She processed data from IBM controllers from the 1/3-scale model of the Space Shuttle before it was flown. She also watched the first Mars landing at 5 a.m. there as the vertical pixels came in from left to right, and she was hooked at age 17.

Both of her parents were academics, so there was no question; growing up, her mind was made up that she would go to graduate school and have advanced degrees. She started at a community college in Palo Alto, where she says she had a fantastic math teacher, and then went to Boston University for a combined M.A.- and B.A.-degree program in computer science and math.

"Don't shy away from the field because of lack of resources or not having all the skills," Benzel advises.

Benzel thought about doing a Ph.D. in abstract algebra but says she needed to work a lot to pay her way through college, so she started working at Draper Labs with a co-op arrangement and decided against a Ph.D. At Draper, she worked on the F14's Image Processing Group and did her master's thesis work, arranging for her advisor there and a coadvisor at Boston University.

"Look for opportunities, recognize when they come, and take them," Benzel advises. "I started my career in research labs at a very young age by taking advantage of them when I could."

While pursuing her master's, she read a journal article for one of her graduate seminar classes titled "Verifying Security," which focused on work going on at the MITRE Corporation in nearby Bedford, Massachusetts. Her fiancée's best friend worked there and invited her to a recruiting night they were having. At this stage of her career, at age 21, when she was finishing her master's degree, she was excited because the article had everything in it that she wanted: logic, computers, and security. She went to the recruiting event, brought the journal article with her, and jumped into her first job in cybersecurity there following her graduation in 1982.

Grabbing Your Career By the Tail

In her first year of working on Proving Program Secure for the National Security Center, her colleagues encouraged Benzel to attend an IEEE security/privacy conference in Berkeley, California. It was there she met luminaries in the community who were defining the field of cybersecurity.

Every year after that, Benzel volunteered for the conference, first performing unglamorous jobs serving on the organizing committee, handing out badges, and maintaining attendee databases. Over the years, she held every position in the conference, becoming extremely involved. "Sitting at the registration desk and getting to know the 150 most influential people in the community was valuable," she says. "Conferences opened the doors for me."

Benzel worked at MITRE for seven years, serving in a wide variety of computer security capacities, including formal methods, evaluated systems, and distributed systems. She moved to California during what she calls the "exciting period for research," working for the next 16 years at a small company, Trusted Information Systems (TIS) that grew, had an IPO, and was eventually bought by McAfee. She had an interest in organizational behavior and a good business sense managing research programs, and she pursued an executive M.B.A. degree at the University of California, Los Angeles, on nights and weekends. Since her company was in the middle of an IPO, what she learned from the professors at night she would also hear in the talks about valuations at work during the day.

"I want to be fair about what it takes to balance family life and work life," she explains. "I was working full time, traveling, living a commuting lifestyle, and going through my M.B.A. program. Having my then-husband [being] supportive as a stay-at-home parent made this lifestyle much more possible."

She directed the Los Angeles office as well as ran the research group there. When Network Associates/McAfee bought TIS, she knew about the finances of all of the projects—backlogs, revenue streams, product lines, average dollars—and other researchers did not. She had a business point of view and was interested in running the group, so she was promoted and served as vice president of the research group for five years.

After the Internet boom and subsequent bust, Benzel recognized that it no longer made sense to stay at Network Associates. At a meeting in Washington, D.C., with government agencies that sponsored her research, she was called aside to work in the Computer Science Department at the University of California, Berkeley. After a short time working there, she approached the Information Science Institute at USC and asked if they would be interested in hiring her, and she has been there since 2003. She calls USC a fantastic place to work.

Benzel advises anyone embarking on a career in cybersecurity to get involved and look for opportunities to volunteer in organizations. Even though this field has a reputation for being male dominated, she says there are plenty of other perspectives and multidisciplinary areas with opportunities.

"Don't shy away from the field because of lack of resources or not having all of the skills," Benzel adds. "It's more important to have some skills and be willing to go there and do the work."

—Debbie Sniderman

Super-Efficient Workflows

Deelman is impacting science applications

Ewa Deelman was one of the first researchers to explore using cloud computing for science and is now one of the country's leading experts in managing scientific workflows.

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Deelman served as technical paper cochair for the Best Paper and Best Student Paper awards at SC15.

She is a research director in science automation technologies at the University of Southern California's (USC's) Information Sciences Institute (ISI). Deelman leads large-scale, multi-institution collaborations and scientific computing workflow management projects and has received multiple achievement awards. She is also a research professor at USC in the Computer Science Department, occasionally teaching classes, interacting with students and the campus community, and supervising Ph.D. dissertations in addition to doing research.

Early Love of Combining Subjects

Deelman was born in Poland and grew up there during a time when equality for women was encouraged. She felt that she could do math and computer science and was surprised when she came to the United States that girls and women shy away from science, technology, engineering, and mathematics (STEM) fields.

Deelman was always interested in math and physics. When she graduated from high school in 1984, the computer science field was not very well developed, but she thought it was an interesting way to combine her interests in math with the more applied physics.

She studied German in high school and says her English was poor, so after high school, when she had the opportunity to leave Warsaw and come to the United States to study, she thought it would be a good opportunity to learn the language. "My parents thought I would only stay one year and give up," she recalls. "They never told me that, of course. I stayed."

