

Changing scales for a changing science

Daniele Schön, RMN June 2018

Part I: *On the impossibility of drawing a map of the empire on a scale of 1 to 1*

Intermezzo at 500:1

Part II: *social constraints and abnormal scales in science*



"What a useful thing a pocket-map is!" I remarked.

"That's another thing we've learned from your Nation," said Mein Herr, "map-making. But we've carried it much further than you. What do *you* consider the *largest* map that would be really useful?"

"About six inches to the mile."

"Only *six inches*!" exclaimed Mein Herr. "We very soon got to six yards to the mile. Then we tried a *hundred* yards to the mile. And then came the grandest idea of all ! We actually made a map of the country, on the scale of a *mile to the mile*!"

"Have you used it much?" I enquired.

"It has never been spread out, yet," said Mein Herr: "the farmers objected: they said it would cover the whole country, and shut out the sunlight ! So we now use the country itself, as its own map, and I assure you it does nearly as well."

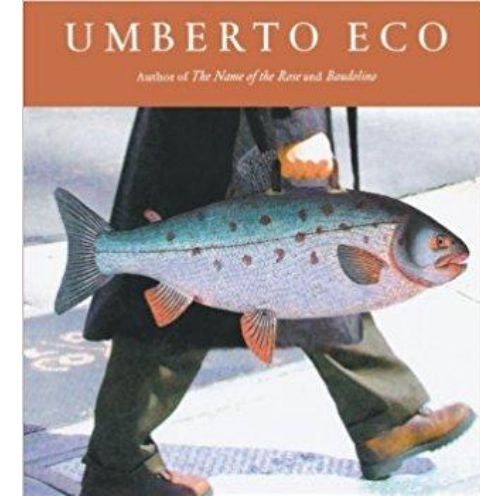
from Lewis Carroll, Sylvie and Bruno Concluded, Chapter XI, London, 1895

“... In that Empire, the Art of Cartography attained such Perfection that the map of a single Province occupied the entirety of a City, and the map of the Empire, the entirety of a Province. In time, those Unconscionable Maps no longer satisfied, and the Cartographers Guilds struck a Map of the Empire whose size was that of the Empire, and which coincided point for point with it. The following Generations, who were not so fond of the Study of Cartography as their Forebears had been, saw that that vast map was Useless, and not without some Pitilessness was it, that they delivered it up to the Inclemencies of Sun and Winters. In the Deserts of the West, still today, there are Tattered Ruins of that Map, inhabited by Animals and Beggars; in all the Land there is no other Relic of the Disciplines of Geography.”

purportedly from Suárez Miranda, Travels of Prudent Men, Book Four, Ch. XLV, Lérida, 1658

Jorge Luis Borges (1946) Del rigor en la ciencia, Los Anales de Buenos Aires, año 1, no. 3

On the impossibility of drawing a map of the empire on a scale of 1 to 1
Eco U, 1995, in *How to Travel with a Salmon & Other Essays* / 1992 Frammenti della
Cacopedia in *Secondo Diario Minimo*



Requirements for a 1:1 Map

- That the map be in fact one to one and therefore coextensive with the territory of the empire
- That the map is not a plaster covering the surface of the empire in which case the empire would be the map of itself with all the consequent semiotic paradoxes
- That the map cannot be spread out in a desert area of a second separate empire X_2 such that $X_2 > X$ (as if a 1:1 map of the Principality of Monaco were to be spread in the Sahara). This would lose all the theoretical interest.
- That the map be faithful, depicting also the artifacts as well as the subjects of the empire
- That the map is not an atlas with partial pages (it must be possible to unfold it)
- That the map is capable of signifying the empire, especially when the empire is not perceptible

It is therefore necessary that i) the map not be transparent ii) not lie on the territory iii) be adjustable in such a way that the reference points of the map lie on points of the territory that are not the one they indicate

Difficulties with the 1:1 map

Opaque map Spread out over the Territory: need a constant update due to the climate changes

Suspended map: the map would still not allow the reception of information about parts of the territory different from those where the map is being consulted; a moving subject would render the map unfaithful

Folding and unfolding of the map

Preliminary conditions: storage, topology of the territory (circular) so that the map can be unfolded in any direction with a fixed central point.

