Thoughts on Comp Arch Futures

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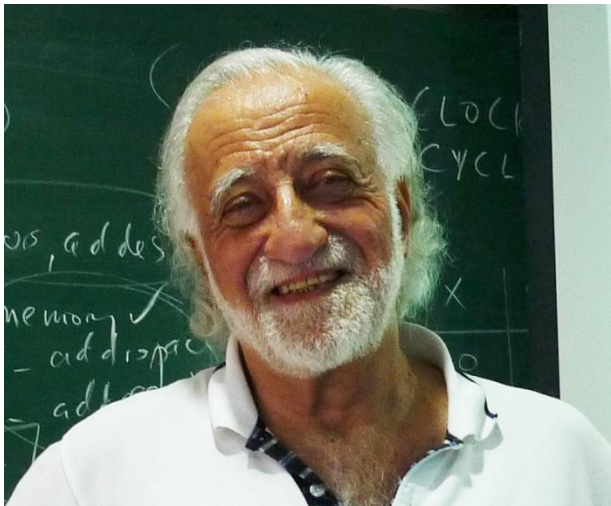
Why does this guy look so worried?

Oh.



My Perspective on Computer Architecture Research

- Is not about instruction sets or ISAs
- Has sometimes been about systems & interconnects

- Biggest payoff has been *microarchitectures* for 35+ years

- Winning formula
  1. Think of a new tweak, simulate in isolation for perf impact
     - If big enough, include in design or write paper
  2. Accumulate ideas into new product
  3. Apply "windage"
     - Experienced designers judge sims down: implementation issues or "feature crosstalk"
     - If publishing, leave out, hope referees don't notice (they probably won't)
  4. Don't go too far or cost, complexity or schedule slips will sink you
  5. Repeat until out of time, then tape out

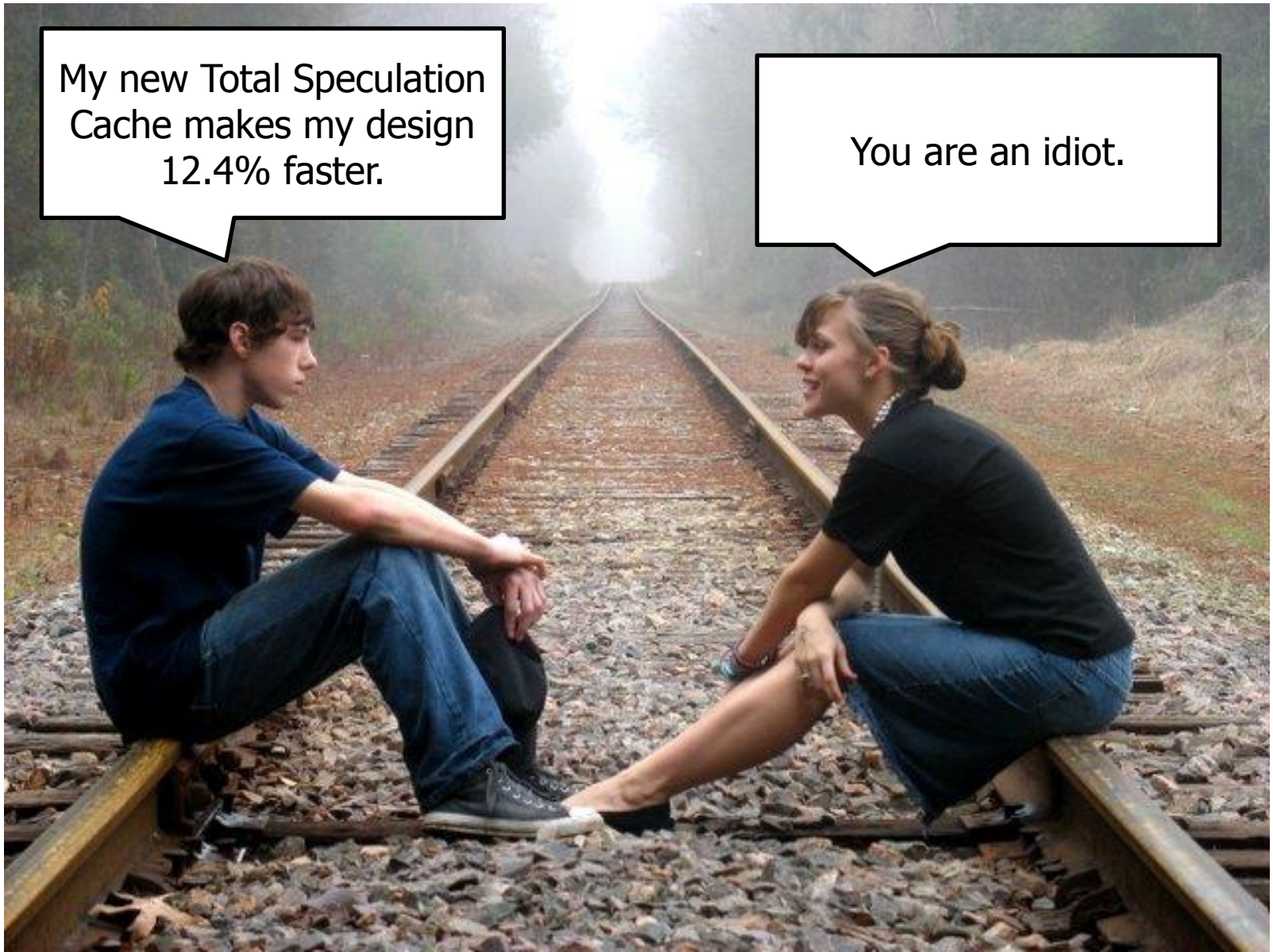
Classic Microarchitecture Paradigm No Longer Works

It has several serious flaws going forward.

