Mark Royce (00:00): Hi, Jane. Hi, how are you today?
Jane Jackson (00:04): I'm fine. I'm enjoying the rain. It's two and a half inches of rain this past evening after a drought of more than a year.
Mark Royce (00:15): That's crazy. Two and a half inches. And how long?
Jane Jackson (00:18): Since last night.
Mark Royce (00:20): Wow.
Jane Jackson (00:21): 12 hours.
Mark Royce (00:23): You're in which city in Arizona?
Jane Jackson (00:26): Scottsdale.
Mark Royce (00:28): Scottsdale. Yeah. Wow. Well, that must be kind of a nice change. From the heat.
Jane Jackson (00:36): Thunder and lightning right now. Right outside.

Mark Royce (00:39): Well, you're warm and cozy and safe inside, so that's good. That's good. So, hey, I'm excited to talk to you today about your career, your experience, the amazing work that you've done with modeling instruction over the years, it's been several years. I want you to kind of go back and, and tell us, first of all, how you got into science and you were a teacher. Am I, am I right? You were a teacher at South Dakota State U? and how long were you there?

Jane Jackson (01:16): I taught there for eight years. And the reason I got there in the first place is that...well, it's a long story. Let me start from the beginning. When I was 19, I married my husband, who is an Arizonan. We met in New York City, and he had already graduated from Arizona State University. He brought me back to Arizona and I started at ASU as a sophomore and went all the way to a doctorate in physics because I loved it. I just loved it. I wanted to understand reality, and physical reality is something I thought was approachable—an approachable aspect of all of reality. And so, in 1970, both of us earned a PhD and he got a job teaching English at South Dakota State University. So we raised our kids, and after six years I started teaching physics there. But by 1984, we were both totally disgusted with the poor educational attitudes in the South Dakota. So we came back to Arizona and I worked at full-time at Scottsdale Community College for 10 years.

Mark Royce (02:42): Were you teaching physics?

Jane Jackson (02:44): Yes.

Mark Royce (02:45): When you moved to Arizona. At Scottsdale Community College.

Jane Jackson (02:49): Right. I taught physics there for 10 years. Until 1994, when David Hestenes called me, said, “Jane, I need your help desperately. I've just been given $4 million by the NSF and my project director, who is a high school physics teacher, cannot get released. So I need a project director, but it'll only be part-time.” 27 years later, my job is near full-time.

Now why David Hestenes? When I was a graduate student, just starting my PhD at ASU, he came to ASU. It was his first year of teaching in 1966. I had him for two courses and he was one of my favorite physics faculty -- in statistical mechanics and relativity theory. Through the years I kind of kept up with him a little bit. And that's why in 1994, he felt free to call me and say, “I need your help desperately.”

Mark Royce (04:01): The grant that he was awarded was for developing modeling instruction concepts; what was your role in helping him with all that?

Jane Jackson (04:11): Well, it was a grant to take modeling instruction out to the nation. Of course, he developed it with a local high school physics teacher, Malcolm Wells, and they had a previous small NSF grant for a series of two summer six-week long modeling workshops for local teachers -- a proof of concept to see if it worked. Well, it did work. And so he got this $4 million grant to teach modeling instruction to 200 leading high school physics teachers nationwide, over a period of five years. So in 1994, he hired me and he also hired Larry Dukerich, a high school physics teacher. Everybody knows Larry in the modeling community.

Larry Dukerich took a year-long sabbatical from his high school, Dobson High School in Mesa. He and I shared a little office at ASU, and together we put together all the application materials and recruitment and everything needed to hold four-week long leadership modeling workshops over three different phases.

David Hestenes was on sabbatical in England at the time. So Larry and I put together the program. David gave us the -- he wrote up the materials and all the requirements for the teachers. It was very rigorous. It was very well done. David Hestenes envisioned it brilliantly; he had every one of the applicants submit a dissemination plan and a cost sharing plan for getting technology -- computers and MBL probes -- in their high school. They had to submit all of this and in return they got a good stipend and they got to have two summers, generally, of four- or five- week modeling workshops, at about eight different sites nationwide. Yes, it was good.

Mark Royce (06:30): So you and Larry pretty much organized and managed the, all those workshops for the first few years.

Jane Jackson (06:37): I would say we did a great deal, with the vision of David Hestenes and all of his connections among faculty nationwide.

