

Algorithms & Power Systems Architecture:

Using Historical Analysis to Envision a Sustainable Future

Oral History Project

Interviewee: Thomas Overbye

Interview Date: June 10, 2025

Place: Department of Electrical and Computer Engineering, Texas A&M University, College Station, Texas

Interviewer(s): Julie Cohn, Daniel Molzahn, Sairaj Dhople, Sanjana Kunkolienkar

Transcriber: Temi

Keywords: Thomas Overbye, system stability, optimization, power flow, simulation, University of Wisconsin-Madison, Madison Gas and Electric Company, Energy Systems Computer Applications (ESCA), University of Illinois-Champaign Urbana, Power World Corporation, voltage stability, geomagnetic disturbance analysis, energy management system (EMS), loop flow, Prime Computer, VAX computer, Fernando Alvarado, Chris Da Marco, sparse matrix, Pete Sauer, contingency analysis, security constraints, Wisconsin Public Service, slide rule, network analyzer, digital computing, punch cards, M.A. Pai, George Gross, John Bardeen, Nick Holonyak, power markets, Power Systems Engineering Research Center (PSERC), Bob Thomas, Bill Tinney, computing library, resiliency, geomagnetically-induced currents (GICs), 1989 Quebec Blackout, 2003 Northeast Blackout, *Power Analysis and Design*, Art Bergen, synthetic grid.

Abstract:

Dr. Thomas Overbye discusses his academic and professional experiences, noting his roles in universities, in utilities, and in Power World, the company he founded. He describes installing an energy management system (ESCA System 3), one of the first in the country, at Madison Gas and Electric and the influence this exposure had on his decision to pursue power systems engineering at the graduate level. His Ph.D. addressed voltage stability, but his real interest developed around visualization of power systems and creating visualization software tools for students and industry. He discusses advances in computing technologies that facilitated his work. He mentions teaching power systems to nontechnical people in the early 1990s, and the importance of animations to help with the concept of power flow. In reflecting

on his decision to go into power system engineering, he recalls his childhood interest in maps and the excitement of technology-rich shows like “The \$6 Million Man.” He continues with further discussion of his work at Madison Gas and Electric and his desire to understand how power flow worked. He talks about older technologies including slide rules, network analyzers, strip charts, and punch cards in the lead-up to using digital computers for power system calculations. Throughout the interview, he names numerous individuals who made significant contributions to power systems engineering and who served as mentors and advisors in his own work. He explains voltage stability. He recalls his involvement with the Power Systems Engineering Research Center (PSERC) and efforts to educate people interested in power markets in how power systems actually work. He muses on the use of the terms “power flow” and “load flow” interchangeably. He explains his more recent work modeling and analyzing the effects of geomagnetically-induced currents (GICs) on power grids. He describes the collegial atmospheres of the universities in which he worked. He notes his experience of synergy between academic and industrial environments and the importance of addressing the “messiness” of the real grid. He discusses a survey of the most influential technical papers of the past 25 years. He explains the concept of a synthetic grid. He closes by encouraging students to choose a supportive environment when they seek their first jobs after graduate school.

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 ([00:02:30](#)):

This is Julie Cohn. I'm conducting an interview with Thomas Overbye on Tuesday, June 10th, 2025, at Texas A & M University in College Station, Texas. Daniel Molzahn is here in the room with us and will be asking some questions. Sairaj Dhople has joined via Zoom and will be asking some questions and we have some other guests who may also, assist with the interview. Dr. Overbye, during today's interview, we are especially interested in your early work on system stability, optimization, power flow, and simulations, and how some of this work has carried forward into standard practice in the industry. But first we'll begin with asking you to give us a little bit of background about your educational and professional positions.

Thomas Overbye ([00:03:19](#)):

Okay. I'm originally from Wisconsin, grew up in Wisconsin by Milwaukee, and then did all my degrees at University of Wisconsin-Madison, first getting a bachelor's degree in 1983. Then I took a couple years to work for Madison Gas and Electric as an engineer. And that, that was really helpful for my career because I got experience in seeing how the grid actually operated. I actually worked on the installation of an energy management system. I put in, or we were involved with putting in ESCA System 3. So, that was a very cool project to be involved with. I then went back to grad school and while I was going back to grad school, I continued to work part-time at Madison Gas and Electric. And that was really helpful because while I was in grad school, I'd be working on research part of the time.

Thomas Overbye ([00:04:14](#)):

And when I got sick of doing that, I'd go work at Madison Gas and Electric. And it was like a nice mix between the academic and the applied, and that was really good. Graduated in '91, got a job at University of Illinois, Champagne Urbana, and then spent the next 25 years there. And then eventually retired at the end of 2016 and came down here to College Station, Texas and been a faculty member here at A & M since 2017.

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Julie Cohn ([00:05:01](#)):

So, if you were to describe where you are situated in the field. Would you characterize yourself as more of an academic, as more of an industry person, some sort of a hybrid?

Thomas Overbye ([00:05:15](#)):

I'm definitely a hybrid because along the way starting in about 1993, I started working on, well, actually starting when I was a grad student, I started working on software that eventually we commercialized and created Power World Corporation. Power World Corporation was incorporated in 1996. And I have continued to be involved with it in one form or another throughout my entire academic career. So, I'm a mixture. I mean, my position here is a faculty member and usually when I introduce myself, I say I am a faculty member at Texas A & M, which is what I just did. But I'm also, involved in Power World Corporation and have been throughout its entire history.

Julie Cohn ([00:06:00](#)):

Can you tell us a little bit about what that software was?

Thomas Overbye ([00:06:04](#)):

Yeah, power World Corporation makes power system analysis and visualization software. They've got well over a thousand different corporate entities as customers and do power flow, optimal power flow, stability, voltage stability, geomagnetic disturbance analysis, and lots of other things.

Julie Cohn ([00:06:27](#)):

So, looking back, were there one or two technical challenges that you found either really absorbing or difficult or exciting to work on?

Thomas Overbye ([00:06:41](#)):

Well, all of the stuff I've worked on has been very exciting over the years. One of the main niches that I got involved with was power system visualization. And that came from my desire to explain complex topics in a way that was understandable to students and engineers and the general public. And that got me into using computers. And as I was going through my career, the PC was developing. When I started, it wasn't clear that the PC was going to be a very powerful engineering analysis platform, or visualization platform, but that's turned out to be the case. And so, I've been able to focus on visualizing power system results. That was not my PhD. My PhD was in voltage stability. But I would say that was my most important contribution. And certainly, that helped us in the development of Power World Corporation. Because Power World's claim to fame was that we could analyze power systems well, and there was other software that could do that, but we could also, visualize it and we would say, "do it in a very user-friendly way."

Julie Cohn ([00:08:01](#)):

So, is that something that had been missing in the industry prior to that time?

Thomas Overbye ([00:08:07](#)):

Well, I wouldn't say it was missing. I mean, I think we had a niche. Part of it was I had worked as an engineer on an energy management system and I'd also, worked as an engineer doing planning software analysis. So, I saw both of them. I saw what we could do on an energy management system in a control room, and I thought we should really have this—similar capabilities—in software that students could use

or engineers could use or could be used to explain rather complex topics to whole hosts of different people. And in the '90s, the electric grid was restructuring, and there were a lot of people that were wondering: "how does the grid operate? What do these transmission lines do?" There was something called "loop flow" that everybody's wondering: "what is loop flow all about?" And we could show what was going on. So, there was a good niche available. There was power system software that had been developed many decades before I came on the scene. And we just used similar algorithms, but then did it in a very user friendly, visualization sort of way.

Julie Cohn ([00:09:23](#)):

It must have been advances in computing technology that facilitated that process.