Risks in folding and unfolding the map

Indetermination principle: The folded the map would not represent the folded map and would thus become unfaithful and useless. If it were to depict the folded map, once unfolded it would become unfaithful.

Once unfolded every subject should assume the original position at the moment of the creation of the map.

The paradox of the normal map (Russel): when the map is installed it does not describe the map over the territory



Every 1:1 map always reproduces the territory unfaithfully

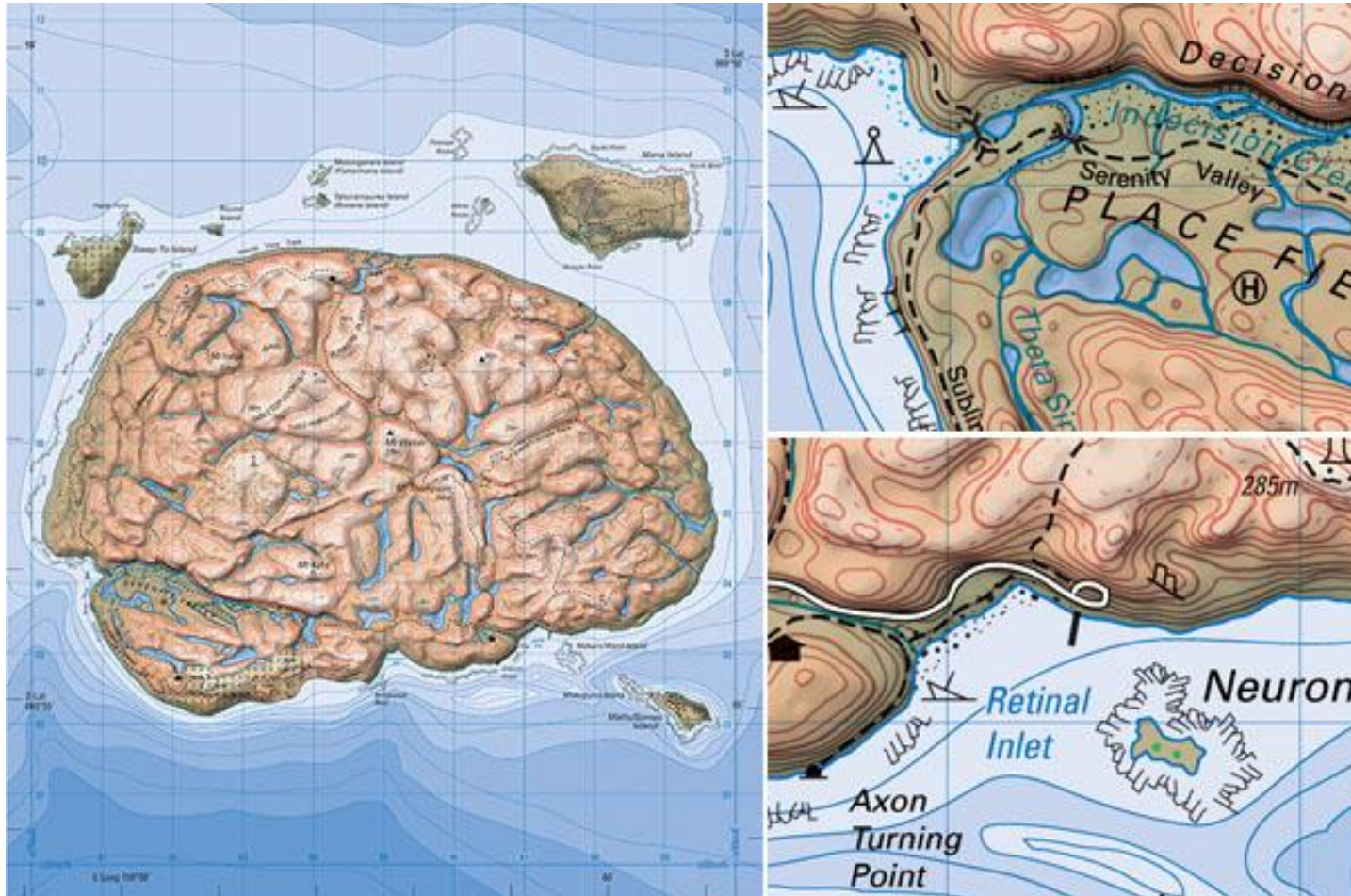
At the moment the map is realized, the empire becomes unreproducible

