from the grid, from the customer, from the consumer, from the meters to try to discern patterns, discern issues, problems, and do prediction.

Bahman Hoveida (00:53:28):

So, definitely I think AI and machine learning is going to be, probably, a recommended, if not required, course in any sort of engineering. It'd be interesting for engineers to definitely have an appreciation of that discipline. And it would come handy in whatever they're doing.

Daniel Molzahn (00:54:14):

Interesting. Maybe one kind of follow up on those comments is, So, looking back from what I understand where you're saying the work you did early on, during your master's with Pete, was focused on stochastic power flow modeling.

Bahman Hoveida (00:54:27):

Yeah.

Daniel Molzahn (00:54:28):

And so, that, from my point of view, has a kind of big data flavor to it. You get a lot of data to run these stochastic power flows. So, is that something you think you were a bit ahead of the curve on? And how did that early work you were doing there sort of propagate into both—were those technologies you were directly applying in future deployments in industry? Or maybe if you could trace the path of that work over time, because uncertainty is still a huge problem we're dealing with today, obviously,

Bahman Hoveida (00:55:03):

Right. I think in the old days, for utilities to do planning and reliability analysis, if you remember, they used to use Monte Carlo simulations. So, they would run thousands of power flow solutions for perturbations and, I would say, load or—to see if the network can withstand essentially the loading that was being put on the grid. And of course, running Monte Carlo solutions on the mainframe at the time was very expensive in terms of computing resources. Because every power flow, I don't know, it took—for a large utility, let's say Encore or Exelon—with a large territory, to run a single power flow back in 1979, '78 would've taken probably five minute per solution.

Bahman Hoveida (00:56:18):

So, when you run a thousand power flows, it was time consuming. So, the work that Pete had done, Pete Sauer, was to circumvent running all of these successive power flows, but formulate in network equations, formulate a set of stochastic equations that looked at delta load change to a delta flow change on the, let's say delta P on the load or on a bus to a delta p flow on a line, and be able to then explicitly solve this power flow equation without having to write, I mean without having to run multiples of these expensive power flows. So, that was the basis of the, really, the thesis that he had done. And then what I got involved in was a research project to essentially continue along the same line.

Bahman Hoveida (00:57:57):

So, we were trying to reduce the amount of data that was necessary, rather than—so I would say it may have had the opposite effect to machine learning. But that was the basis of the research that I did. The machine learning to me is a very interesting area. It's essentially a pattern recognition problem. You teach the system a certain pattern, and then you let it detect in future data. That's what this is like, applying AI to face recognition, right? Or, one of the companies that we've invested in, it uses AI to detect equipment failures based on the wave forms received from sensors on a distribution line. You're able to detect whether it's a vegetation problem or it's some sort of a transformer failure or some sort of other apparatus issue.

Bahman Hoveida (00:59:23):

Essentially by detecting these failures, looking at these signatures, coming up with a model and trying to then detect, in future, let's say, waveforms or future data, detect an impending problem. The same thing with cancer. They're going to look, develop some signatures based on analyzing millions and millions of, let's say, x-rays of pancreas, an abdomen, and see if they can detect any sort of pattern. And then once they can validate that that pattern recognition works, then apply it to future—. In fact, there'd be MRI machines that would have that logic in them. So, they would take a photo of a new patient, but they apply this AI to it to read the MRI results and to see if they can see the pattern or they can see the markers for pancreatic cancer. So, very fascinating area. But to me it is purely an easy way of teaching the machine to do pattern recognition, rather than a human doing it. The human eye is not perfect, and you can't pick subtle changes, but the machine should be able to do a better job.

Julie Cohn (01:01:07):

So, for the non-engineer/non mathematicians among us, is this a difference between developing a model that looks like the real thing and running every possible contingency you can imagine, on the one hand, and on the other, taking all the data you can get, and saying, do we see this pattern anywhere? And if so, then that's a problem.

Bahman Hoveida (01:01:39):

Essentially, that's one way of doing it. You either build a—I don't like the word digital twin—I hate these buzzwords that people use—but you can build a digital twin and then run a million different scenarios. Or if you have sensor data from, let's say meters—if you look at meter data from consumers and you associate that meter data to a transformer, a distribution transformer, and then also to a feeder in a substation, you ought to be able to discern overload situations. So, instead of solving for a load variation to see when the, potentially, the transformer could get overloaded, you can kind of look at actual data, data that has happened in the past, essentially to derive some conclusions. So, I would say there's still need for both. I think you still need good simulation software or models. But then also if you have a lot of data that you want to curate, or use to come up with a conclusion, I think machine learning is probably the best technology that there is.