Thomas Overbye ([00:09:28](#)):

Well, what helped me out a lot in the development of Power World was the growth of the PC. When you started, you know, the PC came out by mid'80s sometime. And it wasn't particularly powerful. What we were using for analysis at that time is a lot of minicomputers like the—at Madison Gas and Electric, we used a Prime computer. And then in our energy management system we had VAX computers. So, I was familiar with those computers, and they were pretty powerful, and PCs weren't, but eventually PCs caught up and made it So, that we could have a good niche.

Daniel Molzahn ([00:10:14](#)):

So, one question along those lines, was that widely observed by many people in the industry or was that something you noticed and were an early adopter, because you were able to take advantage of that insight? Or was that something that everyone sort of expected? PCs to get better and better? This was the path forward?

Thomas Overbye ([00:10:32](#)):

I was always amazed that not a lot of people worked in power system visualization. And I thought it's kind of funny that they didn't, but a lot of people didn't. I mean, no, very few people did. So, I had an open field in in that regard. I will say, you know, you're talking about the important people that helped shape us too. And certainly, being an undergrad and a grad student at University of Wisconsin-Madison, that was very good. And I ran into some great people there, one of which was my advisor, Chris Da Marco. And then the other one was Fernando Alvarado. And I learned a lot about, about sparse matrices

from Fernando Alvarado, and I definitely put it into practice. So, I think I had great classes to help me as well.

Julie Cohn ([00:11:33](#)):

I'm trying to think about how to make this more accessible to people who've not dealt with the power industry at all but may have an interest in this topic now. And I know that power system control rooms have had some sort of graphic display in front of the system operators, or even the very early load dispatchers, as far back as the 1920s. So, that's one piece of the puzzle, which is watching where the power's being generated and where it's going. But you're talking about a different aspect of the power system, is that correct?

Thomas Overbye ([00:12:13](#)):

Well, I had worked in a control room, and we had a map board, and it was a static map board, but we had one-line diagrams that were on, I guess, there were eight monitors. And I was used to analyzing grids in a control room in a more graphical sense than we did in the planning software. So, I took that and transferred it over into the educational planning analysis realm as well. So,

Daniel Molzahn ([00:12:46](#)):

Another question along those lines, So, you mentioned a couple times education and students and how much that was driving what you were doing. So, what role did—were you teaching a class that where, like, "oh, I really wish I could show this in a more visual way?" Or what was that intersection like with your educational—

Thomas Overbye ([00:13:03](#)):

The way Power World, we didn't call it Power World then, but the way Power World was born is University of Illinois got a contract from Edison Electric Institute in 1993 to teach power system concepts to non-technicals in the power industry. Lawyers, regulators, engineers from outside the power domain. And we were, I was talking with Pete Sauer, and we were like, "how do we do this?" And we thought, well, we could make a, like an animation of how the power flows in the grid. And at that time, computer software was getting—PC technology was getting where it could support interactive visualization, eventually animation. And we took advantage of that. And it just helped explain concepts. I mean, we were doing animated displays in 1995, which was pretty state-of-the-art at the time.

Daniel Molzahn ([00:14:08](#)):

So, do you think, I mean, it sounds like a lot of this was driven by deregulation going on at the time. Do you think if this had been the '80s or if deregulation happened in the mid two 2000s instead of the '90s, that this would've taken off as much? Was that what was driving the development?

Thomas Overbye ([00:14:23](#)):

Certainly, it helped, and I feel like I was in the right place at the right time with the right background. You know, it's like whether it would've occurred, you know, with the computer technologies of the '80s, probably not. And if there hadn't been a lot of people saying, "Hey, we want to understand how the grid works." And part of the drivers for the early development of Power World is that two utilities in the Midwest were looking to merge. And in doing that merger, some utilities in the middle were very concerned that they would lose transmission access. So, you had these issues of transmission access. How do we explain that to people that really didn't understand intuitively how the electric grid operated? So, that's where Power World got its start, is explaining these concepts So, that the utilities could go and show their regulators or—different politicians were involved and seeing it was, I guess, the right technology at the right time.

Daniel Molzahn ([00:15:35](#)):

So, did you work with people that were graphic designers and people in—perhaps non-technical, but more on the artistic side or graphic design side to do this, or?

Thomas Overbye ([00:15:45](#)):

Not too many. Just made it up on our own.

Julie Cohn ([00:15:51](#)):

Sairaj, did you want to jump in at this point?

Sairaj Dhople ([00:15:54](#)):

Yeah, you mentioned, Tom, at the very beginning something—I might be mispronouncing this, but—ESCA? Is that something that you referenced earlier on?

Thomas Overbye ([00:16:04](#)):

Right, ESCA.

Sairaj Dhople ([00:16:06](#)):

What is ESCA?

Thomas Overbye ([00:16:08](#)):

Well, ESCA was a company that developed energy management systems, and they got started in either, I think it was like the late '70s, I think it was like 1979, to sell utility control systems. What we call an energy management system. And they have since been bought, they were ESCA then they were Riva, then Alstom, and then they went back with one, and now they're a part of GE. So, their software is still widely used. In fact, when I talk to engineers who work on these systems, the concepts that I learned in the '80s are still around. So—

Sairaj Dhople ([00:16:56](#)):

Thanks. And I did have question.

Thomas Overbye ([00:16:58](#)):

What was cool about this is, I was working at this, this pretty small utility, this Madison Gas and Electric. And this is funny because our peak load when I left there in 1991, I think was about 600 megawatts. Now we put in data centers, a single data center might be 2-3,000 megawatts, you know. So, this was 600 megawatts for the whole city. But we had this energy control system, and we were buying it. It was the, I would say, the top technology in the energy control center business. We were their third system. Pennsylvania Power and Light was their second and Gulf States Utilities was their first. And so, we just—a few of us engineers got to work with some of the top people in the industry. So, here I was just somebody with a bachelor's degree working with people whose papers I would learn about when I started taking grad classes. So, it was a great opportunity.

Julie Cohn ([00:18:03](#)):

Were any of those individuals especially influential in the path you took after that?

Thomas Overbye ([00:18:10](#)):

I think just, being exposed to their software, I graduated with an undergrad degree, and I went and worked at Madison Gas and Electric, and we were implementing this state-of-the-art control center. And we were dealing with topics like optimal power flow and contingency analysis and security constrained contingency analysis, visualizations that were state-of-the-art. But I really, you know, as an undergrad, I just hadn't been exposed to all that. So, I was like, "I want to go back to grad school and be a developer of this sort of stuff." So, it was a very exciting time. I mean, I think nowadays it's very exciting with all the changes in the industry as well. But that was a very exciting time because it showed me the potential. So, I left Madison Gas and Electric full-time, went back to school full-time, but then I continued working as an engineer at Madison Gas and Electric part-time.

Sairaj Dhople ([00:19:13](#)):

Tom what got you interested in the power area in the very beginning, even in your undergrad days, what prompted you to take up your Madison Gas and Electric position?

Thomas Overbye ([00:19:24](#)):

I got a job as a student engineer working there. Truth be told, my brother was a power—he had a job at Madison Gas and Electric before me, and he was like, "Hey, you should apply." When I started as an undergrad, I wanted to be a biomedical engineer, wanted to do biomedical engineering. Because I'd watched the \$6 Million Man, I thought, "that is So, cool." And when I started undergrad, the thing I knew I did not want to do was the power engineering. And so, then since my brother had worked there, I got a job at Madison Gas and Electric in 1981. And I got there, and I was like, "what is this all about?" And Dan, you were just looking at that map of the grid that I have over there, which is, I think it's from like 1990 or something, but there was an earlier version of that map, which is an electric grid map of Wisconsin. And I was looking at that. And as a kid, I had always liked maps, not circuit maps, but I was like, "this is a map, and this is what I like is maps." I was like, "that's an electric circuit superimposed on Wisconsin." I thought that was So, cool. So, I was like, "maybe this is a more interesting area than I thought." Because as an undergrad, I was like, "oh, who wants to design like extension cords. It's kind of boring."