Every 1:1 map of the empire decrees the end of the empire as such and therefore is the map of a territory that is not an empire

Every 1:1 map always reproduces the network unfaithfully

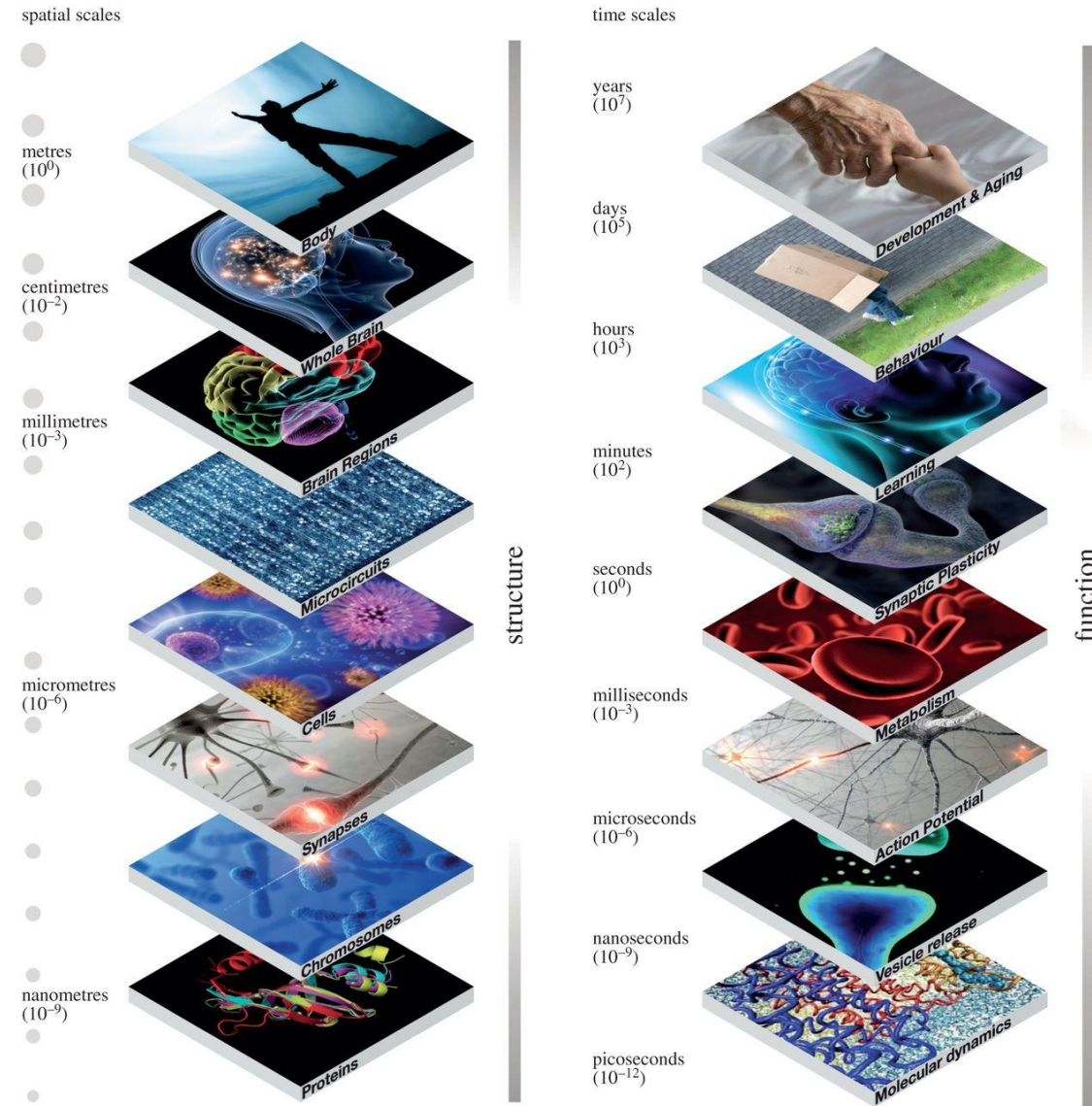
At the moment the map is realized, the brain becomes unreproducible

