What Time Is It?

He used to build massively parallel computers; now Danny Hillis is into massively long-term thinking.

By Jeff Perrott

The Long Now Foundation is reinventing time.

Well, not exactly: not the time we think of as a fixed and natural continuum demarcated evenly, arbitrarily by units divisible by the Earth's rotation around the sun — not the steady continuum pillowing our present between the last and the next moment.

No, the Long Now takes on the time we take for granted, the time we're here: time spared, time to go, time served, time to burn — the time we invented to re-assure and redeem ourselves with each successive moment.

The Long Now is a consortium of diverse scientists, engineers, artists, filmmakers, authors, philanthropists, and Earth-watchers — led by computer scientist Danny Hillis — who are building a 10,000 year clock.

Yes, a clock that ticks once an hour, calculates twice a day, and tolls every ten thousand years. It's the kind of concept and project that makes you reconsider just about everything in your world. What will the earth be like in 10,000 years? What will technology be like? What will we look like? Who will run and maintain it? Who will care? Why are we thinking ten-thousand years into the future?

It was Hillis' idea. You may remember Danny Hillis as the prodigy who in 1985 (while working on his Ph.D. at MIT) designed and built the world's largest, most powerful computer using his theory of building highly parallel architectures. The "Connection Machine," as it was called, was a “massively parallel” computer comprised of 64,000 processors. You may also imagine Hillis has devised some equally potent microelectronic miracle capable of keeping track of 10,000 years of astronomical fluctuation, accounting for chaotic chance algorithms — something we (or the civilization who colonizes us) will be proud of in 12,001.

Think again. "In my work on parallel computers," he says, "I met a lot of people who were obsessed with speed. My customers were always looking at 'faster, faster.' So, I naturally began to think of 'slower' as the unnoticed frontier."[1]

The “faster, faster” thinking that went into the massively parallel computing project simply doesn't apply to the clock. But it wasn't just the obsession with pure speed that got Hillis thinking about a "timeless" timepiece — it was, it seems, the sheer absurdity of viewing that infinitesimal obsession from the vantage point of an unimaginably vast location: the unchained future.

We seem to hit the edge of language when we try to consider ourselves, our lives, and our desires here. Hillis resorts to poetics: metaphor and memory.

"Some people say that they feel the future is slipping away from them. To me, the future is a big tractor-trailer slamming on its brakes in front of me just as I pull into its slipstream. I am about to crash into it.

"When I was a kid, three decades ago, the future was a long way off — so was the turn of the millennium. Dates like 1984 and 2001 were comfortably remote. But the funny thing is that, in all these years, the future people think about has not moved past the millennium. It's as if the future has been shrinking one year per year for my entire life. 2005 is still too far away to plan for, and 2030 is too far away to even think about. Why bother making plans when everything will change?

"How we name our years is part of the problem. Those three zeros in the millennium form a convenient barrier, a reassuring boundary by which we can hold on to the present and isolate ourselves from whatever comes next. Still, there is more to this shortening of the future than dates. It feels like something big is about to happen: graphs show us the yearly growth of populations, atmospheric concentrations of carbon dioxide, Net addresses, and Mbytes per dollar. They all soar up to form an asymptote just beyond the turn of the century: The Singularity. The end of everything we know. The beginning of something we may never understand. I want to build a clock that ticks once a year. The century hand advances once every one hundred years and the cuckoo comes out on the millennium. I want the cuckoo to come out every millennium for the next 10,000 years. If I hurry, I should finish the clock in time to see the cuckoo come out for the first time."[2]

Well, the prototype's built, but the actual, three-story clock is still a few years off. Hillis' five design principles have been in place for some time — a design "philosophy" is more like it — driven by Hillis' 10,000 year thinking:

- **Longevity**
  With occasional maintenance, the clock should reasonably be expected to display the correct time for the next 10,000 years.

- **Maintainability**
  The clock should be maintainable with bronze-age technology.

- **Transparency**
  It should be possible to determine operational principles of the clock by close inspection.

- **Evolvability**
  It should be possible to improve the clock with time.