Julie Cohn (01:03:16):

Thank you. Go ahead Dan.

Daniel Molzahn (01:03:18):

Julie, if you didn't have a follow up on that, I do have a follow up on that question. So, you were looking—at the beginning of the discussion, you were talking a lot about the computing technology improving. You went from the 386 chips to the 486 chips, and it just inherently allowed you to do more. And you recognized that and took advantage of it.

Bahman Hoveida (01:03:41):

Yeah.

Daniel Molzahn (01:03:41):

But then you also—what you're describing here—in this work that you and Pete did, it was really clever ways of reducing the—better algorithms, better methodologies—of improving the sort of approach to solving the problem versus just the computing hardware. Clearly both of those things improved, across the years. But I'm just kind of curious what your opinion is, if—would we have gotten to where we are today or, or be able to solve the key problems or key challenges, if we just had one or the other? Just computing improvements or just methodological improvements, or was it really the combination that was the key?

Bahman Hoveida (01:04:22):

No, I think definitely the combination really helped accelerate the transition or the change. So, definitely improvements in computer technology and processing power, but also better algorithms, more efficient algorithms. And so, I think both of them had definite impact, I would say. You cannot just pick one, say we could have done it with only one.

Daniel Molzahn (01:04:58):

Do you have any examples that you could share? Maybe you're not able to share, but if there's any examples you could share from your company where folks came up with a really clever way of approaching something that, with the computing hardware at the time would've been intractable, or at least very difficult to solve?

Bahman Hoveida (01:05:19):

Yeah, I think the problems were—I mean, power system problems were always solvable if you had the right algorithm, you applied the right algorithm. But it was a question of timing. You could run an optimal power flow on a, let's say, on a 2,000-bus transmission system, and it would take 15 to 20 minutes to solve in, let's say, in the, in the early '80s or mid '80s. So, the advances in—both algorithmic advances, I mean, in optimization—people using quadratic programming, linear programming—there was a lot of clever tips and tricks in formulating an optimization problem that would help reduce your search space. All of that was algorithmic. And then on top of that, you had the better computers.

Bahman Hoveida (01:06:29):

Which nowadays has culminated in the Nvidia chips that essentially have tremendous power—floating point calculation power—that can solve these problems in matters of, I would say, seconds, a few seconds. So, I would say engineers always look at improving the algorithms. I mean, there are the traditional algorithms, but then there's—to formulate the problem, there's a lot of heuristics that have to go into it to reduce your search space, and some clever ways of applying, coming up with the right heuristics. For instance, when you do an optimization problem, you want to limit how many controls you have. You don't want everything to move. You want certain things to move in a certain region. All of that had to be thought about and developed and tested. So, it wasn't purely related to the advances in computer technology.

Daniel Molzahn (01:07:48):

And maybe one other follow up on this, because I just think this is really fascinating. How much of the advances, do you think, came from, sort of, power engineering folks that were, that comes through traditional background, kind of similar, much like yours: went through a program, took power engineering courses, learned about the power grid, and power grid modeling, versus other people that maybe are less familiar with power grids, but were very good optimizers or computer scientists or programmers or mathematicians. Did you try to—I think one of your big successes you mentioned, is forming this really effective team. And so, I'm wondering how did you go about doing that? Was it: you'd find the best power engineers and teach them the optimization numerics and applied math? Or you found the applied math people and taught the power engineering? Or it was a mix? What was your approach?

Bahman Hoveida (01:08:40):

No, that's a very good question. I think definitely we were able to build teams that included power system engineers that understood the power system, essentially, context and formulation. But then we brought in some applied math or mathematicians and folks that understood optimization a lot better, and we put them together and they were able to actually cohesively work together and really solve the problems in the best way possible. We had some power system engineers that had a lot of math, they were good in optimization, but we also really employed—and you didn't need to have a whole lot of them. Let's say we had a power system development group that was, let's say 20 people. You have a couple math people that will be overseeing, or helping the problem—the solution, applying the right optimization technique. But the objective function would be developed by the power system folks telling the math people what we are trying to optimize, what their objective function is, what are our constraints? And then they would look for the best method, whether it's LP or QP or some other algorithm, mixed energy programming. So, definitely a team approach is the best.

