ILLUSTRATION BY MARTIN O'NEILL; ANT PHOTO: ANTHONY BANNISTER/NHPA/PHOTOSHOT

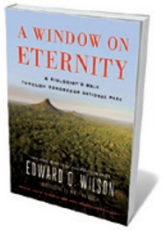
ECOLOGY

Wilson in Africa

Stuart Pimm enjoys a fellow naturalist's first visit to sub-Saharan Africa, and the global lessons drawn from it.

Speeding northwards, I luxuriated in the smooth South African highway: soon we would cross into Mozambique, where I could expect a rutted dirt road. But there wasn't even that. Beyond the border-post's single hut, a braid of narrow, indistinct tracks headed in all directions. We picked the travelled paths; there might be land mines along unbeaten ones. Mozambique had suffered a brutal war of independence and subsequent upheavals between 1964 and 1992. An estimated one million Mozambicans died, wildlife was slaughtered and forests burned. So why were we there?

For the same reason as Edward O. Wilson — the region's exceptional biodiversity. As he explains in *A Window on Eternity*, "Anywhere I am in the world I love it when the air is warm and moist and heat bounces off the sunlit earth, and insects swarm in the air and alight on flowers." In the book, Wilson explores and revels in Mozambique's Gorongosa National Park, where the wet heat makes for a riot of what the eminent biologist calls "the little things that run the world" — insects and other invertebrates. At the heart of the park is Mount Gorongosa, which, at 1,863 metres high, catches enough moisture from Indian Ocean winds to support a dripping rainforest. In East Africa, you can move from dry grasslands to savannah woodlands to montane rainforest in the space of a few kilometres, with each habitat harbouring unique species.



A Window on Eternity: A Biologist's Walk Through Gorongosa National Park
EDWARD O. WILSON
Simon & Schuster: 2014.

Unexpectedly, Wilson is new to sub-Saharan Africa: the book is a chronicle of his first visit there in 2011. His responses recall Darwin's enthusiasm on first encountering the Brazilian tropics, marvelling breathlessly at one fascinating species after another.

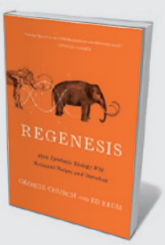
Inevitably, ants — his speciality — take centre stage. Their social systems led to *Sociobiology: The New Synthesis*, his landmark 1975 study on animal societies. Gorongosa's ants are new to Wilson, however. He picks up a Matabele ant (*Pachycondyla analis*), which "gnashed its mandibles impressively, then … thrust a long sting into the flesh of my index finger". (He rates the pain as slightly below that of a hornet's sting.) These are the ant equivalent of "sappers and light cavalry" — heavily armoured and specialized for raiding termite communities that build hardened mounds of mud that can reach the size of a bus. The termites have their own soldiers, but the ants overwhelm them by sheer force of numbers and ferocity.

Wilson also delights in driver ants, whose colonies can number 20 million workers. They are blind, but sensitive to smell and movement. Their leaderless swarms engulf the ground and low vegetation, seizing almost any live animal in their path. Useful things, driver ants: nothing quite like a visit from them to clean out vermin-infested tropical homes.

There is a world of sound, too, although it is mostly hidden. Entomologist and photographer Piotr Naskrecki, who accompanied Wilson, gathers the audio. He brings special equipment to record

NEW IN PAPERBACK

Highlights of this season's releases



Regenesis: How Synthetic Biology Will Reinvent Nature and Ourselves
George Church and Ed Regis (Basic Books, 2014)
In this visionary account of humankind's soaring capabilities in bioengineering, geneticist George Church and science writer Ed Regis redraw the frontier of synthetic biology — and, potentially, some ethical boundaries. Starting with 'simple' bioplastic cups made entirely from plants, they go on to discuss genomic alterations that could spawn virus-resistant humans and resurrect Neanderthals. This is the first book to be translated into a DNA sequence (see go.nature.com/gcgfqa).

sounds of up to 250 kilohertz, well above our human limit of 20 kHz. "The unaided ears of a human walking through the forest at night are assaulted by a riot of unheard katydid cross-talk," Wilson recounts. We humans — and, presumably, potential predators — hear warning sounds, but not other, still vital communications.

