October 29, 2011: Our trees are still festooned with neon-orange, and yellow leaves, advertisements for Thanksgiving, not Christmas. But I know that Christmas will be here in a blink, so I'm starting now. Season's greetings, whatever season you are in when you read this.

Barely a blink later: The leaves are gone and the Thanksgiving turkey is history. After 62 years, I am more amazed by the passage of time than ever.

We have had a year of sweet domesticity, laced with some fun foreignness. There have been glitches along the way, but most aren't big enough to appear in a holiday letter. (And those that are, are best forgotten.) The saddest events were losing both an aunt and an uncle on my side of the family, and even that gave us time to think about what fine people they were and how much we value family. (And to appreciate, once again, relatives who live well into their 80s and 90s.) The world is not the same without them. Understanding it has to be this way may be a hallmark of adulthood.

We celebrated our 20th wedding anniversary, in Shanghai, no less. We have two new grandnieces, one on Bob's side of the family and one on mine. Both, of course, are the cutest babies ever born in the universe. And we're enjoying our last year of granddaughter Crystal's almost full-time company, before she heads off for college – relishing her energy and ruing the impending change. (Her response to this? "Isn't it a little early for separation anxiety?") All of the children and our extended families are doing well.

We've stuck to our usual routines this year – symphony for Bob and me, theater and ballet with friends for me, travel whenever possible. We're happy to report we're in good health and doing our best to stay that way. Bob has been diligent about going to the gym and I've been consistent at twice a week, with close supervision from a trainer who makes sure I do all the repetitions she wants. Life is good.

In no particular order, here are some of the things that have made us happy this year:

- Seeing the San Diego Zoo with Ben and Crystal, and then seeing it again a few months later.
- Waking up every morning in River Forest to Bob's coffee and an hour or so of conversation about the newspapers (still received the old-fashioned way).
- Seeing our Honolulu-based grandchildren twice this year, once here and once in Hawaii.

- ❖ Driving Crystal to her Saturday art workshops at the opposite end of Chicago. The conversation and music made it worth playing bumper cars with buses and delivery vans on city streets.
- ❖ Entertaining visitors and friends.
- ❖ Spending three days in a row in the Shanghai Museum.
- ❖ Sitting on an old barge below the Brooklyn Bridge, listening to music with Sally.
- ❖ Giving my sister (who raised two teen-aged boys and is not easily fooled) a surprise birthday party, for a round-number that is less than mine and more than 29.

Our travel has ranged from San Diego to Washington, DC; from Madison, Wisconsin, to Shanghai, China; and from Bismarck, North Dakota to Oxford, England, with some points and in between. Bob squeezed in a second trip to England, while I stayed home and did legal work for clients. We were at our grandchildren's class day in Manoa (Honolulu), Oahu, and also made several visits to Brooklyn to see Sally. All of this has made for a very good year, indeed. We hope you can say the same.

Bob's Science Page(s)

The science has been too focused in the last Christmas letters so this year I am including a few things on topics of more general interest

Here is what I have tried to do every day since ~1962.

Look at biological systems through an engineer's eyes

Published in Nature 2007 447, p. 376. Note UK spelling is required despite Noah Webster.

SIR — Your Connections series of Essays has taken some interesting looks at the interdisciplinary study of complex, dynamic systems (see www.nature.com/nature/focus/arts/essays/index.html). However, it has not featured a discussion of the physiological tradition of biological research, in which biological systems are analysed using reduced descriptions in much the same sense that an engineer uses a reduced description of an amplifier. An engineer is often not interested (to first order) in what is inside the box that produces gain, but studies the properties of the gain, its linearity, its frequency dependence and so on. A complete description of the structure of the amplifier is far less useful than a reduced description of its input–output relation, when the goal is to use the amplifier or connect it to other devices to make a system.

An engineer told that an unknown black box is an amplifier is rather like a biologist confronting an unknown biological system. Some structural knowledge is indispensable. Engineers would have a terrible time if they did not know which leads were power supplies, which inputs and which outputs. But the last thing an engineer would want to know is the complete circuit diagram, let alone the locations of all molecules or atoms in its resistors, capacitors and transistors. Successful investigation requires some (indispensable) knowledge of structure; but it requires many more measurements of inputs and outputs, under many conditions. Successful investigation also requires a good quantitative model of the system, called a device equation.

Physiologists have successfully analysed a large range of biological systems using this 'device-oriented' approach. For more than a century, medical students have used it to learn that the kidneys filter blood to make urine; the lungs transport oxygen from air to blood; muscles contract; sodium channels produce action potentials; and so on. Each device description in physiology — on each length scale from organ, to tissue, to cell, to organelle, to protein molecule — is associated with a device equation, just as a device description in engineering (for example, of a solenoid) is followed by an approximate device equation for its function, for example, its input–output relation.

No one knows which biological systems can be viewed productively as devices. No one knows how many of the unsolved complexities of biological research reflect problems of the reverse engineering of simple devices, and how many reflect the inherent complexity of biological systems. One can certainly imagine simple systems that are hard to investigate because of the paucity of experimental knowledge. Complex systems — for example, with many internal nonlinear connections like the integrated circuit modules of digital computers or, perhaps, the central nervous system — may not be easily analysed as devices, no matter how many experimental data are available. But it seems clear, at least to a physiologist, that productive research is catalysed by assuming that most biological systems are devices. Thinking today of your biological preparation as a device tells you what experiments to do tomorrow.

Asking the questions in this way leads to the design of useful experiments that may eventually lead to the device description or equation, if it exists. If no device description emerges after extensive investigation of a biological system, one can look for other, more subtle descriptions of nature's machines

Evolution

(Submitted to The Economist, not published.)

Dear Sir or Madam,

Your Science and Technology article on Evolution (February 7th) gives much wonderful detail, while missing the main points, I fear.

The fundamental idea of evolution is more mathematics than science.

If an organism reproduces, and some of its children reproduce more than others, there will be more of them. If organisms reproduce more because of an inherited characteristic, their children will have more of that characteristic than the parents. That characteristic will predominate. The organisms evolve. Writing these sentences as differential equations shows that evolution is a fact of mathematics, not science. The mean value of nearly any characteristic of a reproducing species drifts. Mathematics shows that reproducing systems, subject to selection, must evolve.

Science enters the argument when one observes the world

(1) to see if organisms reproduce
(2) to see if organisms are selected
(3) to see if organisms do in fact evolve.

These observations are not difficult and the conclusion is obvious to anyone who makes them, as it was to Darwin and Wallace. **Life evolves.** Observations show that life evolves.

Observations also show that some physical laws are remarkably accurate. **How a super-natural being can guide the world--without violating the natural laws we scientists study every day---remains a mystery.**

Grappling With the Cosmic Questions

(Published in the NY Times May 15, 2008.)

Dear Sir or Madam,

Any working scientist like me knows that measurements are objective, reproducible by anyone, independent of feelings and prayer. Mathematical laws accurately describe a large number of these measurements, in particular measurements of electrical phenomena, water flow, swaying of buildings, and so on.

The essential problem for believers is to explain how God can change our lives without changing these measurements, or the physical laws that summarize them.