

Comment

Perpetual motion of the worst kind

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“The fact-gathering tendency is apparent not just in structural genomics, but also in functional genomics (to identify the role of each gene in the genome) and proteomics (with similar aim for each protein in the cell or organism). Evidently, there are enough facts to keep biologists busy gathering them for decades. So when will they have time to think?”

Nature 2000, **403**:345

“The speed of acquiring data is now exceeding our ability to comprehend it and put it into the proper biological context.”

Science News 2000, **157**:284

In the history of human communications, first, there was mail. It gave us news of things and connected us with people, but mostly it brought us work to do (“Pay this bill!”; “Correct these proofs!”; “Answer this query!”). We didn’t mind, because it was exciting to receive mail: it was tangible proof that we mattered to someone out there. Then along came the telephone. It was exciting for the same reasons, plus it made connections with people less formal and more rapid. True, it brought us more work to do, but we didn’t mind too much. But - and this should have made us feel slightly uneasy - the volume of mail did not decrease appreciably. Next there was the fax machine. It could send hard copies as fast as a telephone call. But the faxes we received mostly brought us more work to do - from impatient, demanding people (have you noticed how many fax cover sheets say ‘URGENT FAX’, no matter what the fax’s content?), people who seemed to believe that just because they faxed us something, we had to do whatever it was they wanted immediately. And - this was the scary part - the volume of mail and the number of phone calls did not decrease appreciably.

Finally, there came e-mail. E-mail was great. We could communicate with anyone, anywhere, at our leisure and as informally or formally as we liked. We could send documents and

figures as well as messages; we were wired. And yet, our e-mail correspondents didn’t want us to reply at our leisure. They had e-mailed us; didn’t we know that meant we had to answer right now? And the attached documents came in a time-consuming array of incompatible formats. We were expected to read enormous documents that no one would ever have faxed to us, and then reply to them immediately - after all, they had been e-mailed. And despite all this the volume of mail and the number of phone calls and faxes has not decreased to a manageable level.

Although ‘introductory thermodynamics 101’ was quite a few years ago for me, doesn’t all this contradict The Law of Conservation of Matter? Each new technology increases the total amount of work we have to do and the speed at which we are expected to do it. And as if being smothered in work to do weren’t bad enough, now we are about to drown in data. The genomics revolution is flooding us with data at a rate unprecedented in human history. The banks of DNA sequencers at Celera and the Sanger Center - *inter alia* - can turn out the complete genome sequence of a prokaryote in one day. But we need time to study these data. Time to digest them. Time to think deeply about what they mean. Yet we won’t have that time because we’re too busy gathering yet more data, trying to keep up, trying to dig out from under all the stuff to do that our wonderful new technologies are piling on top of us.

If I could change one thing about modern science, it would be this constant busyness. It robs us of so many things: the peaceful contemplation of our results; the time to get to know our students better; the challenge of planning an experiment carefully instead of just rushing to get more data; the simple joy of working with our own hands. It exhausts us, emotionally as well as intellectually and physically. And genomics is only going to make it worse, if in no other way than simply by increasing the pressure for more results, faster. If we don’t do something about it soon, we



will wake up one morning to find that science has become work instead of fun. (And personally, I've never wanted to work for a living.)

If you read the old scientific literature, it's astonishing how much depth of analysis there is in the best of it. Our scientific forebears could draw amazingly perceptive conclusions from a handful of data. We accumulate orders of magnitude more data with techniques they might have drooled over, but we can't seem to match their ability to make sense of it all: we're too busy. Yet if we don't find the time to think about all the data that genomics is pouring out, we'll miss the opportunity - and the fun - of figuring out what it all means.

I can't really see any way of turning the clock back to a simpler time, but I do have a proposal for a solution. It's radical, but desperate times call for desperate measures. I think we should agree as a community to designate one month a year solely for the purpose of catching up and having time to think. February seems like a sensible choice: in much of the scientific world it's a pretty depressing month, weather-wise, so why not make it good for something. During February, no journals could be published, no papers submitted, no papers sent out to reviewers. No one would be allowed to send mail, e-mail, fax, or make a phone call, that required anyone to do anything in the nature of additional work. No scientific meetings could be held. Supplies and equipment could be ordered, experiments could be done, papers could be written and read, but no new work could be dumped onto anybody in the scientific community. In March all the busyness would start up again, but we would know that every year we would have one month to look forward to: a month when we could get the piles of work somewhat under control, reacquaint ourselves with our students and families, and just think.

There would need to be severe penalties for violating this community-wide agreement, or else the temptation to slip back into the old ways might prove too strong. Funding agencies could cut off research support to anyone who broke the rules - but a lot of work is funded by industry instead, and governments police things too much for my taste

anyway. Ostracism is a possibility, but scientists tend to be gentle and forgiving people, so ostracism would be tough to enforce. I am completely opposed, both morally and intellectually, to capital punishment, but I might just be willing to make an exception in this case. I think the matter is so important that we can all agree that no disciplinary action would be too harsh.