towards space observations and developing the use of computers in meteorology.

From the findings of these three men, Fleming expertly weaves a tapestry of broader developments, from early uses of computers and satellites to numerical predictions with supercomputers. He explores intentional weather modification, radioactive fallout, rocketry, air pollution and electromagnetism. For example, the air movements made apparent when researchers tracked the fallout from nuclear-bomb tests in the 1950s provided insight into atmospheric circulation.

The penultimate chapter covers what Fleming calls the birth of atmospheric science in the late 1950s, coinciding with planning for the International Geophysical Year in 1957–58. In 1956, Rossby proposed enlarging the definition of meteorology to include elements such as atmospheric chemistry and relevant biological processes. Much of what we regard as contemporary developments, such as the understanding of atmospheric composition or geoengineering, were in the minds of 1950s researchers, Fleming points out.

Modifying the reflectivity of the planet to avoid harmful climate change was discussed by Wexler and others as early as 1958. In a 1962 speech, Wexler said: "We are in weather control now whether we know it or not." Fleming also focuses on the importance of committees in planning developments such as the creation of the US National Center for Atmospheric Research in 1960, and the role of top researchers in leading these committees.

A historical account has to have boundaries, and Fleming barely hints at what came after 1960. I found the discussion of Edward Lorenz's work on chaos that led to aspects of probabilistic forecasting disproportionately brief.

What shines through *Inventing Atmospheric Science* is the commitment of three men to applications of research to society, and their desire to advance our understanding of weather. This is an inspirational story, very well told. ■

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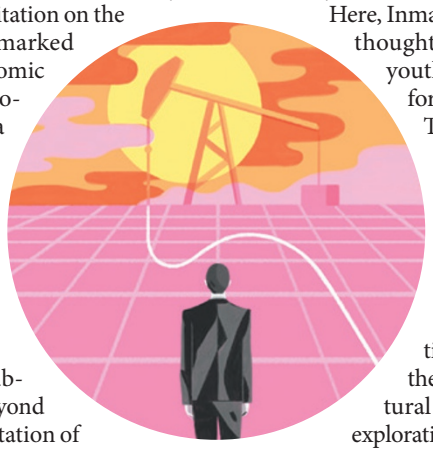
ENERGY

Oilman at the peak

Gregor Macdonald applauds a biography of prescient geologist and energy theorist Marion King Hubbert.

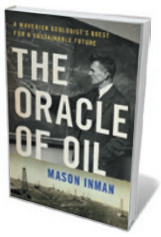
A scientist's work does not always intersect neatly with the events of their time, but that was the good fortune of US geologist and oilman Marion King Hubbert (1903–89). After labouring for decades to perfect forecasting of the oil-production limit, he saw his efforts validated in the energy crises of the early 1970s. His approach would later be known as Hubbert peak theory.

Journalist Mason Inman's meticulous biography *The Oracle of Oil* follows Hubbert from his youth on the plains of Texas through the Great Depression, the Second World War and the rise of US President Ronald Reagan in 1981. But its scope is much more expansive. In Hubbert's story, Inman has found a meditation on the booms and busts that marked twentieth-century economic growth. Hubbert's iconoclastic career forms a perfect arc, from oil's troubling oversupply in the 1920s to its relative scarcity after the peak of US production in 1971, when the US economy suffered oil shocks.



As Inman shows, Hubbert's impact extends beyond oil: it is an early manifestation of ecological economics. At the end of his career, Hubbert remained concerned about nuclear waste; was convinced that high rates of growth were environmentally destructive; and conjectured that solar power might be the most viable energy solution. With regard to growth or sustainability, Hubbert's work is an overlooked contribution to US economic history.

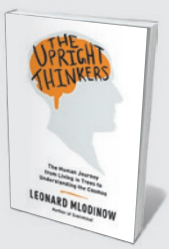
Arriving at the University of Chicago in Illinois in 1924 with little money but no shortage of ambition, Hubbert saw geology as a wide-open field, and gate-crashed it. With precocious brilliance, he began to identify gaps and disorganization in its practices, and published his first paper, on fault classifications, as an undergraduate. In 1930, he was head-hunted by Columbia University in New York City to direct a new effort in geophysics.



The Oracle of Oil: A Maverick Geologist's Quest for a Sustainable Future
MASON INMAN
W. W. Norton: 2016.

Here, Inman's biography reveals its thoughtful design, tracing the youthful roots of Hubbert's formidable achievements. The undergrad pondering Earth's folds one summer later becomes a breakthrough geologist, solving complex scaling problems. The boy surrounded by oil rigs becomes a Shell executive, aggressively pursuing the hydrological and structural complexities of oilfield exploration. The young man who questioned religious faith becomes a nonconformist US Geological Survey (USGS) researcher, insisting that popular forecasts are built less on data than on optimism.

Inman's direct, explanatory style is well suited to describing the evolution of Hubbert's thinking. At Columbia, Hubbert began to ponder the S-curve of growth that has long fascinated observers of economies, biology and natural-resource extraction. He perfected his technique over decades, from rough ▶



The Upright Thinkers
Leonard Mlodinow (Vintage, 2016)
Carrier pigeons once toted stock prices. Today, instant messaging manages the job. Theoretical physicist Leonard Mlodinow explores how the most human of desires, a thirst for knowledge, grew from Neanderthal hunger pangs to measuring our planet's orbit around the Sun.

