Micro Essays

ON THE EDGE

Fascinating questions arise when dissimilar objects come into contact. One discipline that articulates this phenomenon is ecology, where *edge effect* refers to what happens when one type of ecosystem borders another type. For example, when a field abuts a forest, each ecosystem has an effect on the other, at least some distance inward. Edge effects also arise in systems engineering. The digital/analog interface is a ubiquitous case, where sample and hold operations have ramifications that include aliasing. Historically, meetings between diverse groups such as explorers and aboriginals create edge effects. The cultural and social ripples from such interactions make for fascinating but often tragic consequences.

Dennis with sons Jason (left) and Sam.

OVER THE EDGE

The tipping point, made popular by Malcolm Gladwell, refers to the situation in which a society radically changes its behavior due to momentum that becomes "unstoppable." This is clearly a dynamical systems phenomenon, but the control systems field hasn't yet formalized it. A simplistic quasi-linear model of the tipping point might be based on pole locations. If the goal is to introduce a new product into the market, sales will grow only when a pole moves into the open right-half plane. When the pole crosses the imaginary axis, the behavior bifurcates from decay to growth. More sophisticated nonlinear models are possible. Applications to climate change and national debt are obvious candidates.

SNAP, CRACKLE

As the end of a project is reached, a curious phenomenon often occurs. After the major pieces are completed, they must be carefully fitted together in their final locations. During that step, if everything to that point is done correctly, a process of flexing and jockeying occurs. You can always tell when the final stage is reached when the pieces snap together. A simple case is when you install the last piece of a jigsaw puzzle, but you might also notice it when you put the finishing touches on a paper—when all of the theorems, definitions, proofs, and examples mesh perfectly. That's when you've reached the *popping point*.

DOES IT WORK?

Across the hall from my office is a utility room, where a large copier resides. This machine has numerous parts and subsystems, consisting of mechanical, chemical, electrical, and software components. Not surprisingly, every once in a while a technician arrives to perform maintenance and repairs. On any given morning, before the machine is turned on, I wonder, "Is it possible to predict whether the machine will work today?" An analogous question arises on a much more rudimentary level in structures. Suppose I hand you a wire in the shape of a ring. I then ask you to predict the shape of the wire after you cut it at some point. Will the cut ring still form a circle, or will it twist into a new shape? This answer depends on residual stress, which is the stress residing inside the material. Residual stress is critical to structural failure but is difficult to determine without resorting to destructive testing. Diagnosing the dormant copier seems even harder. Perhaps we need a theory of testing.

Ravi Venugopal of Sysendes and Dennis Bernstein.

KEEP IT LIVE

The most valuable communications often occur in hallways and offices. Face-to-face conversations typically provide more insight than the most carefully crafted articles. The same principle applies to teaching. We show up to class to speak to students in person. The more classroom technology we place between

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the instructors and the students, such as videotaping or Powerpoint slides, the more we undercut the most effective mode of communication. The day that instructors e-mail an entire set of videotaped lectures to the class is the day that the dean concludes that a lot fewer instructors are needed. When that happens, students and faculty alike will lose out.

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WHAT WE DO

Our name—IEEE Control Systems Society—is something of a misnomer. In fact, only a fraction of what the Society does is actually control systems. Estimation and identification come to mind, as do simulation, computation, optimization, signal processing, and modeling in support of software and hardware implementation in diverse applications. So what glues this group together? Surely, dynamics is one aspect, where time is crucial, delays cause havoc, and online implementation precludes do-overs. We have a penchant for abstracting ideas, which we use to develop tools that have broad application. We develop algorithms that reside inside a relatively clean digital world but must interact with the messiness of the natural and fabricated world. And we have an abiding faith that a combination of rigorous math and careful computation is the best way to do all of this. But control is arguably the most demanding of all of these tasks—requiring modeling, computation, and optimization within the context of dynamics—and therefore provides a driver for almost anything that has a systems feel to it. On second thought, the name largely works.

Dennis S. Bernstein

Utility Versus Truth

The process began much earlier. Newton, for example, "revolutionized" physics and the so-called natural sciences by reducing the physical universe to a linear mathematical equation. Descartes did the same thing with culture. John Locke did it with politics, and Adam Smith did it with economics. Each one of these "thinkers" took a piece of the spirituality of human existence and converted it into a code, an abstraction. They picked up where Christianity ended: they "secularized" Christian religion, as the "scholars" like to say—and in doing so they made Europe more able and ready to act as an expansionist culture. Each of these intellectual revolutions served to abstract the European mentality even further, to remove the wonderful complexity and spirituality from the universe and replace it with a logical sequence: one, two, three. Answer!

This is what has come to be termed "efficiency" in the European mind. Whatever is mechanical is perfect; whatever seems to work at the moment—that is, proves the mechanical model to be the right one—is considered correct, even when it is clearly untrue. This is why "truth" changes so fast in the European mind; the answers which result from such a process are only stopgaps, only temporary, and must be continuously discarded in favor of new stopgaps which support the mechanical models and keep them (the models) alive.

—*Where White Mean Fear to Tread: The Autobiography of Russell Means*, by R. Means and M. J. Wolf, St. Martin's Press, Page 546.