Julie Cohn ([00:20:49](#)):

No extension cords then in your professional career.

Thomas Overbye ([00:20:52](#)):

No, I haven't done much with extension cords.

Julie Cohn ([00:20:56](#)):

Is there a through-line in any way from your PhD thesis on voltage stability to other things that you've done?

Thomas Overbye ([00:21:03](#)):

Is there a what?

Julie Cohn ([00:21:05](#)):

A through-line?

Thomas Overbye ([00:21:08](#)):

Well, it's kind of funny, because I was just talking to my students yesterday, yeah, Monday, about a problem that dates back to—I was telling them this is a problem that I talked about a little bit in my master's thesis, and we just saw it in some large-scale grids that we were solving. So, issues that I was dealing with back then are still issues. We hopefully are working on solving them. And one of the people that is going to help with that is sitting in the audience here. But part of it was, I was doing theoretical stuff in voltage stability energy methods, which sounds difficult. And I'd write papers and, you know, the papers would get accepted, but people would say, "well, I don't know if there's actually a usefulness in this." I think there is. But then I started doing visualization and everyone was like, "this is So, cool." So, there's certainly a continuity. And I think I had a great advisor, and I think I did a pretty good thesis, but when I switched away from that and got into visualization, I got a lot more interest in my research.

Daniel Molzahn ([00:22:27](#)):

I had a couple follow-ups on the visualization questions. So, one was, Power World came in, had these, I think, much, much nicer visualizations than was available in other software. Did other companies try to

catch up? Was this something that they tried to improve over time? And if not, why not? Why wasn't that something that pushed the industry forward if it did happen?

Thomas Overbye ([00:22:51](#)):

Certainly, other companies have—when you work in engineering, in general, and in software development, certainly you're looking to some extent at what others are doing and building on that. And others have certainly built on or copied what Power World did.

Daniel Molzahn ([00:23:14](#)):

Another question—because I'm very interested in Wisconsin—So, it always seems like there's a lot going on in Wisconsin. We talked to Anjan about some of the first energy management systems, or, from his telling, the first energy management system going into Milwaukee. I spent some time at Wisconsin Public Service, and they at least claimed that they had the first GIS systems in place at Wisconsin Public Service. You're describing maybe the third EMS system, at least from this company, at MG&E. What was going on in Madison or Wisconsin?

Thomas Overbye ([00:23:46](#)):

I don't know. It's like—but there was a lot of cool stuff going on in Wisconsin and, you know, again, my small company was putting in this pretty state-of-the-art energy control center. And Wisconsin Electric, which—they were over in Milwaukee, we were in Madison—they were doing some really cool stuff as well, and like security constrained optimal power flow. I remember going over there and talking to their engineers. So, there were cool things going on there. And in terms of why, it's like, I don't know. I was just a bachelor's degree engineer. We did have an integrated plan that the state of Wisconsin was doing, but whether that was what was driving it, I don't know. But it was a great place to be.

Daniel Molzahn ([00:24:37](#)):

Yeah. We'll keep asking that question to Wisconsinites until I figure out the whole story,

Thomas Overbye ([00:24:43](#)):

You know, when you're a student, you don't necessarily know how famous your faculty members are or not. I just think we had a lot of great faculty members at University of Wisconsin-Madison,

Daniel Molzahn ([00:24:56](#)):

No complaints there.

Thomas Overbye ([00:24:57](#)):

No, it was great place. Still is a great place.

Daniel Molzahn ([00:25:00](#)):

One other question along those lines. So, you put in place Power World. you have this nice tool to be able to visualize things, show it to lots of different audiences. How much did you—it seems like that was a really nice platform for your research as well, right? I remember seeing some of the GIC work with the geomagnetic storms and making really nice visualizations of that and going to Congress and showing off these challenges. It seems very fortuitous that you had this tool in place—that you could take your research work and then make very nice visualizations for lots of audiences. Was that always the plan or this sort of was a tool that worked out and it all came together?

Thomas Overbye ([00:25:41](#)):

I wish I could say it was the plan, but it certainly wasn't the plan. I started developing software—I mean, I like doing software development. Once I started working at Madison Gas and Electric as an engineer, I started doing software development while I was still an undergrad. And that was a lot of fun. I was like, "this is fun stuff." So, I just continued doing that. When I started writing the code that became Power World, the reason why I started writing it is I just wanted to understand how a power flow works. That was all. It's not like I was thinking, "oh, I'm going to make this great software package that in, you know, however many years later we'll be talking about."

Julie Cohn ([00:26:22](#)):

In some of our prior interviews, we've heard people talk about transitioning away from analog computing and calculating machines. And some lamented the loss of access to network analyzers because they felt that those provided a young engineer with kind of a physical sense of how an electric system works. And they complain that the digital version, the digital modeling available at that time didn't really confer that same experience. Do you think your approach to the software for Power World solved that problem?

Thomas Overbye ([00:27:05](#)):

I don't know. I laughed, because I'm thinking those people you were talking to must have been older than me. One of the things, my brother was, he got a degree in electrical engineering two years before me. When he went, he had to take a slide rule class. That was an analog device. Okay. When I came along, just two years later, we no longer took the slide rule class. The office I had at Madison, they said there had been a network analyzer in that office, but I never saw the network analyzer there. I never used a network analyzer. By the time I was in engineering classes, we were using digital computers. We still use punch cards. We definitely used punch cards. You'd go down and you'd punch them up, and then you'd throw them in the card reader and wait for your paper to print out. But I was of the digital era, So, I wouldn't lament them because I wasn't there to lament them.

Julie Cohn ([00:28:10](#)):

I guess the point I was working toward was, you, moments ago, said you were curious about how power flow worked.

Thomas Overbye ([00:28:19](#)):

I was.

Julie Cohn ([00:28:19](#)):

And that was just starting?

Thomas Overbye ([00:28:20](#)):

I still am to some extent.

Julie Cohn ([00:28:22](#)):

Yes, I think many are. But you developed software to help you understand that better,

Thomas Overbye ([00:28:35](#)):

Right? Because when you actually have to code in an algorithm, you really have to know how it works. Because ultimately, you're going to be solving problems and people are going to be putting all sorts of different inputs in. And you've got to make sure your algorithms are pretty robust and really understand

how they work. As a faculty member, when we explain stuff to the students, sometimes you understand what's going on, but if you don't fully understand what's going on, you can just say, "well, this won't be on the test." And then they'll be like, "okay."

Thomas Overbye ([00:29:13](#)):

I mean, you can kind of wave your hands and nobody—but when you code it, it's like—I remember coding machine saturation and initializing for machine saturation. And I was like, "how do you initialize this?" And I worked a lot with Pete Sauer and Pete Sauer is like a legend in our industry. And Pete Sauer has written the book on synchronous machine modeling. And I talked to Pete, and I was like, "well, how do you initialize these with saturation?" And I don't think I ever got a satisfactory answer from him on how you initialize them with saturation. But I had to do it. I mean, when you code it up, it's like, you can't just say, "well, then a miracle happens." You have to actually know how it works.

Julie Cohn ([00:30:00](#)):

Well, I guess my question is then, do you think that algorithms you developed are more like a power flow algorithm would look than like a computer software algorithm for a different set of outcomes? I'm not sure if I'm framing that question, but—

Thomas Overbye ([00:30:26](#)):

I mean, there's different types of algorithms and I would say I work more in scientific computing than in other parts of the software industry. But you have to know different aspects of algorithms like how to do sort and things like that. And when we started coding, there weren't nearly as many libraries available to take advantage of. So, you had to write your own code—like some of the early code in Power World to make graphs. We had to write, and you'd go, "tick, tick, tick, tick, tick" for the access and where to put the tick marks. And because we didn't have packages to do that, now there's packages to do all this stuff.

