Physics is everywhere:

The profound influence of physics in my life and career.


Shortened from guest of honor speech at ASU Dept. of Physics in 2016

What is most important? I ask myself that, often. What is most important to me is growing in wisdom and love; i.e., evolving in character. Love encompasses and includes understanding – so understanding is important to me. Physics is a great way to understand the world. Physics has profoundly influenced my life & career.

When I was a teenager, I wondered: “What is the essence of reality? What is life? What is the essence of being a human? I finally said, “These questions are too hard; I cannot address them!” Then I asked, “What is the essence of physical reality?” I decided, “This is do-able. I can pursue this question.”

In high school, I took physics. It was boring, textbook-oriented, seemingly unrelated to my questions and my life. At the public library, I checked out THE EVOLUTION OF PHYSICS by Albert Einstein & Leopold Infeld. It convinced me to become a physicist. It seemed to address the essence of physical reality.
My career is in physics education. I taught physics for 18 years: 8 at South Dakota State University, and then 10 at Scottsdale Community College. Since 1994 I have worked in the ASU Department of Physics, co-directing the Modeling Instruction Program of professional development for high school science teachers. Modeling Instruction produces thinkers; it promotes understanding in science. David Hestenes, now Emeritus Professor of Physics at ASU, developed a Modeling Theory of Instruction in the 1980s. Malcolm Wells, physics teacher at Marcos De Niza High School in Tempe, adapted it for high school. It is VERY effective!

Modeling Instruction re-creates scientists’ practice, in the classroom. The central activity of scientists is building and deploying scientific models. That’s what we do. **Modeling Instruction reveals the structure of physics.** And it promotes teamwork, communication, and problem-solving skills. It develops character: empathy, self-reliance, grit. That’s our work -- social and cultural embeddedness in the community, an ASU Design Principle.

My greatest accomplishment was expanding Modeling Instruction to the nation. I did this with David Hestenes at first, and later as a volunteer for the American Modeling Teachers Association (AMTA). In 14 years at ASU, I grew the program to 50 Modeling Workshops nationwide each summer. 10% of the nation’s high school physics teachers have taken a Modeling Workshop. Colleges use it too.

In my daily life, physics has a profound influence. Every day, I am aware of physics. Physics is everywhere! I use physics, not just for fixing things around the house, but also when I move my body. When I sit, stand, lie down, I am aware of being in a gravitational field. If I hadn’t studied physics, I wouldn’t be so aware; I wouldn’t make these connections. Education empowers us to understand.

Understanding enhances our awareness. Awareness can magnify our appreciation, our awe and respect for nature.

Global warming: how often do you think of it? I think of it daily. I look at the sky, and because I know physics, I can see in my mind’s eye the invisible blanket of CO2 that is growing, day by day, when we drive our cars, and when we burn the world’s coal, oil, and gas. Global warming is by far the biggest challenge to humanity. We could destroy civilization. What is at the heart of understanding global warming? Physics.

That is why I persist in Modeling Instruction in physics – it empowers people to become aware, make connections, see cause and effect, THINK. And appreciate nature and our place in it – and, I hope, to work to slow down global warming.
I married my husband, Paul, at age 19. He put me through college at ASU, while he worked full-time in TV and studied part-time at ASU for a PhD in English. General physics at ASU was terrible – lecture, cookbook labs. I almost switched to math. But advanced lab was great! My lab partner and I didn’t understand capacitors, so we chose to make one, and take measurements on it. Having freedom to choose a project, in order to understand, made it memorable.

I did well in physics, so the faculty asked me to stay on as a graduate student, with a fellowship. I was always the only female in the class, but I never thought about it. **My studies and my husband were most important to me.**

ASU graduate school were the most fulfilling years of my life! I took almost every physics course, and loved every bit of it. David Hestenes was my professor for statistical mechanics and relativity – he taught us geometric algebra. I love how geometric algebra unifies Maxwell’s equations. I aced all graduate courses but one. It was not the lectures that made for success. I have learned very little in lectures. It was the DOING: homework, writing out the logic on my own, outside of class.