1. It presumes that perf improvements are all that matter for winning product
    1. This has not been true for at least 10 years

2. It does not account for opportunity costs
    1. New ideas cost
        Design time
        Chip real estate
        Degradation of other features
    2. But mainly it ignores power dissipation, and you can no longer (ever) do that

uArch Perf Tweaks Mean Nothing In Isolation Any More



Don’t Get Trapped in the Horizontal Mindset

Computer systems are extremely complex.

You are taught to think of them in horizontal layers

Apps at top

OS under that

Instruction set arch

Microarchitecture

Circuits

Gates/devices (and so on)

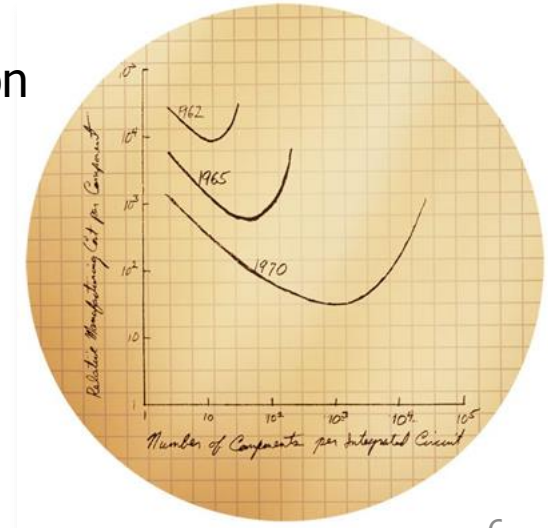
But electronic systems don’t care how you think of them. They must work correctly at all levels, all the time. And they will only do that if you design them so they *can’t possibly do anything else*.

<u>You must be able to transcend the horizontal mindset.</u>

Future Good Ideas in Comp Arch Must Comprehend…

- Power
- Energy & cooling
- Signalling
- Errors from worsening CMOS
- Huge, bloated SW and/or buggy apps
- Battery form factors, weight, lifetime, recharging
- Packaging
- EMI, RFI, radiation
- Unbalanced systems from unbalanced components
  - very slow DRAM, low bandwidth I/O
- High cost pressure from impending commoditization

And the end of Moore's Law



Where to look, what to consider

- Ask the right questions
  - What do buyers really want?
    - They don't want to buy *computers*, they buy *solutions*
    - Faster isn't always better
  - Where should computations be done?
    - Locally?
    - Cloud?
  - How should computations be done?
    - No more {bits; ops; movement} than necessary
    - No faster than necessary
    - Would approximate solutions work?
    - Find right balance in heterogeneous system (and learn to program it!)
  - What will your new product do that's never been possible before?

Most Importantly

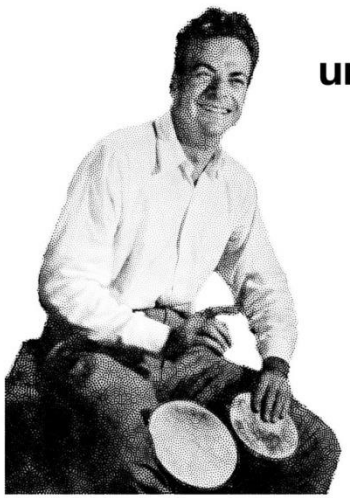
It isn't technology that rules the computer kingdom.

It's economic$.

Last Words, far beyond computer architecture

- Don't believe everything you hear today from us "old guys"
  - If instruction set design is your passion, I think you're nuts, but go prove me wrong and I'll salute you
- We all have our blind spots
  - Your job is to avoid ours so you can have your own
- Note that this talk assumed no new technology would come online
  - That was on purpose to show what a blind spot looks like
  - That's my story and I'm sticking to it
- The more certain we old guys are, the more skeptical you should be
  - I'm *sure* of *that*

The End



"Study hard what interests you most, in the most undisciplined, irreverent and original manner possible"

Richard Feynman-
Physicist and Bongo player

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"Fall in love with some activity, and do it!

Nobody ever figures out what life is all about, and it doesn't matter. Explore the world. Nearly everything is really interesting if you go into it deeply enough. Work as hard and as much as you want to on the things you like to do the best. **Don't think about what you want to be, but what you want to do.** Keep up some kind of a minimum with other things so that society doesn't stop you from doing anything at all.

Richard P. Feynman

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