A Window on Eternity revels in biodiversity and nature's inventiveness. Wilson damns "the corporate priesthood" that views "restructuring … Earth to accommodate vast numbers of people" as progress. There may be those to whom species do not matter, to whom extinction is an abstraction. To Wilson, species are our "phylogenetic kind" and individual species matter to him. He indicts those for whom 'Anthropocene' is a term that carries the political baggage of acquiescence to human domination of landscapes. The world cannot dwindle into a vast garden, he urges. To him, wildlands are "our birthplace"; a further "slide into extinction will turn the Anthropocene into the Eremocene, the Age of Loneliness".

His choosing Gorongosa is surely no accident. In common with much of Mozambique, it lost almost all of its large animals during its wars: by 2001, buffalo had dropped from 13,000 to 15; wildebeest from 6,400 to 1; and hyenas and rhinos had become locally extinct. Entrepreneur and philanthropist Greg Carr drove across the area in 2004, going days without seeing large mammals. He initiated the Gorongosa Restoration Project to plant trees, reintroduce large mammals, and create a tourist centre to make the park self-sustaining. Wilson plants his defiant flag defending biodiversity in a place once so brutally despoiled that its recovery is truly momentous. ■

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CLIMATE ECONOMICS

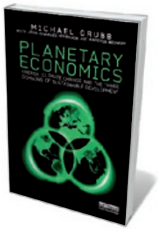
A strained relationship

Scott Barrett examines a study probing the nexus between climate change and energy.

Michael Grubb's provocative *Planetary Economics* claims to be about the "grand challenges of energy and environment", but is really about the relationship between energy and climate change. Grubb briefly notes the scale of the problem: for atmospheric levels of greenhouse gases to be stabilized, net emissions must fall to zero. His focus, however, is on reducing energy consumption and carbon emissions, irrespective of the need to meet any particular target for greenhouse-gas concentrations. It is unclear how much emissions would fall if the book's ideas were actually implemented.

Written with input from fellow climate-policy researchers Jean-Charles Hourcade and Karsten Neuhoff, this is a long and at times repetitive book; but there is something interesting on every page. It reflects a wealth of accumulated wisdom: Grubb has engaged with these issues for more than two decades.

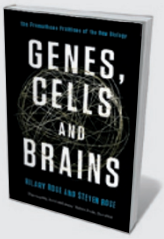
He is critical of dominant theories, such as the assumption that economic agents are rational and optimize every decision. He says that this approach fails to capture the complexities, overestimating the costs of reducing emissions and underestimating the benefits. He rejects the cost–benefit framing and its estimates of the "social cost of carbon" — a concept that puts a monetary value on the damage associated with a 1-tonne increase in carbon dioxide emissions. Instead, Grubb seems to endorse the political target of keeping global temperature rise below 2 °C, as agreed at the 2009 meeting of the United Nations Framework Convention on Climate Change (UNFCCC). Yet the economist Nicholas Stern has supported the same target, in part with reference to the social cost of carbon. It is true that greenhouse-gas concentrations have continued to creep up, threatening any possibility of achieving the target. However, there is no evidence that economic theories are to blame for the failure to cut emissions.



Planetary Economics: Energy, Climate Change and the Three Domains of Sustainable Development
MICHAEL GRUBB WITH JEAN-CHARLES HOURCADE AND KARSTEN NEUHOFF
Routledge: 2014.

What is the solution? Grubb's thesis is that reducing energy consumption and its associated emissions requires policy changes in three domains: satisficing, optimizing and transforming. In satisficing, people and firms overlook cost-effective ways to save energy, such as investing in insulation that promises a reduction in energy bills. Policy can help by nudging an economy closer to the energy-use efficiency frontier, for example by introducing standards for appliances, production processes, buildings and cars. In the second domain, optimizing, people and firms respond to price signals; this ushers in an argument in favour of carbon taxes and cap-and-trade schemes, which allow participants to trade emissions allowances under an overall cap. Transforming involves revolutionizing technology through innovation and investment in infrastructure such as improved electricity transmission.

Grubb argues that advancement demands progress in all of these mutually reinforcing domains. This argument is compelling, but the real questions are how far policy should go in each domain, and precisely how such policy should be devised. How should decisions be made about setting standards, designing cap-and-trade schemes and choosing strategic investments, if not through a cost–benefit rule? How should a carbon tax be chosen if not with reference to the social cost of carbon? Grubb challenges the idea that the price of carbon should be the same everywhere, ▶



Genes, Cells and Brains: The Promethean Promises of the New Biology
Hilary Rose and Steven Rose (Verso Books, 2014)
In this exposé of clashes between society and science, sociologist Hilary Rose and neurobiologist Steven Rose lambast multibillion-dollar biotech research, showing how the Human Genome Project, for instance, has not found disease-triggering genes.

