

APIC/GETTY

Simple fixes can be as key as costly instruments. Isaac Newton cut a hole in his window shutters to cast a beam of light in his early optical experiments.

LAB LIFE

Retrofits, hacks and kludges

Derek Lowe draws lessons for today from a history of scientists' experimental fixes.

Many students of science spend a fair bit of time learning about the theorists and experimentalists of the seventeenth and eighteenth centuries. Yet it can be hard to picture these figures through the layers of historical scholarship and popular accounts. Our mental images of luminaries such as chemist Robert Boyle, co-founder of the Royal Society in London, may be hazy scenes of demonstrations with air pumps, prisms and microscopes performed by men wearing elaborate wigs. Science historian Simon Werrett's *Thrifty Science* is, among other things, a lively attempt to show another side of these figures and their era.

The word "thrifty" is key, in the 'make do and mend' sense: using objects to multiple ends, repurposing materials and being inventive with what's on hand.

Much has been made (justifiably) of the impact of new instruments on early scientific discovery. But Werrett makes the case for the importance of seemingly mundane household items in the same experiments. For example, in his early optical experiments, Isaac Newton cut a hole in his shutters to cast a beam of light. And Werrett shows the importance of houses themselves as sites of experimentation: natural philosophers such as Robert Hooke and John Wilkins



Thrifty Science: Making the Most of Materials in the History of Experiment
SIMON WERRETT
University of Chicago Press (2019)

mixed lodgings with laboratories. No small amount of work was done in kitchens and barns. Pottery vessels, cooking fires, stewpots and string had roles, alongside made-to-order vacuum pumps and expensive lenses.

Some of this was by necessity; advanced apparatus was scarce and expensive. As a result, protecting and repairing it took a lot of work. Researchers in Britain's American colonies, such as polymath Benjamin Franklin and astronomer David Rittenhouse, had to find substitutes for equipment that might have existed in London or Paris — but not Philadelphia. However, thriftiness of this sort was also seen by many experimentalists (notably Boyle) as a virtue of its own.

The book's discussion of the nitty-gritty of early lab work is interesting. Werrett

uncovers a wealth of detail about experimental design and apparatus, both from primary documents (correspondence, memoirs and contemporary reports) and from a wide range of secondary sources such as biographies, dissertations and historical monographs. He notes that early experimentalists, starting with sixteenth-century English natural philosopher Francis Bacon, were sometimes at pains to distinguish their work from what looked like just messing around at the kitchen hearth.

“Has science moved on inexorably, or is there still a role for found materials and reused parts?”

And, of course, many discoveries over the centuries were crucially influenced by the instruments available. The single-lens microscope invented by seventeenth-century Dutch cloth merchant Antoni van Leeuwenhoek, for instance, revealed protozoa, red blood cells and more for the first time. Theoretical physicist Freeman Dyson (in his 1999 book *The Sun, the Genome and the Internet*) has written about the question of whether entire fields are driven more by theory or by technology that allows theories to be formulated in the first place. (The answer is almost certainly both, with either one ascendant at different times.)

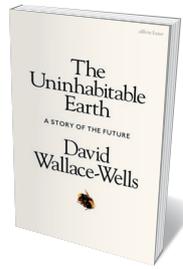
CHANGING TIMES

A major question, however, is how much had to do with the simplicity of the principles uncovered at the time. The foundations of optics or of the behaviour of gases could be worked out in rooms off a kitchen; characterization of Bose–Einstein condensates and nanomaterials is another matter. Modern investigations, in many cases, call for temperatures, pressures and energies that need complex, costly equipment. Has science moved on inexorably to fancier equipment, larger labs and bigger research teams, or is there still a role for found materials, reused parts and home experimentation? Here is where I began to part company with the book and its arguments.

Werrett wonders, towards the end, whether “the era of ‘Big Science’ has been only a brief hiatus in an otherwise long and thrifty history”. He sees the ‘maker’ community of recent years — such as those engaging in ‘thrifty innovation’ in do-it-yourself biology or the South Asian *jugaad* movement — as a return to small-scale experimentation with recycled and retrofitted equipment. He ties this, too, to a burgeoning environmental consciousness. Looking at what was accomplished in the past centuries of scientific research, ►

Werrett rightly points out that this attitude was tinged with prejudices about the place of domesticity and women in society.