Mark Royce (06:49): So what are some of your fond memories from those days, those first 10 years, I guess, of the modeling instruction development?

Jane Jackson (06:59): Oh, I think working with colleagues on such an important project. There was not only Larry Dukerich and David Hestenes, but there was also Ibrahim Halloun from Lebanon who was wonderful at research, and our graduate student – a PhD student in statistics -- Sharon Osborn Popp, who took care of all the data gathering and analysis. So those were the main folks in the project. From afar, Gregg Swackhamer worked mostly with Larry. Gregg was an initial modeler, even back in the 1980s where he -- he's from Chicago and was teaching high school physics there. And he actually took a sabbatical in the late 1980s [to Malcolm Wells' classroom and to ASU].

[a LOUD thunderclap!]
Mark Royce (07:51): Wow. That was, that was, that was, thunder. Oh, yeah!

Jane Jackson (07:57): Gregg Swackhamer was in Chicago. He and Larry put together the actual content of the modeling workshops, the mechanics content in particular, and Gregg led the five-week modeling workshop at the University of Illinois in Chicago in 1995 and 1996 for 24 teachers, along with one of the original modelers, Don Yost from Sacramento, California. And Larry Dukerich led the modeling workshop in 1995 and 1996 and 1997 for 24 teachers at ASU.

Mark Royce (08:40): So the workshops spread not only at ASU, but around the country.

Jane Jackson (08:46): Yes. David Hestenes arranged for more workshops in 1997 at University of Akron, Ohio, and also University of Wisconsin at River Falls through his connections. And then he also arranged for another phase -- phase 2-B, they called it, in 1998 and 1999 at the University of Maryland. And the University of California - Davis, that's where your wife attended,

Mark Royce (09:21): Right. That's right, 1998.

Jane Jackson (09:24): And University of Central Florida in Orlando.

Mark Royce (09:27): So, and then from there, it just continued to grow.

Jane Jackson (09:32): David got another grant in 2000 to take it further out to the nation. That was another four or five-year grant. And for that one, I worked with up to 24 different physics and chemistry faculty around the nation in 18 different states, eventually, to hold local modeling workshops led by some of the 200 teachers who had attended the leadership workshops. So, one of my major jobs was working with them.

Mark Royce (10:10): So things are growing. You've got several hundred people now that are modelers in the U.S. and it begins to grow to a point where there needs to be some more formal structure around it. And I know that somewhere around the mid, early two thousands, AMTA was born. Can you tell me a little bit about how all that came about and what that transitional period might've been like from your perspective?

Jane Jackson (10:40): Yes, that was wonderful. One of the major purposes of David Hestenes' second grant, which began in 2000, was to institutionalize modeling instruction by a Master of Natural Science degree at ASU. And so David took a lot of time and effort to formulate this Master of Natural Science degree program. And he got a whole lot of teachers nationwide to enroll in it. And they would come to ASU in the summer. They got free tuition -- that made all the difference -- that made it affordable. They took modeling workshops and then more advanced deep content courses in physics and integrated science as well. So by 2005, there was a large contingent of teachers from all over the nation, really leading excellent teachers, in our MNS degree program. And not just that, but some teachers who took the courses just to become a better teacher -- to become a better teacher.

And so in the summer of 2005, they got together at one of the local Mexican restaurants and said, we can't let this die. We've got -- we're going to start a professional society or professional organization. And they decided to call it the AMTA, American Modeling Teachers Association. And one of them, Patrick Daisley, of Eastern Washington, knew how to start a nonprofit. So he went right out and did the paperwork and got the AMTA started -- and Colleen Megowan took a leading role. And several others -- and AMTA was born.

I continued to be a volunteer for the AMTA and to work with physics and chemistry faculty around the nation to hold local modeling workshops, but it became harder and harder for anybody to get a grant -- just because of the federal government's changing policies, unfortunately.

Eventually, by 2012, the AMTA had enough money to hire Wendy Hehemann to do a lot of the work that I had done as a volunteer. And thank goodness, because I was overworked by then, by 2012.

Mark Royce (13:09): Yes, because you were still working with ASU at that.

Jane Jackson (13:13): Yes. And I still am.

Mark Royce (13:16): And your role there at ASU has been what?

