Business Plans

FREEBIES AND HIDDEN COSTS

A compelling argument in favor of wind and solar power is the fact that the "fuel" is free. Once you invest in a solar panel and the requisite electronics, there is no charge for the sunlight that powers it. This is obvious but remarkable in contrast with the commercial world, where profits depend on recurring sales of gasoline, ink, wireless minutes, and other consumables. Of course, you must purchase the equipment, maintain it, and lease space to install it—so nothing is truly free. But at least sun and wind can't be depleted.

Nuclear power, on the other hand, requires refueling and has a steep delayed cost associated with it. Sequestering waste that remains toxic for eons costs money, and that cost is left for our descendants to bear. The advantage of nuclear power, on the other hand, is the ability to locate a power plant almost anywhere in a limited amount of space, along with nonstop operation independent of time of day and weather. But these advantages come with a cleanup cost. The only question is who pays it.

REAL LAWS AND REAL REGULATION

The legal system is essentially a large feedback control system, where laws regulate human behavior and business transactions. It would be interesting to analyze the performance of this system in terms of feedback principles. Most penalties are proportional, some appear to be derivative, and others are integral. Laws with low penalties are often ignored, while laws with severe penalties are taken more seriously. Gain matters. Some legal control laws (note pun) are meant to drive the error to zero, such as the integral control law known as "three strikes and you're out." Perhaps game theory is more apt for understanding this system than PID control. In any event, even the most severe penalties don't seem to eradicate certain types of crimes, suggesting that, even in the high authority case, some actions are uncontrollable. Manageability is perhaps the only realistic goal.

One of the most politically contentious issues is the level of regulation that government ought to bring to bear on commerce. Regulation protects consumers but can decrease profits. Those opposing regulation argue hyperbolically that the government should not be concerned with every obscure food allergy. Short of making peanuts an illegal crop, the question becomes where to draw the line. As a consumer, I prefer to see regulation err on the side of safety. In the financial world, where irresponsible exploits have caused widespread havoc, limited regulation has shown experimentally that the open-loop system is unstable.

AGAIN AND AGAIN

Aside from watching a favorite old movie for the umpteenth time, repetition can be boring. We may enjoy a good meal, but not if it's same every night of the week. In research and development, the goal is to develop and implement new ideas, which helps preclude monotony. Yet, ironically, the goal of engineering is—repeatability. In manufacturing, the objective is to produce identical units with identical specifications. When a space system is implemented, the goal is to have it operate exactly as it operated before launch, zero-g effects notwithstanding. Engineers make every effort—even sacrificing performance and glitz—for the sake of repeatability, and thus reliability. Linearity isn't just a

AE345 Flight Dynamics and Control at the University of Michigan hosting NASA astronaut Col. George Zamka (center).

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mathematical convenience; engineers know instinctively that linearity is more likely to lead to repeatability than does nonlinearity. What isn't repeatable is arguably not science and, except for statistical regularity, is not useful to engineering. In the end we desire devices, systems, and processes that are just plain boring. Nonrepeatability may be the spice of life, but surprise is the bane of technology.

P \ NE NP

Most computer scientists believe that P is not equal to NP. If I give you a set of 100 integers and ask you to determine whether any subset adds up to 5, you'll have a lot of work to do. But if I ask you whether the elements of the subset {22, 13, –26, 6} have this property, you would know almost immediately. The point of this example is that solving is harder than checking. The first problem is NP, whereas the second problem is P, where P means polynomial and NP means non-polynomial. If you can prove that there really is a difference—that is, no algorithm can easily determine whether such a subset exists—then you will solve one of the most famous problems in computer science.

There is a vein of research that focuses on showing that certain problems are NP. These results are sobering, but I'm not quite sure what to make of them. A problem that is NP doesn't mean that we should never attempt to solve it or look for better algorithms; rather, it means we cannot expect to find an *efficient* way to solve it, and thus large-scale versions are ultimately off limits. Assuming that P is not NP, knowing which problems are NP can guide us in our search for problems that are P, and thus more tractable and useful. But NP problems arise whether we like it or not, so I guess we'll just have to keep doing the best we can.

Mario Sznaier, Tryphon Georgiou, Kristie Bellman (daughter of Richard Bellman), and Dennis Bernstein.

MARS TO EARTH

Some applications of control are exotic. For example, figuring out how to land a spacecraft on another planet is exciting enough to enroll an entire department of students in Nonlinear Systems I. But what's special about control is that it's also a crucial technology for some of the dirtiest applications. For example, operating a waste-treatment plant is downright messy. For each planetary landing there are millions of tons of waste on our own planet that need to be processed safely and efficiently. And while exploring remote worlds is a scientific luxury, cleaning up this one is a practical necessity. Filth is our calling. And, if the waste is nuclear, we can expect to be busy for a long time to come.

Dennis S. Bernstein

K+E Robustness

Here's a simple truth: It's better to bend than to break, and it's best to be prepared for the worst. This age-old wisdom is going by a new name in slide-rule circles: "Resilience engineering" starts with the insight that it's smart to design and maintain systems so they have some give. That means building technologies that offer extra capacity to handle sudden loads, plenty of warning when normal operations are beginning to break down, backup systems in case things do go wrong, diverse digital architectures so that a single bug doesn't produce widespread failure, and decentralization so that when (not "if") communication breaks down things don't grind to a halt.

— Glenn Harlan Reynolds,
"Ready for Anything: Why Our Complex World Is More
Disaster Prone Than Ever—And What to Do About It,"
Popular Mechanics, vol. 186, no. 10. p. 48, Oct. 2009.