Forecast
Mark Buchanan (Bloomsbury, 2014)
Disassembling the "marvellous machine" of the free market, physicist Mark Buchanan analyses the tempestuous global economy. Principles such as positive feedback loops and fluid dynamics explain the market's natural instability and inform ways to weather future fiscal storms.

supporting instead a "base level" price for developing countries, with others setting higher prices. He backs this in part by appealing to basic welfare economics. But that, as he notes, assumes that financial transfers from rich to poor countries are infeasible, which sits oddly with the fact that rich countries have pledged billions of dollars to the UNFCCC's Green Climate Fund to help poorer nations to mitigate emissions and adapt to climate impacts.

The book's greatest weakness is its lack of an overarching framework. The introduction acknowledges the importance of global collective action, but states that the problem is beyond the book's scope. Grubb concludes that the "next phase of the global effort … is a question of investment and returns". But which nations are to make the investments, which to earn the returns? Countries care about the answers. That is why so much effort has gone into climate negotiations.

Such answers will not be central to how countries address most of the issues in Grubb's first domain. Measures to increase energy efficiency must satisfy mainly domestic criteria, although international trade links will be important for setting technology standards. However, global questions and answers are key to the other domains. They will matter when a country sets a carbon price. They will matter in relation to the investment that countries are willing to give to decarbonization, not least because such investments will pay off only if the carbon price is high.

Despite the criticisms, the book's thesis is relevant to current climate negotiations, which seem to be focusing on what countries are willing to do individually: a kind of enhanced 'business as usual' approach. But for the immense scale of action needed to stabilize concentrations of greenhouse gases — even at a level allowing global temperatures to rise by more than 2 °C — collective action is essential. ■

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MEDICINE

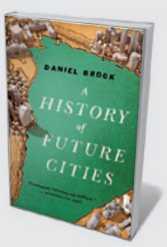
Outside the fold

Giovanna Mallucci assesses the autobiography of Stanley Prusiner, the discoverer of prions.

In his autobiographical book, *Madness and Memory*, Stanley Prusiner charts his journey to winning the 1997 Nobel Prize for Physiology or Medicine, 30 years after his first laboratory posting as a fourth-year medical student — in Sweden, coincidentally. As the subtitle states, the story hinges on Prusiner's discovery of prions, "a new biological principle of disease". It is a remarkable tale: for the scientific discovery at its centre; for its recording of the extraordinary resistance the idea engendered; and for the sheer unfettered animosity, both personal and professional, directed at him throughout from scientists and the media.

Prusiner introduces us early on to how, in 1972, his imagination was caught by the then-unknown infectious agent causing scrapie, a degenerative brain disease of sheep. Then, in the first year of his neurology residency, he was caring for a patient with Creutzfeldt–Jakob disease (CJD), a scrapie-like neurodegenerative disorder we now know to be a human prion disease. What follows is a chronicle of his voyage to isolate and characterize the scrapie agent during the 1970s, up

ILLUSTRATION BY MARTIN O'NEILL; STANLEY PRUSINER PHOTO: RUSS FISCHELLA

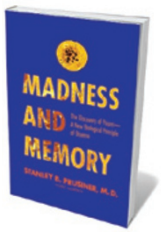


A History of Future Cities
Daniel Brook (W. W. Norton, 2014)
As urban innovation soars in skyscraper-studded Dubai, Daniel Brook looks to the original instant cities, where Western architecture invaded Eastern streets. St Petersburg, Shanghai and Mumbai, he argues, traded culture for economic power. (See Mike Davis's review: *Nature* **494,** 427–428; 2013.)

Permanent Present Tense
Suzanne Corkin (Penguin, 2014)
Neuroscientist Suzanne Corkin worked with Henry Molaison, who had irreparable memory loss, for decades. Here she documents discoveries such as the hippocampus's role in classifying memories. (See Douwe Draaisma's review: *Nature* **497,** 313–314; 2013.)

to his demonstration in 1981 that the agent is a protein, devoid of nucleic acid and capable of replicating itself and transmitting disease.

Details of scientific milestones are interwoven with Prusiner's accounts of personal interactions with colleagues at each stage; descriptions of dramatic epidemics of prion diseases across the globe punctuate the story. These include the phenomenon of kuru, a scrapie-like disease first described by Carleton Gajdusek in the 1950s, found among the Fore people of Papua New Guinea who practised ritualistic cannibalism; and the late 1980s disaster of bovine spongiform encephalopathy (BSE) in UK cattle, which spread to humans as variant CJD. Altogether, the story highlights the extraordinary scientific, medical and political climate of this period. There are struggles for funding, Prusiner's battle for tenure at the University of California, San Francisco, and the fight for scientific recognition at every stage of his career.