Jane Jackson (13:20): I'm co-director of the ASU Modeling Instruction program, which now we have about 65 to 75 teachers every summer who come to take our modeling workshops and our more advanced courses for the MNS degree. Most of the teachers, about 90% of them, are from Arizona because out of state tuition is way too expensive. And it's bad enough for Arizona teachers who are among the worst paid in the whole nation.

So my job is mostly working with the Arizona teachers. I keep a state database. I manage a state listserv for physics and chemistry teachers. We have expanded to chemistry, starting in 2000 actually. Larry Dukerich took the lead on that because he's primarily a chemistry teacher.

Then by popular demand, modeling instruction extended to biology. This was around 2010, I think. And now astronomy and earth science. It's a great way to teach.

Mark Royce (14:35): So, tell me how the ASU modeling workshops -- summer workshops that you guys host -- is it connected or affiliated or integrated with the AMTA workshops that are promoted? Is it the same thing -- you're under the same umbrella? or is it kind of a different thing?

Jane Jackson (14:54): Well, it's the same umbrella. The AMTA is loosely organized with certain general guiding principles, which we follow. And so it's just a loose partnership of several universities around the nation. And we're always looking for more, too, more workshop sites.

Mark Royce (15:17): Yes. So the content in your workshops is no different than workshops that people will find at other places around the country.

Jane Jackson (15:24): That's correct. We might be more rigorous. In some ways we're more rigorous because teachers can get graduate credit for our modeling workshops. So we add assignments.

Mark Royce (15:39): Yes. And is it more -- I know a lot of the workshops, they try to do three weeks. Sometimes they're cut down to two weeks because of the costs involved. But are you guys under that same thing or do you have more extended workshops?

Jane Jackson (15:54): We're committed to three weeks. We have found through lots and lots of years of evidence that three weeks are a minimum to start to implement modeling instruction. Two-week workshops are okay if you

have some follow-up sessions during the school year, but that's hard to do. And it's expensive.

Mark Royce (16:20): And it's no longer funded by grants, like it used to be when you got the first 10 years of your work.

Jane Jackson (16:26): Yes, that's right. I gave a talk on that issue recently. I'll send you the URL. [it's https://www.youtube.com/watch?v=eoDzvuTgUdo]

The Federal government used to have a very good program 20 years ago called the Eisenhower Math and Science Program. Teachers all over the nation know that every state gets money every year from the U.S. Department of Education. And that some of that money must be used for professional development for teachers. It's called Title II. It's been in existence since the 1960s, I believe. And 20 years ago in that Title II program, some of the money -- a small proportion of the money that went to every state by formula -- had to be set aside for universities in that state to use for competitive grants, for professional development, for K-12 science and math teachers. Well, that was wonderful.

And part of the program's guidelines was that it was to be used in part for teachers who are out of field. Well, that was wonderful too, because two-thirds to three-quarters of the physics teachers in the nation don't have a degree in physics. Usually their degree is chemistry or biology, or sometimes engineering, sometimes elementary ed, and I've even had a case where home economics was the degree of one of our physics teachers.

So anyway, it was a boon, it was a wonderful program. And so I helped a couple dozen physics and chemistry faculty around the nation, 15 to 20 years ago, to get grants under this program for local modeling workshops led by teachers who had been in David Hestenes' $4 million grant for leadership Modeling Workshops.

Then "No Child Left Behind" came along and diluted the program, that Eisenhower program, and said, well, it's going to be for all subject matters. And it's going to focus mostly on high poverty schools. Well, that was not a good idea for physics. It was a detriment, and fewer and fewer physics faculty were able to get grants because they said, "Well, we don't qualify. We don't have enough physics teachers in high poverty schools." So it got harder and harder.

We lucked out [at ASU] because I extended modeling instruction to physical science -- eighth and ninth grade physical science -- and that was broad enough to please our grants people in Arizona, that we were tackling enough subjects. So they funded us at a quarter of a million dollars for four years, but then they said, oh, we're going to drop physics and chemistry. And we're just going to do math. We need to get our test scores up in Arizona in math. So we were left out from 2010 on.

Since 2010, we have been funded only at about $15,000 a year from one of our local utilities, Salt River Project, and another $15,000 from various companies, like Boeing at first, and now ON Semiconductor, for partial tuition scholarships to make it affordable for teachers. It's been really hard. It's hard to get money. I have to write grants every year and corporations don't give much compared to the federal government. So my talk, my recent talk this summer that you can download is...

Mark Royce (20:15): Where was this? Where was your talk?