Her father was a physicist and her mother a psychologist, and both had Ph.D. degrees, so it wasn't surprising that she would pursue higher degrees. She was awarded a fellowship from Wells College and graduated with a B.A. degree in mathematics. Deelman started her master's study at Brown University and met her husband, who majored in physics, there. His job moved them to upstate New York, so she completed her master's degree at the State University of New York (SUNY) New Paltz and was encouraged by a professor there to pursue a Ph.D. degree.

Eva Deelman

Pioneering Planning in Scientific Workflows

Deelman chose nearby Rensselaer Polytechnic Institute and obtained a fellowship funded by General Electric to study there. When she met her advisor, Deelman says the story begins—not only pursuing computer science (CS) but applying the knowledge to other domains.

She recalls her earliest project was during her Ph.D. Her advisor was leading work in high-performance computing and thought it would be good to apply CS principles to a scientific domain and see how advances in computing could benefit them. For her thesis, Deelman helped biologists at SUNY Albany apply parallel discrete-event simulation techniques to the spread of Lyme disease in nature. Her work helped make more detailed models of how the disease spread through mice and deer and carried through geographic areas to understand how to prevent its spread.

After a post-doc position at the Computer Science Department at the University of California, Los Angeles, where she worked in high-performance computing, Deelman joined USC as a computer scientist and introduced an innovative concept to workflow management, decoupling a workflow's description from its execution, allowing scientists to describe workflows in an abstract, resource independent way. Today, a similar concept is used in big data systems such as Spark.

That work led to studying optimization techniques and found that clustering short tasks into "larger" more compute-intensive jobs can reduce the overhead incurred by the overall workflow, making large improvements in workflow performance. Deelman and her students developed task-clustering algorithms that dynamically adjusted cluster size based on the observed failures in the environment and algorithms that improved resource provisioning to dramatically reduce a workflow's waiting time.

Before the notion of "big data" and cloud computing, she researched different

types of data "clean up" algorithms based on how the data was used in a workflow that reduced the data footprint and investigated optimal ways to configure cloud resources to maximize overall performance.

Impacting Science

Deelman and her team translated their research into a software product that is being used by many science applications. The Pegasus Project that she designed at USC in collaboration with the HTCondor team at the University of Wisconsin–Madison, researches how to conduct automated processes in distributed systems. It looks at data management, task and job scheduling, issues of reproducibility, and how to use cloud computing, clusters, and HTCondor pools. The software tools make CS research principles available to scientists.

"The Pegasus Workflow Management tool allows scientists to describe computations in an abstract way," Deelman explains. "For example, if you run an application on this data, the result will be another data set that can be processed by another app. Providing Pegasus with a graph or a recipe of what to do, it looks at the computational resources and data available, maps the computations to the resources, and plans the movement of the data across different resources."

Pegasus has helped manage large-scale computations and data involved in the Laser Interferometer Gravitational-Wave Observatory (LIGO) Gravitational Wave physics project since 2001. Collaborating with computer scientists, astronomers, and gravitational physicists, she helped improve their computer systems and data processing in the computational environment that led to the first detection of a gravitational wave.

"LIGO had its own infrastructure for computing and storing data," she says. "But they needed to process large amounts of data to confirm the detection and wanted to use other resources. Pegasus allowed them to perform their computations and seamlessly use other resources such as the Open Science Grid and XSEDE. It offered a huge benefit. They didn't have to rework their workflows or figure out how to use these different resources; Pegasus did it for them."

"It managed the movement of data computation, monitored how computations and data stages progress, and allowed them to recover from certain failures, Deelman continues. "LIGO workflows may have millions of tasks. LIGO scientists don't want to babysit every single failure. Pegasus allows them to recover without losing data or computations. If a task fails, it resends it to another resource to try another system to do the computation. It automates the tedious tasks."

Pegasus is helping bioinformaticians unlock the secrets of cancer cells. It was used with the Montage astronomy software to verify the presence of a new structure called a *bar* in the spiral galaxy M31. And it helped generate the world's first physics-based probabilistic seismic hazard map for the southern California region by efficiently managing workflow tasks in the CyberShake project.

Deelman also applied automation technologies such as Pegasus to perform quality control on data used in a study linking adipose and insulin biology to body fat distribution. In addition, she participates in large cyberinfrastructure projects such as the Open Science Grid and XSEDE and was part of the first National Science Foundation cloud project FutureGrid. "Pegasus is a terrific example of a project that looks at how people can work together to build systems that enable science to be done at large scale," she says.

In 2016, Deelman received the USC/ISI Achievement Award for "technical contributions and leadership in the field of scientific workflow systems for high-performance computing."

There is an additional need for people with interdisciplinary skills, combining CS and domain science.

Helping People

There's an idea that computer scientists sit behind a computer all day, but Deelman gets to work with people, joining in on large-scale projects, collaborating, and sharing ideas. In addition to working with other computer scientists, she is in contact with people in various science communities—astronomy, bioinformatics, climatology, earthquake science, gravitational-wave physics, material science, and others.

"Working in STEM fields is rewarding; you get challenging problems and the opportunity to collaborate with people," Deelman says. "That's something that doesn't come through about CS often. Computer science is everywhere. There are great chances to make a real impact anywhere."

Deelman adds that there is an additional need for people with interdisciplinary skills, combining CS and domain science. She advises anyone interested in joining the CS field to take on broad collaborations between different domains or specialize in one domain and go deeper.

—Debbie Sniderman