Madness and Memory: The Discovery of Prions — A New Biological Principle of Disease
STANLEY B. PRUSINER
Yale University Press: 2014.

The idea of an infectious protein was first mooted in London in the 1960s by the mathematician John Stanley Griffith, and separately by the radiation biologist Tikvah Alper. Both published papers in *Nature* in 1967: 'Self-replication and scrapie' (J. S. Griffith *Nature* **215,** 1043–1044; 1967) and 'Does the agent of scrapie replicate without nucleic acid?' (T. Alper *et al. Nature* **214,** 764–766; 1967). But it was Prusiner who pursued the idea and Prusiner who proved it, with a determination that earned him both admiration (including the Lasker and Nobel prizes) and blind hostility.

Prusiner's proof of the revolutionary concept that infectivity in these disorders proceeds without nucleic acids, and his coinage of the term prion — for proteinaceous infectious particle (S. B. Prusiner *Science* **216,** 136–144; 1982) — engendered disbelief, anger, denial and widespread refusal from a hostile scientific community, including many virologists. This antipathy persisted right up to the awarding of his Nobel prize. A 1997 article in *The New Yorker* asked, "But what if he's wrong?"; one in *Slate* was entitled 'Nobel Gas: Sure, Stanley Prusiner deserves a prize — for his persistence, not for his prions.' That Prusiner withstood these public attacks in his moments of greatest recognition is laudable, and gives some insight into his tenacity.

PRUSINER'S PROOF ENGENDERED DISBELIEF, ANGER, DENIAL AND WIDESPREAD REFUSAL.

Scientifically, the story progresses from descriptions of labs full of antediluvian centrifuges with custom-built safety cabins around them (for isolation of the infectious agent from infected hamster brains) to the elegant transgenic mouse experiments of the prion era and the concept of misfolded endogenous proteins associated with disease. The story is testament to the staggering intellect and courage involved in one of the most exciting discoveries since the DNA double helix.

But for all its drama, this extraordinary scientific story is not always an easy read. Prusiner's description of scientific rivalries inevitably reflects his version of events. His relationship with Gajdusek, whom he had visited in Papua New Guinea, ends bitterly, with arguments over Gajdusek's claims to the prion concept. Prusiner's collaboration with Swiss molecular biologist Charles Weissmann began brilliantly but became strained. Weissmann discovered that prion protein is encoded by a host gene — a finding as important to the prion story as the infectious protein itself. Prusiner's account of that collaboration's end, complete with transcripts of letters he sent to Weissmann, is an uncomfortable read. 'Scientific Interludes' explaining concepts and technicalities in some detail are interspersed through the text. There are other inserts: technical, graphical and bibliographical. Many are fascinating, but they tend to interrupt the flow of the compelling narrative.

The concluding chapter's meditation on the prion concept in widespread neurodegenerative disorders such as Alzheimer's is highly topical, albeit inordinately specialized in its detail. The book ends with an exhortation to the US government to fund research into cures for neurodegenerative disorders, diseases that Prusiner claims have "been ignored". He will be glad that last December's G8 Dementia Summit means that the world is heeding his call and taking this issue seriously at last. ■

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Time Reborn: From the Crisis in Physics to the Future of the Universe
Lee Smolin (Mariner, 2014)
Scientists unscrambling the fundamentals of the Universe dub time an illusion. Theoretical physicist Lee Smolin resurrects the concept as a constant around which other universal laws evolve. (See Pedro Ferreira's review: *Nature* **496,** 430–431; 2013.)

Jane Austen, Game Theorist
Michael Chwe (Princeton Univ. Press, 2014)
Using Jane Austen's novels and craftiest characters, such as George Wickham in *Pride and Prejudice*, Michael Chwe proves that game theory — mathematics-based strategizing — has been harnessed for social and emotional advancement as well as for military victory.

ILLUSTRATION BY MARTIN O'NEILL: STOMACH: LIGHTSPRING/SHUTTERSTOCK.COM; *C. DIFFICILE*: SPL/D KUNKEL MICROSCOPY/VISUALS UNLIMITED; *E. COLI*: A. B. DOWSETT, SPL/L. CARO, SPL/L. STANNARD, UCT/SPL; *S. AUREUS*: GETTY; MRSA: GETTY

DRUGS

Gut response

Maryn McKenna finds much to digest in a warning about the demise of our bodily bacteria.