Every 1:1 map of the brain decrees the end of the brain as such and therefore is the map of a territory that is not a brain



<http://visualizingscience.ryanwyatt.net/>

The multi scales problem



Frackowiak, and Markram 2015

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Growth rates of modern science and the salami slicing approach

Darwin publishes in 1859 ... years after the the journey on the Beagle

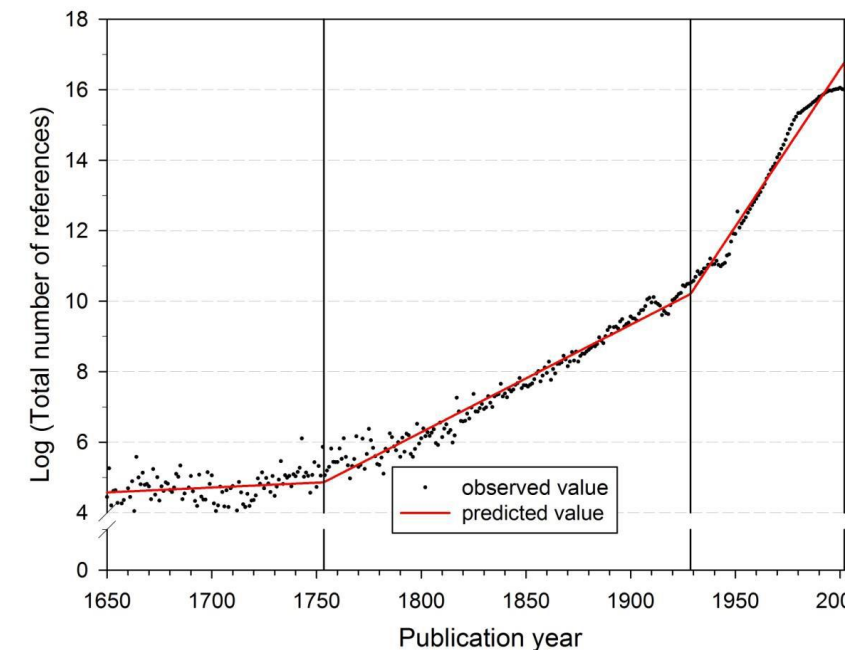
Today >2million publications/year equivalent to 150 years of publications in ancient time...

Every 8-9 years we double the number of existing articles

The individual knowledge paradox

The more we publish the less we know
(relatively to the number of publication)

Segmented growth of the annual number of cited
references from 1650 to 2012 in
the medical and health science