Julie Cohn ([00:31:10](#)):

Sairaj, any other questions at the moment?

Sairaj Dhople ([00:31:13](#)):

Tom, I want to take you back to your early days at Illinois. Can you share a little bit about what they were like for a young assistant professor coming out of grad school and who your colleagues were, and you know, what sort of discussions and topics that people cared about at that time were.

Daniel Molzahn ([00:31:29](#)):

We can cover both our alma maters here.

Thomas Overbye ([00:31:32](#)):

I was super honored to get a job at Illinois, and that was such a—So, many great things happened at Illinois. And what I would, what I would say, and I meant to say this to my students yesterday, but I forgot, but when you get a job, if you have supportive colleagues, that is So, helpful. And at Illinois, I fell into such a supportive environment there. We had like Pete Sauer, and M.A. Pai was there, and then later on, George Gross joined. And it's just a very supportive environment. But I will say when I interviewed at Illinois, I interviewed there in 1991, I guess I had gotten a job. I was in Everett lab on the third floor, and I walked up there when I started, and I'm pretty sure I walked by a door that had John Bardeen's name on it.

Thomas Overbye ([00:32:30](#)):

John Bardeen, of course, invented the transistor. He had died by then. I think he died in 1990, but I think his name was still on the office door. And it's like, okay, that's kind of intimidating. You know, it's like, that's pretty intimidating. And my office was two doors down from one of Nick Holonyak's offices, and Nick Holonyak invented the LED and the silicon-controlled rectifier. And won just about every award there is to win except the Nobel Prize. So, it could seem—I mean, I felt very intimidated there. But the faculty were So, supportive. It's like they were So, supportive. So, I felt like I just came into not—I mean, certainly the power faculty were very supportive, but all the faculty were supportive. And it's like, I'd talked to people in the faculty office and they're National Academy of Engineering members, and here I was just an assistant professor, but they made me feel very at home.

Thomas Overbye ([00:33:28](#)):

So, it was a very supportive environment. And a nice thing about Illinois is Pete Sauer ran a very collegial power group. So, we would go to lunch every week, and he'd talk about all sorts of different issues at lunch. I remember starting out talking—sitting there in the meetings and Pete and Pai, and later on

George Gross, would talk about all these giants in the industry that I had no idea who they were. But you know, I was like, "how do you know all this?" And now that I've been around for a while, yeah, you just hang around long enough and you get to know everybody. The problem is that people you know start dying. That's a disadvantage. But having a supportive environment—Illinois is a very supportive environment.

Sairaj Dhople ([00:34:21](#)):

Can you say a little bit about what were the burning topics of the day at that time, just broadly across the power systems research landscape?

Thomas Overbye ([00:34:30](#)):

The main topic when I was in grad school and when I started my faculty career was voltage stability. Everybody was talking about voltage stability. And then suddenly markets came out. And then suddenly everybody was talking about markets. So, by the mid-'90s and towards the later part, I guess it was mid-'90s, suddenly everybody was switching over to markets and restructuring and, and things like that. So, it started out with voltage stability, but then because of the changes in the industry, I think the Energy Policy Act was passed in 1992, and that drove a lot of change. So, it was during a time of rapid change, and that gave us a lot of opportunities.

Sairaj Dhople ([00:35:15](#)):

Just one last follow-up, for the benefit of our audience, can you just, in very simple words, describe what voltage stability means

Thomas Overbye ([00:35:25](#)):

Volt—I mean, how simple do you want me to be on voltage stability?

Sairaj Dhople ([00:35:31](#)):

Let's say for with an undergraduate level understanding of power systems

Thomas Overbye ([00:35:36](#)):

Voltage stability, you could say, in an electric grid, we've got two major quantities. We have the frequency. And frequency is sort of telling you a mismatch between how much power is being generated, how much power is being consumed. And if you don't have enough generation, the frequency is going to fall. And that's what we ran into here in Texas during Winter Storm Uri, is we didn't have enough generation, and we had some frequency problems. The other issue is, if you try to push too much power through your transmission system, the voltages, which you need to keep pretty close to the—what we call "the specified voltage level"—close to one per unit, or a hundred percent—if you try to push too much power through the grid, the voltages start to fall. And as the voltages start to fall, you get this feedback where the voltages falling causes higher losses, and these higher losses drive the voltages further down. So, you can get into a case where your system just loses its ability to support the load. And that's what voltage stability was, and still is, all about.

Daniel Molzahn ([00:36:47](#)):

I might have a brief follow on that, Julie. So, voltage stability was a big topic with many of the folks that we had talked to.

Thomas Overbye ([00:36:54](#)):

Everybody.

Daniel Molzahn ([00:36:56](#)):

Everybody.

Daniel Molzahn ([00:36:58](#)):

And so, one of the things that struck me with some of those earlier interviews was—. Now, I think we have these sort of fundamental principles of what is happening. We understand pretty well what's happening in these multiple stability, instability cases, and we can teach it in undergraduate classes or graduate classes. At the time, we got the impression from some of the other interviewees, that it was this very mysterious thing that you sort of had to model the entire system in great detail, and it wasn't the same fundamental understanding of what was happening. So, how did that develop to where we today have sort of a—I don't want to say first principles—but a fundamental understanding of what's happening versus it being kind of mysterious situation.

Thomas Overbye ([00:37:37](#)):

Well, one of the things is that we have much better sensing of the grid now than we did then. And, you know, back then, if you looked at a control center—and again, I worked in a control center—and walked into a control center back in the '80s, and to large extent the '90s, you'd see a lot of strip charts, paper strip charts. And it wasn't like we were recording strip charts, but we weren't recording digital data. So, if you wanted to know what happened to our grid in the past, we didn't really have a good record. If you think about how much storage cost then, and how little memory the computers had, I mean, it's amazing when you think about the people that were like 10 years before me, and they were coding on computers that had 16 kilobytes of memory.

Thomas Overbye ([00:38:37](#)):

I was working on computers that might have 256 kilobytes of memory. And we thought, "oh my gosh, this is like, So, great." You know. But we weren't recording the data. And even when you get SCADA data, SCADA data was scanning the system every 10 seconds, maybe you'd get an analog reading coming back and it might be good, it might not be good. So, now we have phasor measurement units providing us lots of data, So, we have a much better feel for what's going on with the grid. When I started in the control room, we had a Quindar computer, and that Quindar computer, the way you booted it up was from a paper tape. And I, as a new engineer, when we had to boot it, I would have to boot it, I'd sit there. And when you run paper tapes, you know, the paper tapes have one byte. You watch those bytes go in one at a time, and the paper tape reader would tend to jam up. So, you had to sit there and make sure it got enough. You got an appreciation for the value of a byte,

Julie Cohn ([00:39:43](#)):

A literal bite.

Thomas Overbye ([00:39:45](#)):

It was literally. Yeah.

Julie Cohn ([00:39:50](#)):

With the advent of markets, what were engineers most worried about in terms of what was going to happen to the grid?

Thomas Overbye ([00:39:59](#)):

I know what we were worried about is, I was involved in PSERC at the very beginning, Power Systems Engineering Research Center, and PSERC was trying to get an NSF Engineering Research Center, because we were saying, "we're putting these markets on what is really an electrical circuit, and people don't really understand the ramifications of what they're doing." We were saying, "we really need to study these markets." So, I got involved with, I was involved with PSERC, and PSERC was led by Bob Thomas then, and Bob Thomas is another one of the industry visionaries who unfortunately has passed away as well. And he was looking at the interaction between markets and the electric grid. He got economists involved and I was involved in that. And that was just great, a great place to be. And then, you know, California had their energy crisis, and I guess it was like 2001, and we felt like a little vindicated. Because we said, you should really look at these markets before you just dive in. And the politicians just wanted to dive in. So, they dived in and they lived the consequence of that.