- **Scalability**
  It should be possible to build working models of the clock from table-top to monumental size using the same design.[3]

And, with such principles, as set of design "*rules*":

Regarding "*Longevity*":
- Go slow
- Avoid sliding friction (gears)
- Avoid ticking
- Stay clean
- Stay dry
- Expect bad weather
- Expect earthquakes
- Expect nonmalicious human interaction
- Don't tempt thieves

Regarding "*Maintainability and transparency*":
- Use familiar materials
- Allow inspection
- Rehearse motions
- Make it easy to build spare parts
- Expect restarts
- Include the manual

Regarding "*Scalability and Evolvabilty*":
- Make all parts similar size

- Separate functions
- Provide simple interfaces[4]

It follows, then, that Hillis' massively parallel architectures would not work because the model breaks several rules. In fact, as one of the project's chief engineering designers, Alexander Rose, points out, microelectronics technology was out of the question.

"The clock is innovative and retrospective at the same time," Rose points out. "Microelectronics is contrary to all those principles Danny set forth at the beginning of the project. Any design that does not fit, in some way, all of the criteria has very little chance at real longevity. Microelectronics technology is invisible, unimpressive to watch, and has an unknown longevity."[5]

Then, what is it?

"It is modern logic with 16th-century execution," Rose explains. "While using all mechanical components, we are using modern binary computational techniques. While binary addition is not innovative the mechanical method is.

"We wanted to build a calculation device that has the robustness of the binary method that a microchip does, but one that could be understood by simple observation. This allows people in the future to maintain it with a minimum of technology. It also allows them to modify it to make it more relevant for their time, like adding new calendrics, for example."[6]

Roger Smith, in his January 2000 *Software Development* article, admirably explains the “bronze-age.com” innovation at work in Hillis' clock:[7]

> “Suspended on six columns, the prototype is driven by a torsional pendulum, a whirligig of three rotating 22-pound tungsten bobs suspended from a 1/4-inch wide double ribbon of flexible elinvar. "Elinvar, as its name implies, has an elastic coefficient that is invariable over normal temperature changes," Rose explains. "That's ideal, since we're using this as a spring."
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> The pendulum signals when five circular, binary tracks (the adders that are the "chips" of the clock's computer) should turn. As the adders complete their allotted one revolution per hour, they reset moveable pins that can be programmed as ones and zeros. Each adder tracks a specific measure of time corresponding to one of the dials on the clockface. The clock's face displays the Gregorian calendar, the sun's position, moon phase (with the current star field in the middle) and the precession of the equinox (the axial wobble of the earth that occurs every 25,792 years).
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> Originally designed to be powered by seasonal temperature changes, the current design calls for human winding. Once wound, power is delivered to the mechanical "bit-adder" computer via a pair of weights corkscrewing their way down matching drive towers that hug both sides of the clock. An innovative clock section called an escapement-adapted from a marine chronometer design but using a torsional pendulum instead of a balance wheel like a watch-impulses or feeds energy to the pendulum. The clock is projected to be accurate to within one day every 20,000 years, but just in case it isn't, a solar synchronizer will correct the time shown on the clockface. A lens on top of the clock will advance or retard the display by phase-locking to the local noontime sun. The digital mechanical design also allows the clock to adjust for leap days, leap years, leap centuries — even for the precession of the equinox.”

Crazy? Perhaps. Ambitious? Definitely. Innovative? Without a doubt.

We in microelectronics design too often mistake quantity for quality by equating speed with innovation — faster chips, faster to market, faster info, faster this, faster that. We've bred a generation of velocity-obsessed MD professionals of all rank and color, and we've built our neuroses into the market for consumers, too; for surely not just the speed of getting there first is ego-enhancing — for seller and buyer — but also the first to switch, change, add, move forward is too, as if movement itself is synonymous with improvement, efficiency, even status. And while the MD industry's speed lust won't decelerate any time soon, it may want to slow every once and a while and take a long look at the Long Now Foundation's guidelines:

1. Serve the long view (and the long viewer).
2. Foster responsibility.
3. Reward patience.
4. Mind mythic depth.
5. Ally with competition.
6. Take no sides.
7. Leverage longevity.

What after all, is the “chip” of the 210th century?

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