Last year, two public-health-agency chiefs chose dramatic language to alert their nations to a menacing health problem — a rise in the spread and severity of bacterial resistance to antibiotics. UK chief medical officer Sally Davies called it a "catastrophic threat"; Thomas Frieden, director of the US Centers for Disease Control and Prevention, spoke of a "nightmare". They were flagging the emergence of an almost pan-resistant bacterium, carbapenem-resistant Enterobacteriaceae. This is the latest in a series of tough-to-treat organisms — the result of overuse of antibiotics since the 1940s.

In *Missing Microbes*, Martin Blaser sounds a related alarm. He patiently and thoroughly builds a compelling case that the threat of antibiotic overuse goes far beyond resistant infections. Antibiotics, he warns, are destroying the benign bacteria that are crucial to the functioning of human bodies, and this trend is contributing to health problems from obesity to diabetes and bowel disease.

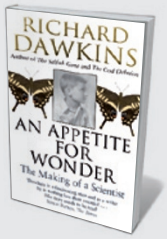
Antibiotic resistance can be devastating for patients, but it has until recent years received scant attention from policy-makers, as Blaser knows. A physician and microbiologist, he has treated many people with resistant infections. And as past president of the Infectious Diseases Society of America, he pressed the US government to curb antibiotic overuse and encourage drug development.

Blaser, who is also director of New York University's Human Microbiome Project, investigates the personal bacterial ecosystems that allow us to absorb nutrients and develop immunity. He has long studied *Helicobacter pylori*, a bacterium that thrives in the stomach and can cause ulcers and stomach cancers. Using mouse experiments and epidemiological data, he has shown that *H. pylori* may also be associated with a reduced incidence of asthma, allergies and severe reflux disease. That should concern us, he writes, because worldwide, the rate of *H. pylori* infection is going down.

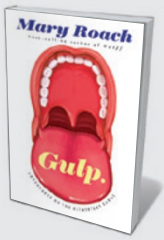
The make-up of human microbiomes is shifting, with diversity declining and keystone species disappearing. Blaser blames these changes on innovations that impede bacterial attempts to set up shop inside us. Examples include germ-killing hand sanitizers, and Caesarean sections that rob newborns of the bacterial kick-start that they usually get by passing through the birth canal. In the United States alone, one-third of all births are now Caesareans.

Blaser is strongest, and most provocative, when he questions a practice that has become routine in much of the industrialized world: feeding small doses of antibiotics to meat animals as growth promoters. The early discovery that antibiotics work as fattening agents gave birth to the entire structure of modern concentrated meat-raising. By saturating the environment with antibiotic residues, Blaser argues, we have effectively recreated that weight-gain programme in humans — and the result has been the seemingly unstoppable increase in obesity, especially in children.

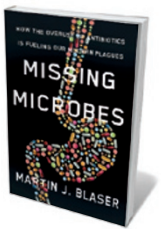
Can the trend of inadvertently destroying our microbiomes be reversed? Blaser is sceptical. The public has been indifferent to warnings about resistance since antibiotic use began: penicillin discoverer Alexander Fleming cautioned in his 1945 Nobel prize acceptance speech that using the drugs carelessly would undermine their power to treat



An Appetite for Wonder: The Making of a Scientist
Richard Dawkins (Black Swan, 2014)
From childhood in Africa to enlightenment in Oxford, Richard Dawkins chronicles his life before *The Selfish Gene* (1976) and the nature and nurture of his science obsession. (See Eugenie Scott's review: *Nature* **501,** 163; 2013.)



Gulp: Adventures on the Alimentary Canal
Mary Roach (W. W. Norton, 2014)
Journalist Mary Roach offers a consummate tour of the digestive system. Investigating dog-food-testing facilities, brain-munching Inuits and optimum mastication techniques, Roach maintains a balanced diet of wit and reliable gastro-wisdom. (See David Katz's review: *Nature* **495,** 446; 2013.)



Missing Microbes: How the Overuse of Antibiotics is Fueling Our Modern Plagues
MARTIN J. BLASER
Henry Holt: 2014.

lethal diseases. Antibiotics — like Caesarean sections and hand sanitizers — make modern life easier. Blaser would say that we have ignored Fleming's warning: we have consistently chosen convenient over smart and safe.