Julie Cohn ([00:41:22](#)):

Did you witness other examples? I mean, the California case is somewhat famous, but other examples of the electrical circuit not matching what the market thought it was creating?

Thomas Overbye ([00:41:36](#)):

Well, I think throughout we've put this market structure on, I think the market structure is a good structure to have on the grid and the work that people like Fred Schweppe did, and Dick Tabers. I don't know if you've talked to him, but if you haven't, you should. But it's kind of great, but it's also, very challenging to do. To the extent that the August 14th, 2003 Blackout was due to this is harder to say, but that blackout did occur on the seam between two different markets, if you will.

Julie Cohn ([00:42:18](#)):

Were there any smaller incidents that people looked at and said, well, we know that that happened, let's figure out how to not do that again.

Thomas Overbye ([00:42:29](#)):

Well, I can't think of any specifics, but I think throughout engineering you run into that. You say, "oh, this went on, how do we fix that?" I was just talking to my students yesterday about something that we saw in a power flow, the convergence of a power flow and how to fix it. So, that goes on continually.

Julie Cohn ([00:42:50](#)):

You want to follow on that or—

Daniel Molzahn ([00:42:52](#)):

Maybe. I can talk about power flow a lot, but—

Thomas Overbye ([00:42:56](#)):

Note that we're calling it power flow, not load flow.

Daniel Molzahn ([00:42:59](#)):

I've told my students this story from you about load doesn't flow the power flows

Thomas Overbye ([00:43:06](#)):

Well, right. George Gross is the person that always said—I honestly don't remember what term I'd learned at Madison. I probably learned "load flow," but when I got to Illinois, George Gross would say the load doesn't flow, the power flows. So, he was a power flow guy. So, I'm a power flow person, actually changed my textbook from load flow to power flow. But the two terms have been used interchangeably in the industry since at least the 1950s. And you can have smart engineers talking and one person will be saying load flow, and one person will be seeing power flow. We're talking about the exact same thing, and nobody's going to change. So, the only hope is we change it at the student level. So, we're doing our best.

Daniel Molzahn ([00:43:57](#)):

I try.

Thomas Overbye ([00:43:57](#)):

Yeah, it's like you can do it and there's other people that are pushing load flow. So, it's just kind of funny how it's persistent. And I've looked at some of the early papers and, you know, maybe we did use power flow because Bill Tinney was a power flow guy, and Fernando Alvarado worked with Bill Tinney, So, maybe it was power flow. But it, it could have been that the textbook that I used was load flow.

Daniel Molzahn ([00:44:24](#)):

One other—I have many other power flow questions—but one other one that I've been curious about is how much—as you had said, you were coding these by hand, there was not a lot of libraries available. You mentioned the visualization libraries, but just in general, not having scientific computing libraries. So, how much did the power engineering folks intersect with the scientific computing/applied mathematician sort of folks? Were those communities working together or these were pursuing things separately?

Thomas Overbye ([00:44:53](#)):

Certainly, sparsity developed in different communities. Sparsity in the power domain, we would say we invented sparsity, but other communities would say they invented sparsity. So, there was certainly some interaction between them, but I wasn't really involved in that. I was just looking at it from a power system point of view.

Daniel Molzahn ([00:45:18](#)):

Did you read papers from applied mathematicians and say, "this is how we should implement numerical integration techniques" or these sort of things? Or, you had the methodologies—you were familiar with them?

Thomas Overbye ([00:45:29](#)):

Mostly I learned them in class, and I learned them mostly from Fernando Alvarado.

Daniel Molzahn ([00:45:36](#)):

Yeah.

Thomas Overbye ([00:45:37](#)):

I actually took probably more classes from Fernando Alvarado than any person on this planet. Actually had him— he taught—because as an undergrad there, he taught my sophomore lab class. And I mentioned that to Fernando and he's like, "what? I don't remember teaching you." Probably tried to not think about it.

Julie Cohn ([00:46:01](#)):

Are there other technical topics that have occupied your research interests over the ensuing years that we haven't touched on yet?

Thomas Overbye ([00:46:11](#)):

Well, certainly resiliency. We're all talking about resiliency now. You know, one of the newer hot topics is resiliency, as is AI. And associated with the resiliency, I got involved in the modeling of geomagnetically-induced currents on the grid, what we call GICs. So, that's been a part of my research, I think since about 2011 or '12.

Julie Cohn ([00:46:41](#)):

Can you tell us a little bit more about that? What is the question you're trying to answer with your work?

Thomas Overbye ([00:46:47](#)):

Well, in that area, it's how can a—what we call geomagnetic disturbance, which is a solar storm—it's what causes the northern lights—how can that affect the grid? And in 1989, the province of Quebec was blacked out as a result of a GMD. These are driven by activity on the sun, and the activity on the sun goes through 11-year cycles. So, back in about 2010 or so, there was interest picking up in modeling the impact of GMDs on the grid. And because I was familiar with power flow algorithms, I went to some of the early meetings on it, and I was like, "this is something that we could directly incorporate into power flow software." So, I led an effort to incorporate modeling of geomagnetically induced currents in the power flow.

Daniel Molzahn ([00:47:47](#)):

I was always curious about, was there some event that happened at that time? There was a big solar storm? Or? It seemed like all of a sudden that was a topic that everyone started talking about around 2010.

Thomas Overbye ([00:47:59](#)):

Yeah, and I know there was a DOE/NERC workshop on what they called "high impact low frequency events" that took place. I wasn't involved in that workshop and that took place around that time. It might have been a year or two before. Then PSERC got some money from DOE and that money allowed us to look at these high impact, low frequency events. So, I got a project, a PSERC project to look into this. So, what drove it? Why then? I don't know. I mean, it could have been the August 14th, 2003 Blackout that primed people to be thinking about these. But I don't know specifically where it came from. The Quebec storm, you know, that was in '89, So, that was like years before.

Daniel Molzahn ([00:48:54](#)):

One other technical question on this, when, So, from my understanding, you also, get a large EMP or pulses like this from nuclear weapons in the atmosphere. Is there, was there an intersection between analysis methods for solar storms and explosions?

Thomas Overbye ([00:49:10](#)):

Yeah, and that NERC report listed four high impact, low frequency events. One was a GMD; one was a pandemic of all things. One was a combined cyber/physical attack, and the last one was a high-altitude electromagnetic pulse. So, when we started looking at geomagnetic disturbances, the GMDs, they caused these geomagnetically induced currents, affectionately known as GICS. And an HEMP, a nuclear explosion at high altitude, will cause GICs as well. So, yeah, there's certainly relationship between them.

Daniel Molzahn ([00:49:49](#)):

But I guess two questions. Can you use the same analysis tools?

Thomas Overbye ([00:49:53](#)):

You can use similar methods. They're not the exact same tools, but they're related.

Daniel Molzahn ([00:49:59](#)):

Okay. I've mentioned that to my students. I wanted to make sure I was saying something correctly.

Thomas Overbye ([00:50:02](#)):

The HEMPs, cause—they cause a very fast pulse that can destroy electronics, and then they cause a slower pulse. It's called the E3 pulse. And that can—it kind of looks like a GMD on steroids.

Daniel Molzahn ([00:50:22](#)):

And do you think we have that well—I mean, not specifically the nuclear blasts, but the GICs in general—is that mostly solved at this point in your opinion? Or is there still lots to do on the modeling analysis?

