Common Solutions to Diverse Problems: An Interview with Prof. Margot Gerritsen

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Margot Gerritsen was born and raised in the Netherlands. After receiving her Master's degree in Applied Mathematics at the University of Delft, she moved to the United States. In 1996, she received her Ph.D. in Scientific Computing and Computational Mathematics at Stanford University. She then spent nearly five years in Auckland, New Zealand as a faculty member in the Department of Engineering Science before returning to Stanford in 2001. Currently, Margot Gerritsen is a professor in the Department of Energy Resources Engineering at Stanford and the Director of the Institute for Computational and Mathematical Engineering (http://icme.stanford.edu). Prof. Gerritsen is interested in computer simulation and mathematical analysis of engineering processes and specializes in renewable and fossil energy production. She is also active in coastal ocean dynamics and yacht design, as well as several areas in computational mathematics including search algorithm design and matrix computations.

Biography adapted from and photo from Margot Gerritsen's profile at profiles.stanford.edu.

JN: You have your hand in a lot of different pots. Your research focuses on enhanced oil recovery, and among your side projects are CADS (Computational Approaches to Digital Stewardship) and the Smart Energy podcast. What motivates you to pursue the variety of fields you specialize in and what are you excited about right now?

MG: For my research interests, I'm always looking for problems that improve understanding of physical processes or engineering processes. I like to build simulation models to get better insight on what the reality is. Sometimes, we call them "virtual laboratories." We're able to do this across a large scope of problems because the math and the computing behind these things are surprisingly similar across disciplines. Whether I'm working on CADS, on gas recovery, or on sail design, the mathematical concepts that drive these processes are surprisingly all the same. So, the challenges are all the same as well. It's all about understanding a process, translating it into math, and then translating that mathematics onto a computer. If you have a pretty decent background in mathematics, particularly linear algebra, computing, and numerical analysis, you can apply that to all sorts of different fields. Even though all these fields seem very different, when you look at the engines that drive these applications, they are surprisingly similar.

In general, I'm super excited about diving into a new area, learning about it, and understanding a new process. I'm excited about the translational steps: from understanding the process to developing the mathematical model, from the mathematical model to the computational simulations.

JN: Would it be an accurate simplification to say that you find fields that you're interested in, dive in deep to find out what's going on, and then optimize current solutions?

MG: Not so much current solutions—that implies that people already have a solution to a particular problem. Very often, I try to understand things that are not very well understood. For example, in coastal ocean models, I spent a while working with colleagues on campus to understand internal waves in the ocean, to understand how they propagate and how they break. That required a new virtual laboratory. As another example, we worked on sails for downwind sailing for a while. At that time, people didn't really understand what to use, period. In general, what I'm excited about is understanding something new. Hopefully, my work is able to help others, but what excites me is a personal understanding of something new and unfamiliar.

JN: There's a tremendous diversity in your research and that translates into your teaching. This quarter alone, you're teaching ESF, THINK, and CME. Are there challenges in teaching such a variety of disciplines? Do you make connections between them? Why do you teach this variety of courses?

MG: I teach for two reasons. The first is that I love the knowledge transfer. I like to share what I know with other people. Being able to share your insight with others is very motivating. I'm also teaching to learn. Learning and teaching go hand in hand. Every time I teach, I learn new insights about the material, no matter how many years I've taught the material or what the material is. Another reason for the diversity is that I have two heads. I direct ICME, but I am also a part of the School of Earth Sciences. I feel that to connect with communities that I help run, you really need to teach in those communities. It gives you a relationship with the students. I don't think I could be a director of anything without teaching the students. Because of ICME and the School of Earth Sciences, I always teach something math-related and energy-related. ESF started because I think teaching freshmen is one of most fascinating and rewarding experiences you could possibly have. Fall-quarter first-years are so excited being here. One of my freshmen told me that it's like being in a candy store; there's so many things to do here on campus. Being in front of a group like that is super exciting. I started teaching ESF because of a challenge: I was in a meeting and people were commentating that ESF was mostly non-STEM. One of the people in the room mentioned that it would be hard to get faculty in STEM fields to be interested in ESF, and I decided to take that as a challenge. ESF is one of the best experiences I've had. It's not really even teaching—it's closer to discovering with my students in topics that I haven't thought enough about.

JN: Do you think that this teaching has impacted your research at all?

MG: I like building programs for students. So, ESF gives me both enthusiasm and direction about where the priorities should be set for the students. It also keeps me happy, so that helps. Stanford is a exciting place that requires a lot of energy. Doing things that are exciting helps keep that energy up.

JN: What do you think the role of science and technology has on today's society right now? What do you think the role should be going forward?

MG: The type of science and technology that I work on has a tremendous impact on society. Data generation and data analysis is what I do and many decisions in industry and policy are driven by data. The big challenge we have with science and technology is that we are not connected to society as much as we should be. Scientists need to inform the public about the decisions that are being made based on new technologies so that the public can understand where things come from and the connections that scientists see.

Large groups in society are disconnected from the climate problem, for example. When scientists talk about it, they're often dismissive. We forget how lucky we are to be educated in these areas. We also forget that a lot of people are disconnected from and disillusioned about science and technology. Scientists are driving and pushing these changes into society, but they're disconnected from those who tend to suffer most from technology changes. Take, for example, the impending automation revolution. We've already seen a tremendous amount of progress in automation and artificial intelligence, but continued developments in these areas will grow to replace a lot of human thinking. We need to realize that those who benefit and those who suffer from that are not the same groups of people.

I think the biggest challenge in science is to break this isolation. Currently, we are not developing technologies for everybody; often, we're developing technology for a small subset of the population. As a society, we're moving away from each other faster and further. Everything we develop will have positive and negative consequence for a population that we may not be in touch with. We need to pay closer attention to the second "S" in "STS." We need to understand how to bridge these gaps.