The first step, Blaser says, is to roll back antibiotic overuse in agriculture and medicine. After that, he suggests, we should bend our appetite for innovation towards finding ways to repair the microbiome damage that the wonder drugs have done.

Blaser foresees the development of microbial supplements — a more sophisticated version of the faecal transplants already being used in some quarters to combat *Clostridium difficile* infections — that could restore microbial communities devastated by antibiotics. The regulation of faecal transplants has confounded the US Food and Drug Administration (M. B. Smith *et al. Nature* **506,** 290–291; 2014), but many patients — along with academic researchers in Europe and Australia — have taken to them intuitively and enthusiastically. It seems likely that Blaser's concept of personal, protective microbial cocktails would also find support.

It is urgent that we take these steps soon. *Missing Microbes* explains that our ancient microbiome is akin to an essential organ; we unthinkingly excised it, and only now are waking up to the implications. Changes to it come with costs, Blaser warns, "but we are only just beginning to recognize them. They will escalate." ■

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EDUCATION

Digital lessons learned

Robert Lue enjoys a deft study of online pedagogy.

Massive open online courses, or MOOCs, have generated unprecedented debate over their educational value and impact on the university ecosystem in the past three years. Deploying videos, online assessments and discussion forums to teach potentially 100,000 students at a time, MOOCs have taken off with the advent of for-profit companies such as Coursera in Mountain View, California, and non-profit efforts including edX, founded by Harvard University and the Massachusetts Institute of Technology (MIT) in Cambridge. As the faculty director of HarvardX, the Harvard initiative involved with edX, I have observed the pendulum of media opinion swing between extremes.

Initially MOOCs were lauded as the ultimate way to deliver educational content: they could reach the farthest corners of the globe and cut costs to promote sustainability. Now, views have reversed: the schemes seem to be reaching mainly those who already have a degree, and concerns are emerging that they will threaten faculty jobs in some institutions. The reality will almost certainly lie between.

In her provocative book *The War on Learning*, Elizabeth Losh fires several warning shots across the bows of online education. Along with MOOCs, she takes on active learning methods such as real-time online polling. She provides welcome context on both the recent history of distance education, covering efforts such as the OpenCourseWare movement launched by MIT in 2002, and the surprising contribution of applications such as iTunes. Her book is a timely exploration of the sometimes daunting but often rewarding faculty and institutional experience of teaching with technology; it touches on students' experience more lightly.

Losh is critical of both irrational exuberance over the reach of technology, and panic that it has destroyed the classroom. She presents anecdotes documenting instructors' successes and failures, including her own misadventures using Twitter to engage a large lecture class in the Culture, Art and Technology programme at the University of California, San Diego. It became a platform for humorous expressions of student inattention and class-wide pranks. Indeed, not all modes of digital engagement are suited to education: anonymous mass action can result solely in mischief. Losh seeks a pedagogical silver lining by connecting classroom Twitter with new ways for students to engage with both content and the learning experience.

NOT ALL MODES OF DIGITAL ENGAGEMENT ARE SUITED TO EDUCATION.

Losh's rich selection of anecdotes swerves between triumphs and tragedies — so much so that real success becomes difficult to recognize. She seems to revel in this ambiguity, perhaps seeking to underscore just how much remains unproven and unsettled in a field still finding its way. Is the compelling but carefully scripted drama of a TED Talk a model for engaging students online — or an opportunity for mutual narcissism, whereby the speaker tells the audience exactly what they want to hear? Does the professor lauded for his or her classroom oration promote self-interest above learning when their online reach goes global?

Healthy scepticism is Losh's dominant tone, especially in her discussion of 'gamification' — the use of video-game ▶

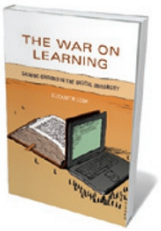
To Save Everything, Click Here: The Folly of Technological Solutionism
Evgeny Morozov (PublicAffairs, 2014)
Can a toolbox of techno-fixes really solve climate change, disease and crime? Social theorist Evgeny Morozov rebels against a technocratic Utopia and critiques the ideology of computerized cure-alls. (See Nicholas Carr's review: *Nature* **495,** 45; 2013.)

Brilliant Blunders: From Darwin to Einstein
Mario Livio (Simon & Schuster, 2014)
Astrophysicist Mario Livio reveals the epic errors of famous scientists that yielded glorious breakthroughs. When Einstein misconstrued universal equilibrium, his equations led to the discovery of the expanding cosmos. (See Mario Livio's Comment: *Nature* **497,** 309–310; 2013.)