My dissertation was in theoretical high energy physics. I published 3 papers, and gave a physics colloquium. In my last year I was a lecturer, and I taught the two mathematical physics courses. I enjoyed teaching -- more so than research.

We both received doctorates in May 1970. There were no jobs for women in physics, so we decided that Paul would seek a job. He got a faculty position at South Dakota State University. I volunteered in the physics department for 6 years, while our two children were young, then taught calculus-based physics for 8 years.

After 14 years at So. Dakota State University, Paul was fed up with the devaluing of education in South Dakota. “Jane”, he said, “Let’s go back home to Arizona. We’ll both look for a job.” I got one: at Scottsdale Community College (SCC). I taught physics and built the astronomy program, adapting ASU labs. I worked hard to make classes active learning and relevant – not just lecture. It was rewarding.

In 1991 I learned about ASU Modeling Instruction. I saw that it was interactive engagement. It was much better than anything I had been doing. I tried to implement it, but failed. To succeed, teachers need a 3-week Modeling Workshop.

In 1994 David Hestenes called me. “Jane”, he said, “I need your help, desperately. I’ve just been awarded $4 million by the NSF, for Modeling Instruction, and my
intended project director can’t get released from his job. It will only be part-time; you can still work at SCC”. It soon turned into a full-time job – and still is.

**ASU is internationally known for Modeling Instruction.** Singapore, tops in the world in science test scores, has sent 54 physics and chemistry teachers to ASU, by 2018, to take our 3-week Modeling Workshops. That’s strong evidence of success!

ASU’s Department of Physics has done a great service to Arizona, by alleviating a chronic shortage of qualified physics teachers. We provide research-validated professional development for 50 Arizona teachers, each summer. Many local schools use it. Ours is the *only* such program for physics and chemistry in Arizona – in fact, unfortunately it is one of very few in the entire nation! We have served more than 1000 Arizona teachers. Modeling Instruction is the foundation of our MNS degree with concentration in physics. 75 teachers have earned this degree.

Until 2011, we had Federal grants. They no longer exist. ASU courses are unaffordable for most teachers. We now serve HALF as many teachers, on 1/5 our previous budget ($50,000 per year, instead of $250,000). Due to low salaries and this insufficient funding, the shortage of Arizona physics teachers is worsening!

Arizona’s neglect of physics threatens the state’s future, because high school physics is the chief STEM pathway. You’ve heard the saying, “*For want of a nail, the shoe is lost, for want of a shoe, the horse is lost, for want of a horse, the rider is lost.*” High school physics is the nail, the STEM economy is the horse, Arizonans are the rider. Arizona may soon become a third-tier state!

Most important, for my work at ASU, are to share my delight in understanding the world, and my deep concern for the well-being of young people and future generations on this fast-warming planet. We need a nation of *thinkers*. Modeling Instruction promotes thinking. **ASU physics Modeling Instruction is crucial -- for the future of Arizona and humanity. That is most important now, for me!**

**Resources:**
1) Modeling Instruction history, evidence of effectiveness, resources for teachers, MNS degree: [http://modeling.asu.edu](http://modeling.asu.edu)
2) The worsening shortage of physics teachers in Arizona, and ways to alleviate it: [http://modeling.asu.edu](http://modeling.asu.edu) Scroll to the bottom, in the section called “Arizona Community”.
3) Two videos on Modeling Instruction: A Hands on Approach to Science and Math (6 min): [https://www.youtube.com/watch?v=4J77kwmc7cpM](https://www.youtube.com/watch?v=4J77kwmc7cpM)
   A Modeling Approach to Physics Instruction [https://www.youtube.com/watch?v=ENyziGXdsrs](https://www.youtube.com/watch?v=ENyziGXdsrs)