Why Information Grows
César A. Hidalgo (Penguin, 2016)
Economies are computers and information is at war with entropy, claims statistical physicist César Hidalgo. He shows how the scientific imagination needs knowledge and resources to grow, such as the Chilean copper that 'feeds' electronics (see Philip Ball's review: *Nature* **521,** 420–421; 2015).

estimates of ultimately recoverable US oil reserves to his eventual winning model: an advanced calculation that incorporated past production, yield per foot of exploration and the tricky variable of reserve growth.

Inman does not, however, cite the work of UK economist William Stanley Jevons, whose 1865 warning about the economy's over-reliance on coal prefigures the Hubbert story. Jevons died in 1882, so never saw his prediction come true: British coal output peaked in 1913. Hubbert, by contrast, was feted with numerous awards, including the Rockefeller Service Award in 1977, and broad coverage in *The New York Times* when his previous reports for the government and the USGS were acknowledged for their accuracy.

Hubbert's forecast was not the end of the US oil story. After his death, production continued to languish, in accordance with his forecast. But with fracking, the United States lifted oil production as recently as last year to levels close to the 1970 peak. Oil production is now falling again owing to a price bust — global supply capabilities were created for demand that failed to materialize. Inman does a fine job of handling this recent history.

The Oracle of Oil offers valuable insights beyond energy. In the demand-side bust of the 1930s, it shows Hubbert thinking deeply about the surplus of labour created partly, in his view, by the effects of powerful oil married to the newest machines: cars, construction equipment and aircraft. Hubbert was co-founder of Technocracy, a group of New York intellectuals aiming to prevent future economic dislocations. Two publications by keen observers of the low-growth problem — Thomas Piketty's *Capital in the Twenty-First Century* (Seuil, 2013) and Robert Gordon's 2012 paper 'Is US Economic Growth Over?' (see go.nature.com/wblxig) — also explore this territory of limits and sustainability.

In Inman's work, the oilman emerges as a restless and prescient figure concerned with the environment. In writing the first biography of Hubbert, Inman has retrieved, if not rescued, the story of a scientist who has much to offer to today's energy conundrum. ■

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NEUROSCIENCE

Listening in on yourself

Douwe Draaisma is intrigued by a study examining both 'the voice within' and verbal auditory hallucinations.

Thinking about thinking is a curious exercise. Most of us probably agree that much of our own thought process takes the form of inner speech. But would we also agree that we hear an inner voice? If not, why would we call it talking at all? Can we experience and observe inner speech simultaneously, or would this be like "trying to turn up the gas quickly enough to see how the darkness looks", as US psychologist William James asked himself in 1890? Each of these questions may lead one into a philosophical forest, dense and dark.

Side-stepping such conceptual intricacies, psychologist Charles Fernyhough convincingly explores inner speech from a practical perspective. In *The Voices Within*, he discusses how people with aphasia (a speech and language disorder that stems from brain damage) may lose their sense of inner speech; how deaf people 'talk to themselves' (mostly in sign language, some by lipreading); how more than 60% of children have had silent conversations with imaginary friends; and whether people who stutter experience their inner speech as fluent (they do). Silent self-talk, evasive as it is to introspection, turns out to be a robust and quintessential part of memory, thought and imagination.

Fernyhough's sources are equally wide-ranging. He draws on internal monologues

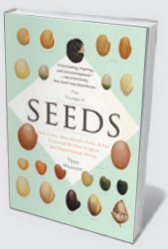
The Voices Within: The History and Science of How We Talk to Ourselves
CHARLES FERNYHOUGH
Profile: 2016.

in Gustave Flaubert's 1856 novel *Madame Bovary* and reports of self-talk by professional cricketers. He mentions physicist Richard Feynman having an argument with himself, and Joan of Arc insisting that God talked to her in French, not Latin. Today, Fernyhough directs Hearing the Voice, a research project at Durham University, UK, funded by biomedical charity the Wellcome Trust.

SILENT SELF-TALK TURNS OUT TO BE A ROBUST PART OF MEMORY.

When I'm invited to write a review, I know from experience that it is wise to switch my inner speech from Dutch, my native language, to English, which I routinely use for scientific communication. Most bilingual people have no trouble identifying the language that they are thinking in. But I would be hard-pressed to say whether I talk to myself at a natural speed or in an abbreviated way, much less whether the stream of my thoughts flows equally fast (or slow) in both languages. Most people say that they have the definite impression that their inner speech unfolds faster than actual speech.

Spirals in Time: The Secret Life and Curious Afterlife of Seashells
Helen Scales (Bloomsbury, 2016)
From beachcombing to shipwreck diving, marine biologist Helen Scales shares her love of molluscs, many of which convert seawater into protective homes. Shells, she reveals, have served as everything from jewellery to calcareous currency.



The Triumph of Seeds
Thor Hanson (Basic, 2016)
Biologist Thor Hanson sows the ultimate celebration of seeds and how they conquered Earth. Kernels can be crafty: unripe fruit, for instance, tastes bitter to deter predators from dispersing the seeds too soon (see Sandra Knapp's review: *Nature* **519,** 288–289; 2015).