Bornmann & Mutz, 2015

The new scales of making science

In 1988 8% of all articles was based on international collaborations

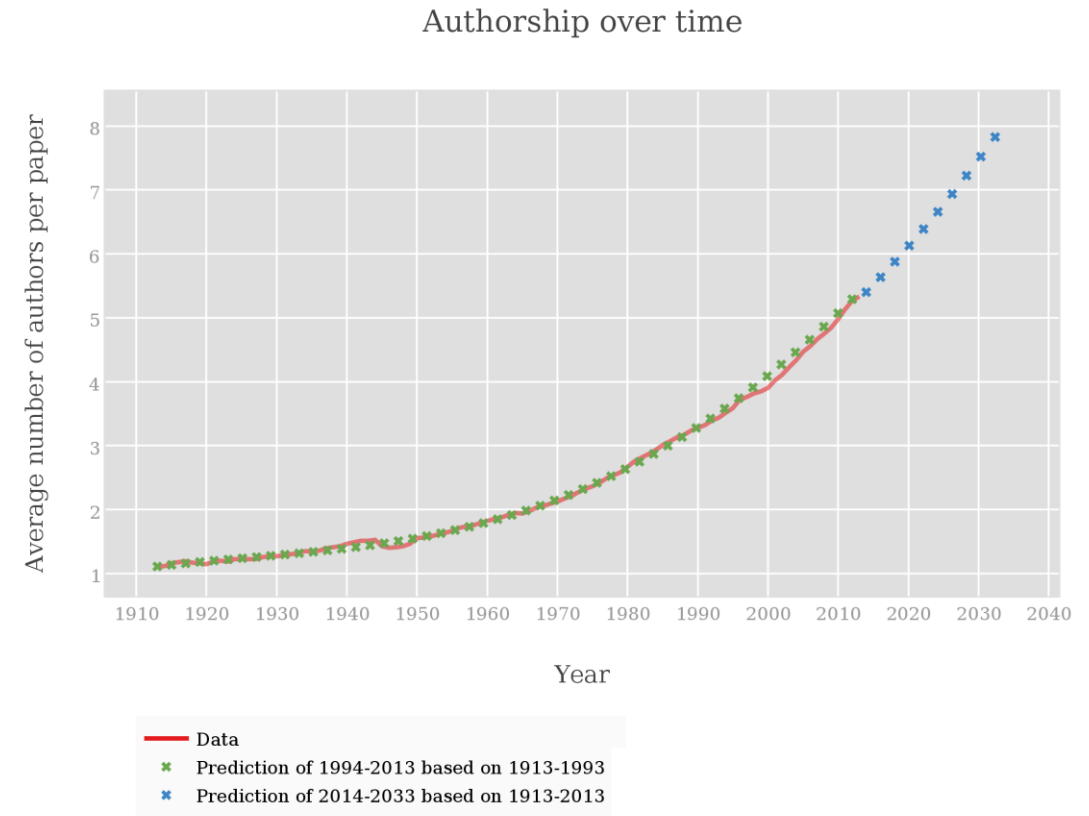
In 2009 23%

In Europe and US between 27 and 42% (NSF)

Number of authors: 3,2 in 1990 – 5,6 in 2001 (in US)

Towards Mega collaborations

In 2015 a paper with 5154 authors
(*Physical Review Letters*)



Publish and perish in rubbish *alias* the New Bibliometrics

G Aad publishes in 2015 115 articles (one every three days)

Many researchers that publish > 150 articles/year ...



The reflexive ignorance paradox (RIP):

R cannot read all the papers he/she publishes

The more R publishes the more his/her ignorance will increase

In biomedical field 4% of duplicated images (12% Int. J of Oncology)

Journals ! Journals !

In 1964: 600 journals with peer review

In 2004: 5969 journals

In 2012: 28100

In 2016 : 9159 open access journals !

Predatory journals

In 2013 John Bohannon submits a fake article with absurd data to 304 journals: 158 journals accept to publish his rubbish on the super effects of a plant on breast cancer...

Business ! Business ! Business ! Business ! Business !

Frontiers published > 1.000.000 articles = > 1 billion euros

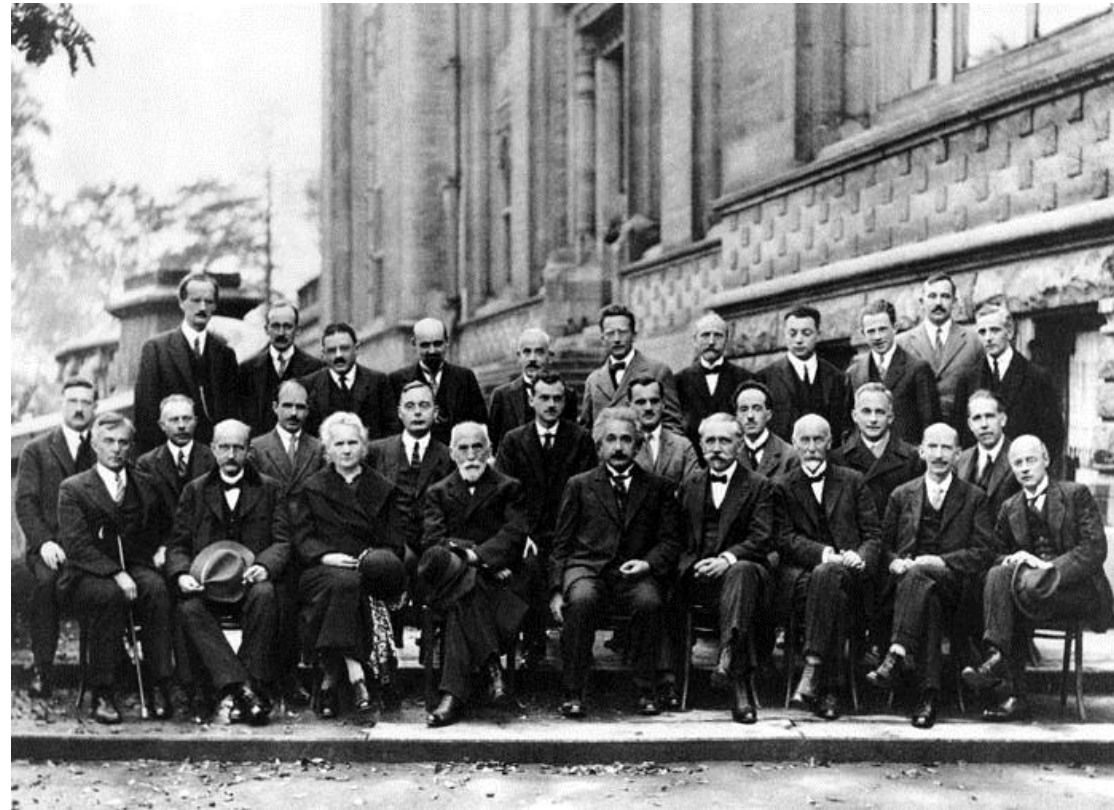
The market evaluation is 23 billion euros (in 2012)

