

**Advertisers in this issue**

AET addax	14
Bertan	13
Bomem	8
High Voltage Engineering Europa B.V.	inside front cover
Huntington Laboratories	3
Janis Research	10
Lake Shore Cryotronics	12
Leybold Vacuum	12
MDC Vacuum Systems	6
Mellen Co.	9
Omicron Associates	7
Perkin Elmer	inside back cover
Plenum Publishers	42
Rudolph Research	4
Siemens	11
UHV Instruments	back cover
University of California, Berkeley	17
Vacuum Barrier	30
Virginia Semiconductor	17
Voltaix	16
Carl Zeiss, Inc.	5

For free information about the products and services offered in this issue, fill out and mail the Reader Service Card, or FAX it to (312) 922-3165.

**In the Next Issue...**

- *Dynamics of Sand* by Per Bak and Michael Creutz, Brookhaven National Laboratory
- *Bandgap Engineering for Advanced Electronic and Photonic Devices* by Federico Capasso, AT&T Bell Laboratories
- *Tuned Tilt of Epitaxial Crystals* by C. P. Flynn, University of Illinois

**Immaturity of Chance**

Most of us trained in science or engineering have been exposed to a course or two in probability and statistics. At least we probably have.

Perhaps at the time, the concepts were not entirely intuitive. That the standard deviation in a total number of occurrences of events occurring randomly in time is the square root of that number may have been obvious to Poisson, but not necessarily to the rest of us. Yet, for example, that the chances of both of two probability-1/2 events happening is one out of four seems somehow natural enough. I suspect that comfort with such concepts comes more from faith ingrained in class than from experience. The Law of Large Numbers, in fact, often prevents us mere mortals from living long enough to test an event's true likelihood.

Probably because I am among the faithful, I am continually perplexed by the apparent predictability of supposedly random or accidental events. (Many accidents can occur randomly but all random events, e.g., earthquakes, need not arise accidentally.) Of all the laws I remember from that statistics course, Murphy's was not among them. Murphy's version of the coin-flipping experiment is the rule that, "more often than not, a dropped slice of bread will land buttered side down." Although it is tempting to work out the torque arising from differential drag between bare bread and my favorite spread, I rarely drop food from so high a height that it would matter. Anecdotal evidence, however, clearly favors Murphy over physics.

Another phenomenon many travelers encounter is the affinity shown by hooks on those elastic "bungee" cords for any and all objects to which you don't want them to attach. Unless you handle these recalcitrant ropes in an excruciatingly measured and methodical manner, always keeping a grip on the free ends, they will invariably latch on to something, despite being surrounded by cavernous regions of free space where they could dangle harmlessly.

Any number of other supposedly random types of events which seem to rise above their natural probabilities could also be cited. The call for which you've waited hours comes just when you step out for a moment. When the next data point should confirm the trend, it falls three standard deviations out of line. Feel free to

send in your own examples. We would have a contest if it were not nearly certain that the best entry would be lost in the mail.

So as not to let down our technical forefathers, the natural philosophers who tried to subject all phenomena to logical explanation, we offer two. Accepting that an event physically (but not necessarily psychologically) uncorrelated with preceding events of its kind will only occur with some well-defined probability (i.e., as we learned in class, the notion of "maturity of chance" is specious), then perhaps we simply fail to count the number of times something could happen but doesn't. I've never seen a newspaper headline read, "Nothing bad happened today." Thus, bias in our measurements is a likely culprit. Not a very satisfying explanation when wrestling with your luggage or degreasing the kitchen floor.

I prefer an alternative thesis, one that came to me as I recalled a plot of past, present, and future consumption of fossil fuel on a geologic time scale.<sup>1</sup> It was a delta function-like spike under which *now* seems to fall. What seems like a *status quo* that has been, is and will be, in fact, wasn't and won't. This leads us to ascribe our observations to "immaturity of chance," which both validates anecdotal impressions and rehabilitates Mr. Murphy. Rooted in the lore of fluctuation phenomena, the laws of small numbers and inadequate sampling, are winning and losing streaks. We are indeed blessed to live in a time of great prosperity, albeit partly because we pass on our debts to future generations. Fairness has dictated that we also live in a time plagued by coincident fluctuation of all randomly occurring annoying events into their high-rate streaks. Being trapped in the statistical nadir of a long-time-scale fluctuation is not pleasant, but it is heartening to realize that, as our grandchildren are paying out bills, they (or their grandchildren) should expect<sup>2</sup> to ride the crest of an inverted Murphy-ism. "If anything can go right, it will."

E.N. KAUFMANN

1. From a lecture some eight or nine years ago by professor emeritus Hubert King (Columbia University).
2. With no mathematical justification, of course.