

is 400,000 years old. Discovered near a UK coastal town, it might have been a weapon, a snow probe or a lance. Aboriginal Australians invented boomerangs at least 20,000 years ago, as evidenced by rock art.

It was during the Neolithic period, beginning about 12,000 years ago, that humans first made a major impact on the environment. As the climate warmed and forests advanced northwards, humans hafted small flint blades onto wooden handles to craft ‘tranchet’ axes to cut down trees, clearing land for agriculture and leading to the rise of a new material culture. They also began coppicing – cutting trees such as oak, ash, and chestnut down to ground level every two decades or so to stimulate rapid re-sprouting from dormant buds low in their trunks. In California, the Wintu and Cahuilla peoples developed ‘balanoculture’, caring for oak forests and living on foods made from acorn flour.

### Production paradox

Paradoxically, as Ennos explains, the smelting of metals such as copper made people even more reliant on wood. A key element in these processes is burning charcoal, generated by heating wood to high temperatures. And metals such as copper and bronze make better axes for chopping down trees.

Having depleted their own forests, emerging empires looked elsewhere. Ennos describes the arms race that developed in the late seventeenth century between France and Britain. As the nations competed to build their navies, they needed trees tall enough to craft masts up to 36 metres long. For France, the wilds of the Pyrenees mountains yielded huge fir trees; in Britain, tree cover had been slashed to less than 10%. The country turned to its American colonies, “where the old-growth forests of New England contained huge, straight-trunked white pine trees in seemingly limitless numbers”. Growing up to 70 metres tall, they became the British Navy’s “tree of choice”.

Before European colonists arrived, what is now the United States had about 400 million hectares of forests, covering half the total land area. Settlers cleared about 116 million

hectares, roughly the size of Colombia. In Barbados – which was apparently named after the bearded fig tree (*Ficus citrifolia*), by Portuguese explorer Pedro a Campos – 95% of the original forest cover was cleared to make way for sugar cane. Cultivated and cut by enslaved African people, it was a source of monstrous wealth for British plantation owners.

**“Having depleted their own forests, emerging empires looked elsewhere.”**

It’s hard to maintain a sense of optimism in the face of continuing forest decimation, yet Ennos makes valiant efforts. He points to mass-tree-planting projects in Ethiopia (almost 354 million trees planted in one July day in 2019); and rewilding on the Knepp Estate in West Sussex, UK. Allowing vast areas of abandoned farmland and grassland in Europe, New

England and New Zealand to revert to forest, he argues, could absorb billions of tonnes of heat-trapping carbon dioxide. It’s an appealing counterpoint to the sense of doom many feel in these apocalyptic times.

Reading about rewilding, I think back to a beloved picture that hung in my grandparents’ house: a reproduction of John Constable’s 1821 masterpiece, *The Hay Wain*. In the sleepy scene, black poplar trees tower over the waters of England’s River Stour in which the eponymous wain stands, spoke-deep. It was once common practice, I learn from Ennos, for farmers to leave their carts in shallow pools to keep the wooden wheels swollen and the joints taut. Sad to say, the poplars Constable conjured with splodgy strokes were cut down to make carts, house frames and farm equipment, as well as rifle butts for the First World War. One can’t help longing for the return of that lush, woody world.

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## The demons and devils that haunt scientists

### Strange beasts stalk a history of thought experiments. By Ramin Skibba

**T**he workings of powerful computers, the processes of evolution, the market forces that drive the global economy. To conceptualize such unseen forces, researchers have long invoked thought experiments involving demons, devils, golems or genies.

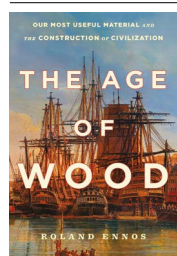
These strange beasts aren’t creatures of superstition and pseudoscience. They are useful ideas that have had an important role in the advancement of science, argues historian of science Jimena Canales. Her latest book, *Bedeviled*, sizes up imagined imps over the centuries and follows their impacts.

The seventeenth-century French philosopher René Descartes conceived of the disturbing possibility that some devious spirit could hijack our sense of reality. This ‘mali-cious demon’ would affect what we think we

see, hear, smell and touch – presaging how virtual reality challenges us today. Descartes’s idea caused him to question his senses, and even his existence. He found his way back to reality by asserting that *cogito ergo sum* – he thought, therefore he was. A reasoning human being foiled the deceptive demon.