Thomas Overbye ([00:50:37](#)):

I think there's a good bit to do still. It's like—we just had a modestly large solar storm that occurred last year and that caused more harmonics than I think we were expecting. So, one of the hot topics, if you want, is looking at harmonic analysis and the GICs-caused harmonics, be it from a GMD or from an HEMP.

Daniel Molzahn ([00:51:05](#)):

Okay.

Julie Cohn ([00:51:08](#)):

Sairaj, did you want to jump in at this point?

Sairaj Dhople ([00:51:12](#)):

Only if I can change the topic of conversation.

Julie Cohn ([00:51:15](#)):

Absolutely.

Thomas Overbye ([00:51:16](#)):

Okay.

Sairaj Dhople ([00:51:17](#)):

So, Tom, I won't embarrass you by listing specifics, but you know, we've heard several stories from other interviewees on how you've influenced their lives and the role that you've played in building community

and the role of service in general that you've held, in a very principled way, close to your heart and how you've made that come across as a big, you know, difference-maker for people's careers. Can you say a little bit about community and service and why you're So, passionate about this and how this has played a role in shaping your career?

Thomas Overbye ([00:51:52](#)):

Sure. I'm passionate about it because I had a great faculty mentor in Pete Sauer and Pete Sauer was just a good role model in all this stuff. And I can't say enough about him and the impact that he has had on our industry. So, I feel like I'm a reflection of some of the things that Pete did. So, it's like here, I do think, you know, we want our students to learn a lot, but we want our students to have a great time in grad school and to feel like they're part of a community. And we try to involve them in different things. Like, I have two of my students sitting in the background here. Whether they'll ask any questions or not, I don't know. But that came from Pete and it's like Pete would put out the—in fact, I, we have some on the bookshelf that I'm looking at—

Thomas Overbye ([00:52:45](#)):

We would put out our Power Affiliates book every year, and Pete would have a bio of all the students in there, and he'd say where your hometown is and things like that. So, he just cared a lot about the students. He had a saying that students aren't buckets to be filled, but candles to be lit. I learned since that there was a Greek guy that predated Pete like by a couple thousand years on that. But I thought it was Pete's. But it's a good sentiment that you want to treat your students well. So, I hope that that's part of the legacy that I pass on. Illinois would have events for their students often, and we try to have events for our students often. So, that's one of the fun things about being a faculty member is you get to interact with these great students.

Thomas Overbye ([00:53:33](#)):

So, it's like, yeah, treat them well. And yeah, I think you are a—what do we call it? You gain from that as well. So, yeah.

Sairaj Dhople ([00:53:46](#)):

Thanks for sharing that.

New Speaker ([00:53:47](#)):

It's the same with faculty, like mentoring and helping along the—you know, as you get older, suddenly everybody's younger than you. So, I was helping along the younger faculty. And we just had lunch with these guys, and I invited some of our younger faculty to that, some of our less young faculty too. But yeah, it's just part of being part of the job. But I remember Pete talking about the importance of service and helping the students out. So, I learned from that.

Julie Cohn ([00:54:26](#)):

Can you talk a little more about straddling the worlds of industry and academia? Because for some, I think they work in very siloed environments.

Thomas Overbye ([00:54:37](#)):

Yeah, I think there's a lot of synergy in being able to work in an academic environment and also, be able to work in an industrial environment. So, I've enjoyed that. And again, part of that was coming out of Illinois and Illinois just had a good relationship with industry. So, I gained that from Pete. And Pete was one of the people that helped me develop the initial version of Power World. Not from a coding point of view, but from a design and a cheering-on point of view. But being able to go out and interact with industry, that's very synergistic with the academic side of things. And I know there's some academics that are more into theory and we need people that are more into theory, but I like to be more on the practical side of things.

Julie Cohn ([00:55:26](#)):

Do you think your experience working for utility engendered a certain amount of trust when you as an academic would interact with people in industry?

Thomas Overbye ([00:55:37](#)):

Certainly, helped me understand where they're coming from. And, you know, it's like you go out and you talk to engineers and it's like, okay, most of them, very few of them are going to remember what an eigenvalue is. And when I was working in industry, if you asked me what an eigenvalue was, it's like, "I don't know." It doesn't relate necessarily. I mean, it sort of does. But it doesn't relate to your job. So, when I publish papers, I try to make my papers more readable to an engineering audience, a practicing

engineering audience. And I think that's something that we need more of. I feel like oftentimes research isn't solving the real problems. One of the fun things I did is I co-chaired a National Academies study group looking at the analytic foundations in the next generation grid.

Thomas Overbye ([00:56:42](#)):

And we had mathematicians there and power engineers there. And it was—you learn to appreciate where they're coming from and hopefully, they learn to appreciate where we're coming from. And, you know, some people would say, "look, I want to simplify the problem down enough that I can formulate it mathematically, and then I solve that problem. I produce a paper that has tons of equations in it, and I declare success." And it's like, well, we need those papers, but they're not going to be very accessible to an engineer who is a practicing engineer out in industry who wants to solve their problems. And their problems involve large-scale grids that are very messy. So, I have that kind of background. When you develop power system software, we have to deal with the messiness of the real grid. So, you work with engineers, and they say, "Hey, you gotta model this." And "yeah, you've got to model this," or "the power flow didn't solve, it solved an alternative solution. How do we fix that?" So, I was just talking to my students yesterday about how do we fix that

Julie Cohn ([00:57:53](#)):

And how do you?

Thomas Overbye ([00:57:56](#)):

You get good students involved in it! You have to solve the problems. Because when you have software and you got customers, you've got to solve the problems for them as much as you can. You can't just write a paper with a whole bunch of equations and say, "if I simplify it down this far, I get a really nice, elegant solution," because that doesn't solve their problem. And I worry a little bit about our industry, that the academic side of our industry is that we have sort of more and more papers read by fewer and fewer people.

Julie Cohn ([00:58:36](#)):

Are there, do you think there are opportunities to bring those real-world problems into focus in the academic setting more effectively?

Thomas Overbye ([00:58:50](#)):

There's opportunities to do that. Yeah.

Julie Cohn ([00:58:54](#)):

What, how would one go about doing that?

Thomas Overbye ([00:58:57](#)):

There's some things that we're thinking about doing. You know, you can have seminars and talk to people about it. I mean, there's some stuff that we're thinking about doing. But probably where all academics agree, and probably most people that write papers agree, is we're all frustrated by the reviewer process. You can talk to anybody, and they'll be like, "yeah, I'm kind of frustrated by the reviewer process." I mean, it is not like I'm unique in that. I'm frustrated by the review process, and I don't know what the solution is.

Daniel Molzahn ([00:59:38](#)):

You have speculations on the solution?

Thomas Overbye ([00:59:43](#)):

I feel like we have a process that was developed maybe 200 years ago to meet the needs of a very small scientific community where everybody was sharing their work, and they were like learning from one another. Now we have a scientific community that spans the globe, and everybody wants to publish a paper, and some universities require that their students publish a paper to graduate. And you just get all of this—papers. And one of the things I recently did is we wrote—I worked with Kate Davis and Jerry Haight and Line Roald from Wisconsin, on writing a paper looking at—we just published it last year at the Texas Power and Energy Conference and the director of the Texas Power and Energy Conference from that year is sitting right here. But we looked at the most impactful papers of the last 50 years.

Thomas Overbye ([01:00:43](#)):

And this was a follow-up to a paper that Jerry Haight had done from 2000 looking at the most impactful papers of the 20th century. The challenge with doing the last 50 years is the last 50 years, particularly, well, really the last 50 years have been the growth of software. And a lot of people will use software that

is based on ideas that were conveyed in papers, but they don't understand the—they've never read the papers, because they don't need to. And I also, looked in—I added up how many pages Power and Energy Society was publishing in 1975 versus now. And now we're publishing twelve times the number of pages, just in our journals, not to mention all the conferences. So, there's all this information, if you will, out there, but it's like, who has time to read it?