ILLUSTRATION BY MARTIN O'NEILL

approaches, such as the modelling in the virtual world *Second Life*. In practice, as she shows, developing the expertise to reach the next level of a games environment is not necessarily the same as learning: obeying a set of rules does not automatically provide insight into underlying concepts or their creative application. Ironically, some approaches lose the very fun that motivates: the Shakespeare game *Arden*, for example, fails to capture the emotional element of the plays. In story after story of instructional technology failing to reach its transformative potential, Losh reveals that by focusing on the broadcasting of information, usually through ever more nifty gadgets, instructors and institutions risk losing sight of education as an iterative process that is based on dialogue and group reflection.

Losh concludes with suggestions for how universities might better harness technology to serve teaching. She argues that the physical classroom should be revived, because "learning benefits from embodied performances of knowledge", and using these spaces for "joyful" educational activities can offer profoundly engaging experiences. Hackathons, for instance, bring students together for intense periods of participatory learning around common challenges, such as writing code. Likewise, Losh warns against blindly valuing innovations above clear pedagogical purpose, or eschewing tried-and-tested tools such as e-mail.



The War on Learning: Gaining Ground in the Digital University
ELIZABETH LOSH
MIT Press: 2014

Losh falls victim to some romanticism in her recommendation that faculty members share their own research tools (say, for mapping or imaging) as part of their teaching, rather than simply give students gadgets such as clickers. This is a laudable suggestion that builds bridges between scholarship and teaching while exposing students to digital tools that have real currency in the world of research. However, such an approach could leave behind students who are not in the upper echelons of the class. Simpler, well-executed pedagogical tools might better serve a wider audience. Merely touching genuine research tools does not ensure a good learning experience, especially if there is nothing to prepare you for it.

The War on Learning is a welcome addition to the debate and is well informed by the literature in this area, as well as cognitive psychology. That said, by largely restricting her focus to instructor and institution, Losh misses an opportunity to address the increasingly complex ecosystem of higher education, including the instructional designers, education researchers and technologists who so often work side by side with faculty members on the crafting of courses on campus and online. As this web of relationships evolves, it will redefine how instructors and institutions sustain innovative teaching through ever deeper engagement with technology. ■

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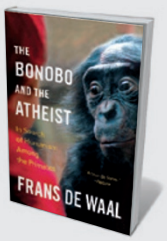
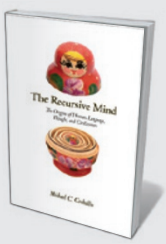


The Bonobo and the Atheist: In Search of Humanism Among the Primates
Frans de Waal (W. W. Norton, 2014)
Primatologist Frans de Waal probes the roots of "human" emotions and morality in the bonobo, whose behaviours include empathy, altruism and even remorse. (See Christopher Boehm's review: *Nature* **495,** 312; 2013.)



The Recursive Mind: The Origins of Human Language, Thought, and Civilization
Michael C. Corballis (Princeton Univ. Press, 2014)
Does language alone make us human? Psychologist Michael Corballis takes a fresh look at the origins of speech, and suggests that our ability to embed thoughts within other thoughts — recursion — gives our species the edge.

ENERGY

The new oil era

Chris Nelder relishes a lively history of fracking that delves into the complexities.

Despite its title, *The Boom* is no sales pitch for fracking. *Wall Street Journal* energy reporter Russell Gold has produced a thoughtful piece of journalism, exploring the complex landscape of drilling, finance and politics that brought a gusher of oil and gas to a country convinced that its hydrocarbon heyday was over. Gold offers no pat answers to the challenges that this new abundance poses, but reminds us starkly of "unforeseen costs and necessary evils".

Skilfully interweaving hard data about US energy with an engaging narrative, Gold covers previous oil booms in Texas, Oklahoma, the Niger Delta, the Bakken shale in North Dakota (which saw its first oil well drilled in 1953), and Pennsylvania. He also relates the biography of businessman George Mitchell, 'the father of fracking'; the fundamentals of petroleum geology; and the long evolution of technology for oil and gas production. Much of *The Boom* focuses on Aubrey McClendon, founder of the Chesapeake Energy company. Describing him as "part pied piper, part early adopter, and part rapacious capitalist", Gold duly credits McClendon for seeing the potential in shale gas and driving its production, but gives equal weight to his rise and downfall.