Jane Jackson (20:18): I gave a talk for Eric Mazur's new NSF grant at Harvard University. It's called PoLS-T. It's the Physics of Living Systems - Teacher network. Eric Mazur got this grant last year from the NSF to start this worldwide teacher network for high school physics teachers. So he has an annual conference. This summer's conference was entirely by Zoom. And so he asked for volunteers to give talks and I volunteered to give a talk on the funding situation, combined with the need for lifelong professional development of teachers. So I detailed that, and the reason I gave the talk is that Eric Mazur just got elected to a committee in Washington that's supposed to help. So I said, okay, I'm going to give a talk because my talk is for Eric Mazur; I'm giving him enough background so that he can make a difference in Washington over the next four years in his lobbying.

Mark Royce (21:33): So tell us a little bit about the talk. Outline it for us. I assume you're going to send me links that I can share on our website. [Note: It's at https://www.youtube.com/watch?v=eoDzvuTgUdo] But give us a little teaser. So, you know, help whet people's appetite.

Jane Jackson (21:50): Here's the thing. In 1997, at the third year of Phase 1 of our leadership modeling workshops, David Hestenes gave interactive lectures to the 50 teachers who were there in their third summer from both locations, ASU and University of Illinois at Chicago. And in his talk, he pointed out that research done by K. Anders Ericsson shows that in any endeavor, it takes many years to become an expert. And you can't become an expert just by doing the job, like teaching or chess playing, or a musician playing violin, or whatever -- you have to do deliberate practice. You have to focus in on definite skill development.

Of course, I had no idea about this research. I had no idea. If I had known that many years of deliberate practice were required, I would have paid much more attention in my own teaching to professional development. It just never occurred to me. It's not part of our culture. It should be part of our culture. And it is part of the culture in Singapore. Singapore teachers in high school are

expected to get 60 to 90 contact hours every year of professional development.

And so David Hestenes gave an interactive lecture on the research of K. Anders Ericsson showing that lifelong professional development is needed and typically 10 years of deliberate practice. And he said, “That's why we have modeling workshops.” He told the teachers, “It’s to give you a mechanism for a way to do deliberate practice, so you don't have to figure it all out by yourself.”

And so I've thought about this through the years. And of course that's what we were trying to do all those 10 years. Well, that's what the AMTA is trying to do for all these years: deliberate practice!

But it's becoming harder and harder, because the federal government has abandoned teachers' professional development. A recent study by Horizon Research that was funded by the NSF two years ago showed that teachers are not doing professional development as much these past several years. So it all fits together. There's cause and effect.

It's got to be changed. The federal government has got to get back into the program of supporting professional development of teachers. And that's what my talk is all about.

Mark Royce (24:33): Well, I'm looking forward to seeing the links that you send us -- and just to remind our listeners, it'll be on the website: https://sciencemodelingtalks.com.

So what do you think the best chances are in the modeling community to promote these workshops and to be able to make more of them available to more people? government funding, grants, that kind of thing? What would you suggest are some solutions to help them make that happen?

Jane Jackson (25:05): More communication urging modelers to promote modeling instruction actively among their colleagues. Word of mouth has always been the chief mode of expansion of modeling instruction. And, of course, trying to get the federal government back into the program. I don't know what else except more communication and probably increased emphasis on the effectiveness of modeling instruction.

Mark Royce (25:43): I think it wouldn't hurt to have more people like you in each state that are proponents of modeling and going after grants and all that kind of stuff, too. I think so.

Jane Jackson (25:55): Yes. Right.

Mark Royce (25:57): I want to ask you about the paper that you co-authored about the crisis in physics education. And I know the paper was focused on

that crisis as it relates to the Arizona school systems, but maybe talk about it as more of a national thing. What are your observations about physics education in high schools? The state of it these days,

Jane Jackson (26:23): I start with the PhysTEC website, https://www.phystec.org. They have analyzed the situation nationwide of the shortage of high school physics teachers. And what I find is that Arizona is one of the worst -- one of the worst states. Nationwide about 40% of high school kids take physics. In Arizona, only 20%. My job is mostly Arizona, and so I've kept a database for more than 20 years of all the physics teachers in Arizona. There's only maybe 250 total [in public high schools]. What I find that's very sad is that since the 2008 economic downturn, the number of schools that don't offer physics has increased. And I mean, these are schools that used to offer physics, and when their physics teacher retires or leaves, the school stops offering physics because they say, “Oh well, physics is only for the smartest kids. It's only for the kids who are going to become engineers.”