Daniel Molzahn (01:10:21):

And were many of those people—? So, when you—especially on the optimization side, there was kind of this whole parallel development in better optimization solvers at IBM and Gurobi and these other organizations.

Bahman Hoveida (01:10:34):

Yeah.

Daniel Molzahn (01:10:35):

How much did you learn from those—was there kind of—a lot of exchange back and forth between kind of the more application-agnostic organizations, like IBM with CPLEX, for instance? What was the intersection between those worlds?

Bahman Hoveida (01:10:53):

Yeah, I think for solving a generation or unit commitment problem for a system that has many generators, which essentially you use dynamic programming traditionally, which is very slow. So, if you have, let's say 300 generators, the solution usually would be suboptimal if you use dynamic programming, which is a traditional way of solving. So, we did look at embedding, let's say, a Gurobi engine to be able to solve these very large generation commitment problems. And we licensed that. So, we were licensing that. And we were getting great results compared to traditional methods. So, definitely I think we need to look for good, embedded engines for optimization or other problems. It can be tough to try to develop all of that in-house.

Daniel Molzahn (01:12:09):

Was there a lot of back and forth between the—would your engineers talk with, in this example, say Gurobi, and say: "here's a really hard unit commitment problem. Your branching bound method is not doing a great job. Why not?" Was it that kind of conversation going on?

Bahman Hoveida (01:12:24):

Yeah, there was, there was. There was exchanges and then we also hear anecdotes that such and such competitor is using this engine or that engine. So, we started with IBM and later on ended up with Gurobi.

Daniel Molzahn (01:12:52):

Got it. Really fascinating. I appreciate the conversation. Julie, I've been asking questions for a while. I feel like I should pass it back to you.

Julie Cohn (01:13:02):

Thanks, Dan. You've talked a little bit about what the future holds. Are there particular aspects of the direction the grid seems to be evolving into that you think are either particularly challenging or great opportunities for a more efficient power system? Either of those?

Bahman Hoveida (01:13:28):

I think from a technical point of view, there are a lot of great, interesting and challenging—again, challenging sometimes means something that is hard to do—but I mean challenging in a positive sense—a lot of great interesting problems for the new power system engineers that are joining the ranks. The power grid is becoming more complex, not only in terms of size, it's getting bigger, but also integrating renewables, batteries, what have you. It's expanding the size of the problem that needs to be solved. So, these are great times. I think, in terms of where the future goes, I think always there's a discrepancy between supply and demand and power grids being able to maintain their stability and resilience serving the demand.

Bahman Hoveida (01:14:53):

So, that's the biggest problem that I guess needs to be solved. And you either overbuild the power grid, which is very expensive and requires a lot of investments, and I think utilities would not do that until they have to. So, they're going to have to rely on a lot of technology to manage, better manage, the grid with their current infrastructure, So, you don't have to reconductor your lines, or up capacity or transformers. And so, essentially bringing in technology, like demand-response, be able to change the shape of the load. A big issue right now is use of EVs, or the impact electric cars are going to have on the grid when 40 to 60% of all cars are electric, these are huge loads that are being put on an antiquated distribution grid. And so, what do you do?

Bahman Hoveida (01:16:10):

It's going to require billions of investment in expanding the grid, strengthening the grid, or coming up with some clever software solutions for demand-response, reshaping that load that EVs are trying to put on the grid. That sort of thing. So, these are great times. I would say, with the integration of renewables and increase in load and just the population increase. I believe utilities are here to stay. A lot of people think renewables alone are going to solve our problem and utilities are going to go away, but I think utilities need to be the backbone of power delivery. So, even if they're like the "FedEx" of electrons, they're going to have to be there to move power from point A to point B.

Julie Cohn (01:17:26):

How much do you think technical innovation can get out of the existing infrastructure?

Bahman Hoveida (01:17:38):

That's a good question. I would say—at least in the US, most distribution grids were overbuilt. I mean, when they were built, designed, they were able to withstand several times load increases.