Emerging agencies where one can buy for 1600 to 23000 dollars
an article ranked in citation index !!!!



How many are we ?

1927, Solvay the Fifth Congress dedicated to Electrons and photons. Important debate between Einstein and Bohr, concerning the recent Heisenberg proposals. There are 29 participants (17 nobel prizes).



Today: the american physical society conference counts 10000 participants and SfN 30000

How many are we ?

Elsevier estimated 6 million scientists in 2009

NSF: 4M in 95 to 6M in 2008 (25% in US and 25% in EU = 1,5M of which 44% in private sector and 42% in academia)

US growth after 2002 is 1%. China growth is 7% from 800,000 in 95 to 3,2M in 2013.

Today we are > 10M scientists and we represent more than 90% of the scientists of all times !

In the 30's scientist to population scale is 1:10000, in the 60's 1:3000 in the 90's 1:1000, in 2012 1:700, in 2048 1:250, ... estimate the 1:1 ?

Science pandemics

R_0 factor in epidemiology. The flu has an R_0 of 1.2 while the Spanish flu in 1918 had an R_0 of 4.

If we define R_0 in research as the number of PhD students that one professor has during a whole career, R_0 in US in 2014 = 7,8, meaning that in stationary conditions only 12,8% of the PhD students will have an academic position.

From 1975 to 2015 PhD number has doubled while post-doc has tripled

Mega grants & the winner takes all politics

HBP: >1 Billion

Brain initiatives (US): 4,5 Billions

Blue Brain project

EU funding schemes (eg: ERC:13 billions, FET, ...)

The LabEx, IdEx, SEx, Instituts de Convergence, EUR, Graduate Programs, Grandes Universités, ...



Mega grants & the winner takes all politics

Who's got the money ?

People with a string of great papers and previously funded grants

The big winners are older, often male

Straight career path, mobility

The rich get richer

More money in the hands of fewer people is bound to affect the diversity of creative ideas and hypotheses



Judge me on my science, not my hair colour!" *Jacquie Boyd*

The slow science manifesto

We are scientists. We don't blog. We don't twitter. We take our time.

Don't get us wrong—we do say yes to the accelerated science of the early 21st century. We say Yes to the constant flow of peer-review journal publications and their impact; we say yes to science blogs and media & PR necessities; we say yes to increasing specialization and diversification in all disciplines. We also say yes to research feeding back into health care and future prosperity. All of us are in this game, too. However, we maintain that this cannot be all. Science needs time to think. Science needs time to read, and time to fail. Science does not always know what it might be at right now. Science develops unsteadily, with jerky moves and unpredictable leaps forward—at the same time, however, it creeps about on a very slow time scale, for which there must be room and to which justice must be done. Slow science was pretty much the only science conceivable for hundreds of years; today, we argue, it deserves revival and needs protection. Society should give scientists the time they need, but more importantly, scientists must take their time. We do need time to think. We do need time to digest. We do need time to misunderstand each other, especially when fostering lost dialogue between humanities and natural sciences. We cannot continuously tell you what our science means; what it will be good for; because we simply don't know yet.

Science needs time.

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Bear with us, while we think