Thomas Overbye ([01:01:40](#)):

And if you looked in my office, which, I know you can't see, but when I was in Madison, and also, at Illinois, I would have copies of IEEE Transactions on my bookshelf. Of course, it all got put online. And there was one time where I was sitting there at my computer at Illinois, I had all the transactions sitting over there, and I wanted to find a paper. And it was easier to find it online than to roll my chair across the office and get that. But you lose the ability to page through them. When I started working in industry, the IEEE—it was called Power Apparatus and Systems—it would get passed around and I would page through it and be like, "what's in here?" And you'd get a feel for what's going on. But now it's: yeah, they put out a journal, but nobody reads it. I mean, maybe somebody reads it, but nobody, very few people get it in hard copy anymore, page through it. So, I don't know what the solution is. I don't know. It's a challenge for next generation.

Sairaj Dhople ([01:02:56](#)):

I just want to take you to something that people do read. And that's your undergraduate textbook. Can you say a little bit about how that project came about?

Thomas Overbye ([01:03:05](#)):

Somebody reads it. What do I want to say about the textbook?

Sairaj Dhople ([01:03:10](#)):

Just how it came about. It's pretty interesting in the way that it combines power exercises and so on. It's quite unique in the way that is set up compared to other texts. Was that deliberate? How did it all come about?

Thomas Overbye ([01:03:26](#)):

Well, right. I'm currently an author. It's the Glover, Overbye, Birchfield, Sarma book. It's Power Analysis and Design, now, in the seventh Edition. It was written by Glover and Sarma, probably in the '80s, I believe, with the first edition. I have never seen the first edition of that book. Then, when I came to Illinois, I saw the second edition of the book. But because I was of the Art Bergen—my advisor, Chris Da Marco, was a student of Art Bergen. So, I used Art Bergen's book when I was teaching. I didn't use the Glover-Sarma book. But then, they came to campus, the editors of the book, and said, "Hey, we want to incorporate Power World in it." So, in the third edition, we incorporated Power World into that book. And then on the fourth edition, they said, "Hey, do you want to come on as an author?" I'm like, "sure." I came on as an author for the fourth edition, and, because Sarma had stopped with the revisions, I moved up in the pecking order. It was Glover, Sarma, Overbye., Now it's Glover/Overbye. And then I added Adam Birchfield. So, Adam Birchfield is now the third author of that book. So, I feel like I did not write a lot of that book.

Thomas Overbye ([01:04:52](#)):

Certainly, you know, as the editions go on, I write more and more of it. But I think it's a great book.

Sairaj Dhople ([01:05:01](#)):

That's a pretty interesting anecdote that somehow Power World had taken off enough that it had caught the attention of these editors. And they said, "Hey, here's an opportunity."

Thomas Overbye ([01:05:10](#)):

Right? They came to us, and said, "integrate Power World." And Power World was integrated into the third edition. That was when we still had floppies, and—maybe it was a CD, it wasn't a floppy, I think it was a CD. But yeah, it came with a CD in the back.

Julie Cohn ([01:05:29](#)):

Is it now all online?

Thomas Overbye ([01:05:33](#)):

There's still a hard copy of the book, but all the Power World stuff is online. Although increasingly the book is online as well. So, I still have copies of the book.

Julie Cohn ([01:05:50](#)):

Dan, do you have additional questions.

Daniel Molzahn ([01:05:52](#)):

I have a couple other questions on some related topics. So, one of the pieces you mentioned a couple times, Tom, was the importance of solving the industrially relevant problems or messy problems. And so, I'm wondering if that was the original motivation for all the work that you've done on synthetic power grid modeling, I'm curious how—that seems like a large stream of your work these days. How did that come about?

Thomas Overbye ([01:06:20](#)):

Yeah. The synthetic grid work is a large stream of my work, or at least our work as a group here at Texas A & M. And we—Bob Thomas was into synthetic grids, and I've mentioned Bob Thomas before. He started PSERC, he started the Hawaiian International Conference on System Sciences, Electric Energy track, which I'm now the co-chair of. He wanted to make these synthetic grids. So, Bob was in it, and I would see Bob at different meetings, and we got talking and the US ARPA_E was having a call for proposals to develop synthetic grids. So, I teamed up with Bob. So, that's how I got involved in it. One thing that I was really a proponent of is saying these synthetic grids have to be geographically based.

Thomas Overbye ([01:07:16](#)):

Because, you know, the real grid is geographically based. I mean, the real grid is real, and it exists in geography. But power flow models don't need geography to solve. So, people have kind of decoupled the two. But we said, "look, to build good synthetic grids, we have to make them geographically based." And then we got the ARPA-E project, and I got a great grad student, Adam Birchfield, who is now a faculty member here. And Adam did a superb job of building synthetic grids, and he keeps working on building synthetic grids, and his students work in it, and some of my students work in it as well. Truth be told, I personally have never built with an algorithm of the synthetic grid. But Adam, I've had students and Adam—and Jonathan Snodgrass works in this area as well. It's really needed because, again, this was something that, this was an opportunity that came out of the fact—if you want to call it an opportunity—that after September 11th—prior to September 11th, there was a movement to make the power grid models publicly available. And actually, in the '90s, I downloaded a lot of the FERC 715 KV

power flow models for the US grid using a pretty slow modem, but they were publicly available. And then September 11th occurred and suddenly that data wasn't available. So, university researchers lost access to actual grid models. And we spent quite a few years without really any good grid models. And then the synthetic grid stuff got going about 15 years later.

Julie Cohn ([01:09:07](#)):

How is the synthetic grid different from a model?

Thomas Overbye ([01:09:14](#)):

We like to say, this is a phrase that I got from my advisor at Wisconsin, "realistic, but not real." We look at real grids and we figure out their topology, and then we set up fake grids that have a similar topology, but they're—none of the transmission lines in them are real. The reason for this is, after September 11th, of course, terrorism was a key concern and is a key concern. People didn't want detailed engineering information about the grid made public. So, suddenly what had been out there was pulled, and that left a void. So, we would make fake ones up. So, they look real. If I showed you one and you didn't know the actual grid, you'd be like, "that looks real." But if you knew the actual grid, you'd be like, "none of those transmission lines are real." And Sanjana was—sitting back behind you—she's working on some additional topology properties that we don't think our current synthetic grids have, but that the actual grid does have. So, that's a current area for research. And she's working on a paper that she will have done within five days.

Julie Cohn ([01:10:35](#)):

So, this brings me back to analog machines again, because, I believe the network analyzer, you would set up something that reflected an actual grid configuration or portion of a grid configuration. So, this is in effect doing that. But there's no—you can't relate power line A to an actual transmission line out in the real world is just representative of how that transmission line might behave.

Thomas Overbye ([01:11:08](#)):

Well, it's like—an analogy is a road system. We have a road system. And if you were to design the road system from scratch, would you design it the way it is? And it's like, well, you know, you connect large cities together and things like that, but maybe not the same way as it is. And that's what we do is we use actual geography. So, we use—we just did a grid for Sweden, right? Just did a grid for Sweden. We've

done the US, North America. So, we'll take the topology in North America, the population distribution in North America, where the generators are, because the generators are public information. And then we will string transmission lines between them. But where the real lines go and where our fake lines go is not going to be the same.

Julie Cohn ([01:12:08](#)):

Do you use the Department of Homeland Security's mapping, GIS, as part of that process? Because they have—

Thomas Overbye ([01:12:21](#)):

Yeah, I know what they have.

Julie Cohn ([01:12:24](#)):

Do you use that at all?