### The spectres of physics

In the early nineteenth century, scientists built on the physics of Isaac Newton to understand the forces of nature, making it possible to calculate with precision the motions of atoms and planets or the forces of a steam engine. Taking those ideas to their logical conclusion, French mathematician Pierre-Simon Laplace proposed that some demonic intellect would be able to calculate the past and future of anything if it knew the precise location and



**The Age of Wood: Our Most Useful Material and the Construction of Civilization**  
Roland Ennos  
Scribner (2020)

## Books & arts

trajectory of all particles and all forces acting on it. British mathematician Ada Lovelace was aware of Laplace's work, and in 1842 she was arguably the first to speculate about whether computing programs could be considered thinking beings. Laplace's demon thus seeded a debate that continues 180 years later.

In 1867, Scottish physicist James Clerk Maxwell summoned an even more powerful demon while trying to understand the statistical behaviour of gas particles. Maxwell's tiny demon operates a door between compartments in a gas-filled vessel, choosing when to allow molecules to pass from one side to the other. The demon can open the door for faster-moving molecules but leave the slower ones on the other side, thus heating up one compartment and cooling the

**“Today's demons dwell in genetics, economics and artificial intelligence.”**

other – decreasing entropy and thwarting the second law of thermodynamics. To some, Maxwell's ideas suggested the possibility of a perpetual-motion machine, or even of reversing time.

In practice, Maxwell's research informed improvements in the efficiency of engines and refrigerators. His demon also demonstrates the surprises that can arise from probabilities, because every once in a while, the rarest events do occur – such as only fast gas molecules spontaneously slipping through a hole.

Canales also surveys thought experiments on the uncertainties in quantum mechanics. Unlike in classical physics, for example, particles in the quantum world can seem to go through two doors at once. But German mathematician Grete Hermann and, later, US physicist David Bohm suggested that such paradoxes could be resolved if “hidden variables” or unknown mechanisms determine whether a particle travels through one door or another. A few physicists dubbed this “Bohm's demon”.

### Nanoscale demons

Canales explores so many fields and societal implications of scientific debates, from atomic bombs to stock-market fluctuations, that she seems to weave in nearly every demon reference of the past four centuries, however tangential. Some meandering historical asides stray from her solid survey of seminal demonic invocations.

Today's demons dwell in genetics, economics and artificial intelligence (AI). Searle's demon is named after the US philosopher John Searle, who in the 1980s pointed out that a powerful nanobot – or some nanoscale demon – could control which neurons in a person's



SCIENCE HISTORY IMAGES/ALAMY

Physicist James Clerk Maxwell envisaged a demon that could reverse entropy.

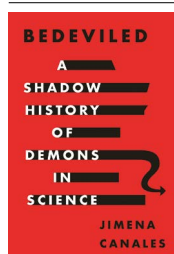
brain get stimulated and which don't, thus making the brain's base operations similar to a computer program. If such a demon were possible, then one could imagine AI mechanisms almost indistinguishable from human intelligence. Taking this debate about consciousness versus machine learning further, Searle criticized the idea of “strong AI” – that machines could think as well as or better than humans, operating not merely as tools but as minds of their own. (The University of California, Berkeley, stripped Searle of emeritus status in 2019 after finding that he had violated its sexual-harassment policies.)

Canales highlights some women, including Marie Curie, who envisaged quantum-level

demons acting on radiation, and mentions others in passing, such as Rosalind Franklin and Lise Meitner, who did groundbreaking work on DNA and nuclear fission, respectively. But she mostly takes in demons imagined by male scientists in Europe since the Renaissance. Her history would have benefited from an exploration of the disputes between astrology and science in the medieval period, such as those between figures such as Abu Rayhan al-Biruni and Ibn Sina (Avicenna) in Persia. These scholars, too, probed the limits of theory, observation and experiment, and their demarcation from pseudoscience.

In his classic 1995 book *The Demon-Haunted World*, astronomer Carl Sagan wrote that because scientists frequently use their imagination in their work, they don't know what to expect as they push against the boundaries of knowledge. Canales has given us a glimpse into this haunted realm.

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**Bedeveled: A Shadow History of Demons in Science**  
Jimena Canales  
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