As a lens on the conflicts between ethics and raw need that characterize today's energy industry, Gold uses a personal experience. His parents had co-owned land in Pennsylvania since the 1970s. In 2009, Chesapeake Energy was snapping up leases there to drill for natural gas in the Marcellus shale formation underneath. As he advised his parents on Chesapeake's US$400,000 offer, Gold was torn between their desire to prevent groundwater contamination, and his certainty that fracking would proceed around them, driven by the need for domestic gas, income and jobs. As one farmer told him, local exploitation of forests and coal had been unsustainable: "We can't do that three times in a row … If we don't do this right, what the hell have we done?" Despite the doubts, the lease was signed.

The Boom: How Fracking Ignited the American Energy Revolution and Changed the World
RUSSELL GOLD
Simon & Schuster: 2014.

Along with his hard-hitting analysis of the disruptive nature of fracking, Gold offers deep reportage on two previously untold stories. The first concerns the close relationship between McClendon and his best friend since university, Ralph Eads. Starting in 2004, Gold says, McClendon talked to Eads regularly about how to round up more capital. Eads "set out to create a new financial ecosystem to find money to drill shale", pitching Chesapeake's opportunities to institutional investors globally. The company raised $33.7 billion, with Eads serving as financial adviser for nearly all of the deals. Chesapeake also bet heavily on the future price of gas.

By 2008, Gold writes, "McClendon and Chesapeake were whales in the futures market". But as competitors arrived, a gas glut developed and prices plummeted. "With its heavy debt and drilling commitments, this price decline was a recipe for trouble," Gold explains. He writes that during the stock-market crash of 2008, Chesapeake's shares lost 59% of their value; subsequently, there were revelations that McClendon had taken out large personal loans from EIG Global Energy Partners (an investor Eads had connected with Chesapeake) without the knowledge of his company's board. Large shareholders became increasingly restive, he writes. McClendon's job was terminated in 2013.

The second story that Gold details is of a secretive partnership between McClendon and Carl Pope, head of the Sierra Club, the United States' largest environmental group, for 18 years. The two had a mutual interest in fighting coal power, but very different motivations: Pope's, to combat climate change; McClendon's, to secure natural gas as the nation's power-grid fuel of choice. Without the knowledge of the Sierra Club board, Gold alleges, Pope allowed McClendon to underwrite the organization's Beyond Coal campaign, even as its New York chapter was fighting fracking over water contamination. Gold describes how tension within the Sierra Club grew. Pope was ousted in 2011.

That the costs and benefits of fracking are complex is never fudged. The rapid decline rates of wells for shale gas and 'tight', or fracked, oil condemn frackers to increase the pace of drilling continually just to keep overall production flat. Embedded in the unfettered, market-driven US approach to energy development is the risk of dependence on finite resources. The US Energy Information Administration forecasts that tight oil will peak by 2021, although some think this optimistic.

The Boom carefully explores technical issues around water contamination and the failure to develop solutions. The inability of regulators to keep up with entrepreneurs' advances — a problem as old as the oil industry itself — opens up scenarios of irreversible damage. And drilling has "thrown a lifeline to fossil fuels" just when dependence on them, and the risks of climate change, are more dangerous than ever.

Gold points out that over the 150-year history of oil and gas exploitation, we have worked our way down from vast accumulations of cheap, high-quality hydrocarbons to poor-quality shales. "Source rock is where plankton turned into hydrocarbons," he muses. "There is no further back." We "fossil-fuel addicts", he suggests, should think of shale gas as methadone, a stepping stone on the way to a renewably powered future. ■

Chris Nelder *is an independent energy analyst and journalist. He wrote* Profit from the Peak *and* Investing in Renewable Energy, *and he blogs at GetREALList.com. e-mail: chris@getreallist.com*

The Serpent's Promise: The Bible Retold as Science
Steve Jones (Little, Brown, 2014)
With sensitivity towards religion and sardonic wit, geneticist Steve Jones delivers a masterful scientific take on biblical events such as the Deluge — which he attributes to the end of an ice age. (See Tim Radford's review: *Nature* **496,** 432–433; 2013.)

My Beloved Brontosaurus
Brian Switek (Farrar, Straus and Giroux, 2014)
The film *Jurassic Park* aside, velociraptors were turkey-sized, reveals Brian Switek in this paean to palaeontology. He joins the scales-versus-feathers debate, and mourns the 'second extinction' of the brontosaurus, now called apatosaurus. (See Xu Xing's review: *Nature* **496,** 30; 2013.) Emily Banham