Thomas Overbye ([01:12:26](#)):

There's two ways you can make synthetic grids. One is you can say—the location of the transmission lines is not what we call critical energy—electricity—infrastructure information, CII. That is available. And I show that there's something called open infrastructure that shows grids all over the world, and we could use that. The concern with using that is our synthetic grids might become a little too real. So, we deliberately don't use that.

Julie Cohn ([01:13:07](#)):

That makes sense.

Thomas Overbye ([01:13:08](#)):

But I know there's other people that go further along using that. And my concern is—and I fully agree with the need that we have to protect our critical infrastructure. So, we want to be teaching open science and helping our students, and students around the world, understand how electric grids work. But we don't want to be revealing any vulnerabilities in the real grid. So, we try to make our synthetic

grids realistic, in that they match broad characteristics, including some, like what Sanjana is coming up with, but are not in any ways compromising the integrity of the real grid.

Julie Cohn ([01:13:58](#)):

Dan or Sairaj, do you have any more questions you want ask before I see if our other guests would like to ask Dr. Overbye anything about his professional or academic experience over the last many years?

Daniel Molzahn ([01:14:17](#)):

I think I have one, but I can let Sairaj go first.

Thomas Overbye ([01:14:22](#)):

I don't have any on my side.

Daniel Molzahn ([01:14:24](#)):

Okay. So, going back a little bit, Tom, you mentioned the this most impactful papers—the last 50 years—the survey that you put together. I'm curious, were you surprised at all by any of the results or any reason any of the—I guess both in that paper and maybe the original 100-year history, were there any particular ones that jumped out at you as surprising.

Thomas Overbye ([01:14:48](#)):

I could talk a long time about this. The world's changed in the last 25 years. And so, the way you find out the most impactful papers is you have to survey people. So, we did a survey, and we got about as much response from the survey in terms of total responses as Jerry got in 2000. But the people that we sent it out to was probably like a factor of 15 larger. So, you get very few people responding. And when you get very few people responding, you know, there can be bias and people will say, "ah, you know, I'm going to say the most impactful paper was my paper that I wrote two days ago. That's the most impactful." Or "my friend's paper that they wrote." So, there's certainly that that goes on.

Thomas Overbye ([01:15:42](#)):

The other thing is that, again, people aren't reading papers. Certainly, once you get outside of the academic world, people aren't tending to read papers that much. But they might go to a NERC event or a

WECC event or an ERCOT event, or they're using software and that software is based upon an algorithm. But they don't even know where those concepts come from anymore. So, it's almost like an outdated concept that—and again, when I talked about—we're publishing 12 times the number of papers than we did in 1975—and it's like, "okay, how do you become the most impactful paper?" So, if I had to say, I think we identified the major topics. Like, certainly the stuff that Fred Schweppe did with the markets and some of the other papers like optimal power flow, and things like that, were major topics that we identified. But I think the major papers from the 2000 paper, like symmetrical components, and Park's transformation, things like that, those are classics.

Daniel Molzahn ([01:17:08](#)):

Maybe the similar question for the NAE report on the analytic foundations and the future power grid, through doing that process, was there anything—you're working with very different community, or an adjacent community than the power engineer community. Did you learn anything particularly interesting or surprising from the process of putting that report together?

Thomas Overbye ([01:17:30](#)):

I think there's a lot of good ideas from the mathematical world that we can leverage. I found it interesting that optimal power flow, which, you know, I learned about optimal power flow in my grad student days, and I thought it was a solved problem in 1990. I was like—there we were—and 25 years later, and still here we are 35 years later, and it's not quite a solved problem. Yeah. So, there's always new opportunities and it's certainly a very exciting time in the electric power industry with the changing generation and now the rise of the data centers, and how we're going to leverage AI. It's a very exciting time. I felt like—when I was in grad school—I felt like, oh, exciting stuff was sparse matrices, and stuff had been done 20 years before. But I wasn't realizing that I was living in a pretty exciting time as well. Luckily, I did take advantage of it in the sense of creating Power World and things like that. But I think we've got that same opportunity now, as there's a lot of excitement on where's the grid going to go?

Julie Cohn ([01:18:44](#)):

Would either of you like to ask you a question? Yes, of course. Can you speak pretty loudly?

Sanjana Kunkolienkar ([01:18:50](#)):

I'll try. So, I know I look at Power World as a tool, and when you talk about Power World, it's more from your curiosity, like when you're working on functions. But with today, I think I realize that Power World is also, a commercial venture. When you were working on Power World as a grad student, how did you realize the commercial value in the industry?

Thomas Overbye ([01:19:19](#)):

When I was working on what became Power World—So, the question is how did I realize the commercial value of it—the answer is I didn't. When I was a grad student, I was using this code first to learn how power flow worked, and then later on to do my thesis research. So, I developed that code to do energy measures and things like that, low voltage solutions, stuff like that. And then we got this class in '93 that Pete Sauer and George Gross helped us to get, to teach, you know, teach power system concepts to non-technicals. So, then I took my power flow code and merged it with some visualization code that I had written, and that gave birth to what is now known as Power World. And then, as I started working with industry and you know, you work with industry and they'd say, "Hey, can you add this feature?

Thomas Overbye ([01:20:18](#)):

Can you add that feature?" Because originally when I did Power World in '94, you could say it was a toy. But very rapidly people said, "Hey, rather than solving 13 buses, what if you solved a hundred buses? What if you solved a thousand buses?" So, industry drives you to solutions because they say, "we want you to solve our model." And then because the FERC 715 cases were available, I was like, "oh, I've got to solve the ECAR case or the PJM case or the WECC case." And then you make it better and better. And I would show it to people. And I remember one time I was talking to Jerry Shebley, and he had just stopped by Illinois for a visit, and I was showing him Power World. He said, "you know, I think you've really got a commercial tool here." So, different people encouraged me along the way. And what I found is when you're working with customers, we would have some super customers that just really loved the tool and would promote it for you. And that was like really, really, really helpful.

Julie Cohn ([01:21:32](#)):

Did you have a question? Well, we've kept you talking for almost an hour and a half.

Thomas Overbye ([01:21:41](#)):

Luckily, I'm used to giving lectures. I talk that long.

Julie Cohn ([01:21:45](#)):

Usually, Sairaj asks a closing question. Sairaj, would you like to ask it?

Sairaj Dhople ([01:21:52](#)):

Sure, I can do that. Tom, any words of advice you'd offer to our next generation of power engineers who are happening, who just happen to be listening on this?

Thomas Overbye ([01:22:03](#)):

One word of advice is, it's a great time and it's a very exciting field. So, it's a great career choice. Advice for students looking to go to grad schools, "you're going to invest a lot of time with your advisor, So, try to choose wisely on who's going to be your PhD advisor." And of course that's hard to do. Because, I mean, how do you know? So, when I talk to students, I will say, "you should probably go talk to the grad students when you go on campus visits. Because they'll give you the inside scoop on what's going on." And then words of advice, "the first jobs that you get, if you can land in a very supportive environment, that is going to be So, crucial to your success. And there's a lot of supportive environments out there, but unfortunately there are some toxic environments out there as well. So, if you find yourself in a toxic environment that just can't be changed or you can't change it, you might want to consider moving on quickly. Because the support of your colleagues—treat your colleagues well, treat the staff well. The staff is going to be very helpful to you, So, be nice to them, be nice to your students."

Julie Cohn ([01:23:28](#)):

Do you have any thoughts you want to share to conclude the interview about your professional experiences?

Thomas Overbye ([01:23:36](#)):

I feel very blessed in my professional experience. And I feel like I, I lucked out in a lot of different ways. I mean, you know, I just feel like, wow, it was like I landed at Illinois and this and that, and it's like, it was—Wisconsin as well, So, you know.

Julie Cohn ([01:23:54](#)):

Well, thank you very much.

Thomas Overbye ([01:23:55](#)):

Thanks.

[End of interview]