Bahman Hoveida (01:18:08):

So, we have a good resilient distribution grid that, during normal times—I mean, they fail when there's a weather event—we have high winds or icing on the lines—they fail. But during normal times, I think they can withstand quite a bit, coupled with some clever ways of managing loads, demand response—which is good not only for decarbonization, but also shifting the economics of essentially power consumption—with variable rates. I think you could change consumer behavior by reshaping, trying to reshape the load for like charging, or electric energy usage in the home. So, I would say, I don't have a number to put on it, but I think it's lot cheaper to add a demand response program to your power grid than build a substation or upgrade all your transformers or feeders. So, definitely it's a lot easier to, to apply a software solution to the problem. And a lot of utilities are doing that, right? I mean, especially the smaller cooperatives and rural companies are. I mean, demand responses has always been an important part of their power delivery in order to manage demand charges, I guess. Because they have to buy power, and they have to stay below a certain limit. So, they've been managing the load by shutting off air conditioners and furnaces and that sort of thing.

Julie Cohn (01:20:23):

Would that increase burden of sorts on maintenance of the infrastructure, and is that an interesting place where perhaps high-tech solutions have been absent in some ways over the past generations?

Bahman Hoveida (01:20:50):

I think running a utility operation is very complex. You're dealing with hundreds of thousands of equipment, you don't know what you have, where it is, what manufacturer provided that. And they have to manage, make sure that everything works all the time, and the consumer is served with a high reliability. So, aside from the infrastructure itself, I think in order to create reliability, you need to have a lot of good processes in place. You've got to have good software to be able to manage the assets that you have, schedule the work, schedule the work during the right times if you have to change out a transformer on a pole, when is the best time to do it with least impact to the customers.

Bahman Hoveida (01:22:08):

So, there's a lot of logistical maintenance and asset management problems that need to be solved with better tools. And a lot of tools out there are not optimal. These are not analytical tools. They don't care about the power flow. But it's a bunch of logistical tools, business tools to manage this very large inventory of assets that the utility has. So, that's an area of shortcoming that I've seen is that a lot of the systems out there cannot handle effectively this asset management problem for utilities. So, that's an area that I think is a good opportunity for somebody to take on.

Julie Cohn (01:22:56):

Thank you. We have occupied an hour and a half of your time already. Dan, you may have one or two additional questions. I don't want to take too much longer. And then also, if there are topics that we haven't touched on that you want to talk about, we would welcome that as well.

Daniel Molzahn (01:23:22):

Yeah, maybe I can ask one question that I think we haven't touched on too much, which is, So, you had mentioned some of the organizations and people that were really influential for you. IEEE was one, you talked about Pete Sauer and Illinois, University of Illinois. Were there other people or organizations that you thought were really inspirational or you got some great ideas from in terms of either technical developments at your organization or for you personally. Who are you looking to as kind of the thought leaders in this space?

Bahman Hoveida (01:24:03):

I think definitely all the power programs in the industry. I mean, in academia, not necessarily University of Illinois, but it's a pity that we don't have as strong power programs that we had in the '90s, I would say. And I hope that's an area that universities would—improve their power programs. And there are other power utility organizations like EEI, Edison Institute, and which are good forums to essentially exchange ideas about utility operations, technology. And there's a—definitely CIGRE in Europe is an influential and interesting organization. And there are typical trade shows. There's a trade show circle, like DistribuTECH, that is interesting. You can always learn a lot when you go there. You see different technologies being presented or exhibited.

Daniel Molzahn (01:25:36):

Great. No, that's really helpful. Julie—.

Julie Cohn (01:25:41):

Oh, I was just going to ask, was that one strategy you used back in the '90s to get your foot in the door? To go to present what you had at a trade show?

Bahman Hoveida (01:25:51):

Yeah, I mean, we, yeah, that's the best thing to do is to present yourself at a trade show. Yeah, we exhibited almost every year since we started the company. There used to be another trade show, I don't know if you remember called PICA, P-I-C-A or a conference. It was power industry applications—something like that.

Daniel Molzahn (01:26:24):

Power Industry Computer Applications.

Bahman Hoveida (01:26:27):

Computer applications. Yes. that was a very interesting, I would say, conference, but that somewhat ended back in the, I don't know, mid '90s was the last one that they had. That was a lot more technical than DistribuTECH. So, you had a lot of good technical presentations. And also, there was exhibitions—companies exhibited their solutions.

Daniel Molzahn (01:27:01):

Yeah, we had talked with a few other folks that had mentioned PICA as well—really this was before my time but really engaging. And an interesting conference.

Bahman Hoveida (01:27:14):

Yeah.

Julie Cohn (01:27:16):

We've really enjoyed this opportunity to chat with you and hope that it's been fun for you as well.

Bahman Hoveida (01:27:24):

Yes. Thank you very much. It was fantastic. Great.

Julie Cohn (01:27:27):

Thank you So, much.

[End of interview]