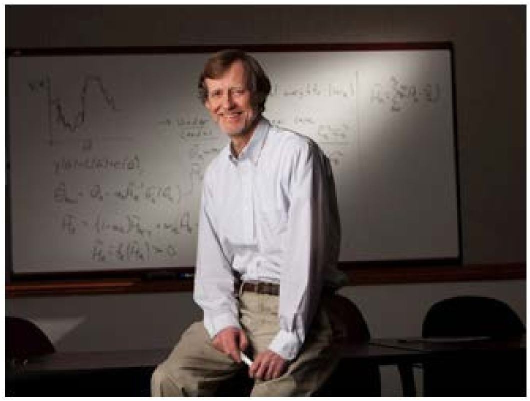
James Spall: Finding Order in the Random



James Spall has made a career out of finding order in the random.

"The field of stochastics is the study of randomness and what you can do and say about it," says Spall, a systems engineer in the Force Projection Department. "The world that we live in often appears to behave in a random way. If you commute through an urban area every day, the traffic will be a little different due to random events [like] rain, a flat tire, construction, and so on. Analyzing these kinds of events and trying to make sense out of it falls in the realm of stochastic analysis."

Stochastic algorithms can help researchers and practitioners work out the best possible solution to countless real-world problems, Spall explains, including refining the design of a missile or aircraft, determining the effectiveness of a new drug, or developing the most efficient timing strategies for traffic signals.

Spall has conducted groundbreaking research in this area, writing a popular graduate-level textbook on the subject, *Introduction to Stochastic Search and Optimization: Estimation, Simulation, and Control*, and publishing countless journal articles. Years ago, he developed a revolutionary algorithm—known as SPSA or simultaneous perturbation stochastic approximation—that dramatically reduced the time it took to conduct trial-and-error function evaluations for the purpose of optimizing systems.

SPSA is widely used by researchers worldwide, including here at APL, where it has informed scores of projects ranging from human–machine interface, sensor placement, robot control, and atmospheric and planetary modeling. It has even been applied to brain surgery. "Apparently the surgeons were using some kind of irradiation, and they wanted to minimize the damage done to healthy tissues, and they used the SPSA algorithm," he says. "It makes me just a little nervous," he quips. "I hope for the patients' sake my math is right!"

He's even developed a mathematical model to predict the success of oboe reeds. His wife, Katherine Ceasar-Spall, is a professional oboist and teaches the instrument. "Normally our careers don't intersect. But after watching her toil for hours making oboe reeds, only to have many of them not work, I thought there had to be a way to predict the success of a reed before wasting too much time on it."

Their collaboration resulted in a coauthored journal article and was profiled in 1997 in *The New York Times*.

Spall's interest in the field was stoked by a statistics class he took as a college sophomore. "I loved that class! I thought it was the neatest thing that you could collect data, do a rigorous analysis of what the numbers mean, and make sense of things," says Spall, who went on to earn a bachelor of science in systems engineering from Oakland University, a master's from MIT, and a doctorate in systems engineering from the University of Virginia.

Spall's father was an engineer. "From a young age I was gently pushed toward engineering, and never really pushed back," he says. But it was the underlying math in engineering, as opposed to the laboratory-based physical experiments, that held him captive. "My undergraduate and Ph.D. programs both had a fairly wide breadth and focused more on the mathematical study of systems, and my dissertation [on stochastic systems] was grounded on mathematics," he says.

When he arrived at APL in 1983, Spall fully expected to spend a couple of years here, then head off for a career in academia. Nearly three decades later, he's still here. "My work is not what you would consider mainstream, and APL has been quite cooperative in tolerating this type of work," he says. His research has become influential in the field both within and outside of APL.

But he did not quite escape the fate of academia. He holds appointments in The Johns Hopkins University Whiting School of Engineering—as chair of the Applied and Computational Mathematics Program of the Engineering for Professionals Program and full research professor (and thesis advisor) in the Department of Applied Mathematics and Statistics. He also has editorial responsibilities with several scholarly journals, including the *IEEE Transactions on Automatic Control*, for which he handles approximately 200 papers a year.

With all these professional responsibilities, plus family activities, there is less time to spend on the golf course, an erstwhile favorite pastime of Spall's. But he relishes the opportunity to shape the field of mathematics by conducting basic research and teaching future mathematicians. "My various teaching roles put me in touch with three very distinct groups of students," he says, "the traditional graduate student, the professional seeking advanced degrees, and the APL professional seeking continuing non-credit education."

He finds problem solving "simultaneously frustrating and gratifying. These mathematical problems consume me sometimes, even when I'm taking the dog for a walk, which is maddening. But I know eventually I'll crack it, and that is very rewarding."

Right now he's wrestling on his own time with a concept that's haunted him since concluding work on an independent research and development project last fall with colleague Coire Maranzano. "We had some success with the project in the area of studying reliability for systems, and I had the idea that I could generalize this concept to a broader setting, not just reliability, to include prediction, control, and general modeling of communications networks and other systems," he says. "Lately, I've thought of one more idea that I am almost sure will pan out to be true, but I just can't prove it...yet."