Well, that's misinformed because in this day and age, everybody needs physics. I mean, they need modeling instruction type physics because modeling instruction teaches you how to think with evidence. And that's absolutely crucial for humanity to tackle these huge problems that we face, like global warming: sea level rise, these huge storms that we're getting now, these days, you know, these destructive wildfires -- and all these other problems that are arising because of our ignorance and greed. We've just got to change as a civilization.

Mark Royce (28:28): You mentioned how high school physics, how it's being taught is getting less and less prevalent across the U.S. in our education systems. How a dearth of physics understanding in our students could lead to a bit of a crisis in the job market for the need for people with a physics background,

Jane Jackson (28:51): Let's take Arizona again, for another example. The federal government is going to invest a whole lot of money in semiconductors. Well, one of the chief semiconductor companies, Intel, is right here in Chandler, just south of Tempe, where ASU is located. A Taiwan semiconductor company is starting a huge plant north of Phoenix. Well, these two companies alone are going to require a tremendous number of technicians as well as engineers. And of course their associated companies that provide the materials will need technicians and so forth. And, and yet there's a dearth of physics to give young people the foundational knowledge that they need to become employed by these companies. That's just one example. I'm sure

there's many more.

Mark Royce (29:51): I hadn't really quite thought of it in a way that you did, but the need for STEM folks to address the deep issues of our world today. You know, you've mentioned climate change and all the issues going on with weather; and the way population growth is happening and where it's happening and designers and engineers are going to be needed to address those issues as well. So I thought that was very interesting.

Jane Jackson (30:23): Another area is health: health science. Physics is essential in all the health science, health careers; and with our increasing number of older people who have chronic health problems, the needs are expanding for jobs.

Humanity has reached the point where we have power to destroy civilization, and we sure are on track with that, in regards to putting a whole lot of polluting gases into the atmosphere and due to our excessive use of coal and energy needs. So we've got an energy imbalance, and it's at the interface between physics and chemistry. We know that carbon dioxide -- we in physics and chemistry know -- that carbon dioxide is like a blanket in the atmosphere. But the public doesn't know that. The media don't know that. I never hear about it and read about it in the New York Times or other places. I hear about the average temperature increase, but that really doesn't tell us what we need to know.

It's the nighttime temperature, the low temperature that matters. And yet we're not seeing things like that -- simple things like that -- reported. For example, outside my house, 25 years ago, even 15 years ago in summertime, the typical low temperature at 6:00 AM was about 78 degrees. Now for the past three to five years, the typical low temperature is higher by about eight degrees. It's 86 degrees. Little things like that.

Extreme weather. We had, in the past 14 hours -- last night and this morning -- in 14 hours, we had almost three inches of rain in Scottsdale, 50 mile an hour winds. Trees are down everywhere. We never had weather like this 'til just a few years ago. Never, ever.

Mark Royce (32:35): So the importance for education in the sciences is more critical than ever as we need people to invest themselves in discovering solutions.

Jane Jackson (32:46): Right. And by understanding our physical world in which we are embedded -- we live and move and have our being in this physical planet -- by understanding it, we grow to love it more. We grow to be connected more to it. We grow to care more about it. Understanding brings

that caring, and that commitment to preserving it and improving it.

Mark Royce (33:10): Wow. Jane, I've got to say, and I think I speak for many, many people. Thank you for the years that you've invested in helping people grow in their understanding of education, helping people discover modeling instruction. And, you know, we wouldn't be where we are today without a lot of the efforts that you've been putting into it for the last 27 years. So it's really, it's been really great to talk with you. And I just want to say thank you.

Jane Jackson (33:47): And thank you too, for caring and doing this as a volunteer effort on your part.

Mark Royce (33:52): It's my pleasure. It's a really cool thing to be involved with. And even though I'm not a science background person, it's been really awesome for me to get to know people like you and interview, you, David Hestenes, Larry Dukerich, you know, all the wonderful conversations that I've had from the modeling community people. It's been just great for me. So, again, just thank you so much, and I hope you have a great rest of the day. I hope the rain settles down and gives you guys some respite, but also enjoy it. You haven't had it for a while. Yes, so it's good. Thank you, Jane. Have a great afternoon.