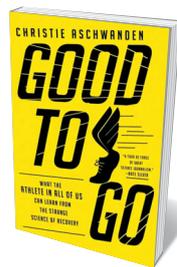
Books in brief



The Uninhabitable Earth

David Wallace-Wells TIM DUGGAN (2019)

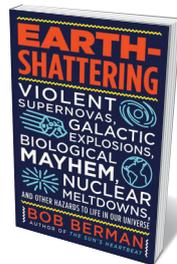
Out of fear, faith in technology or lack of interest, millions of us tell ourselves decontextualized fictions about climate change. So declares journalist David Wallace-Wells in this powerfully argued polemic, drawing on research into current and near-future impacts. Wallace-Wells examines cases of systems crises from heatwaves to sea-level rise; considers pandemics, economic collapse and conflict in context; and probes the miasma around climate, from metaphorical framings to the politics of consumption. A masterly analysis of why — with a world of solutions — we choose doom.



Good to Go

Christie Aschwanden W. W. NORTON (2019)

In the tortuously complex world of sport, stunning athletic performance is only half the story. The shadow side, reveals science writer Christie Aschwanden, is recovery from all that muscle-popping, nerve-straining effort. Aschwanden investigates claims for recovery “modalities” such as ice baths, electrical stimulation and even beer — a journey that also takes her through byways such as hyponatraemia (water intoxication), ‘nutrient timing’, blood biomarkers to track training impacts, and more. Celebrity solutions figure, too, including American footballer Tom Brady’s infrared pyjamas.



Earth-Shattering

Bob Berman LITTLE, BROWN (2019)

It’s fairly peaceful out there in the “celestial acreage”, notes astronomer Bob Berman: among the trillions of stars in the visible Universe, the lifespans of more than 90% are relatively predictable. But what about the cataclysms that rattle cosmic neighbourhoods? In this gripping primer, Berman encapsulates meltdowns and mayhem, from the ur-event of the Big Bang to γ -ray bursts from the neutron stars known as magnetars. He ventures, too, into nuclear disasters, pandemics and a monumental event 4 billion years hence, when the galaxy Andromeda will collide with the Milky Way.



Underground

Will Hunt SIMON & SCHUSTER (2019)

Anthropology goes underground in Will Hunt’s unclassifiably brilliant foray into human cultures beneath the skin of city streets and rural scapes. Hunt turns subterranean ethnographer in far-flung places, meeting NASA astrobiologists in South Dakota caves, the ochre-mining Wajarri people of Australia, French aristocrats who steward 14,000-year-old clay sculptures deep under the Pyrenees, and intrepid explorers of subways, steam vents and sewers. Invoking Surrealist poet Paul Éluard (“There is another world, but it is in this one”), Hunt leads us into illuminating depths and darkness.



The Making of You

Katharina Vestre (transl. Matt Bagguley) WELLCOME COLLECTION (2019)

Few dramas are as fascinating as the one that plays out in the human womb. Embryologist Katharina Vestre’s engrossing primer gives us the script, from the harrowing journey of sperm towards egg, to that first gulp of air in the dazzle outside. Vestre intertwines snippets of genetic and embryological history into her narrative, and has the knack of sparking wonder at developmental details — whether the “tiny firework” of cell division, the inner wanderings of nerve fibres, the cartilage prototype skeleton we have at week seven, or the gradual creep of ears up the neck. [Barbara Kiser](#)

► he claims that there is “no reason to suppose” that this trend “could not generate the same kind of revolutionary discoveries in the future”.

One wonders. Simple apparatus was perfectly suited for picking what (fairly or not) now looks like the low-hanging fruit of science — and there was a vast garden of fundamental discoveries, from microorganisms to the laws of motion, to be picked. I have had the impression over the years that some historians of science dislike using the word ‘progress’ for fear of implying that all history was building towards the modern age. But although human history is under no obligation to make or demonstrate progress (by whatever measure), science is explicitly designed for it. My fruit-picking reference might make me sound like a pillager of the environment, out of tune with modern sensibilities, but that’s a problem with our metaphors, not with our reality.

Science really does build on its history, those shoulders of giants and bricks of knowledge. That’s its point. And as a working scientist myself, I can’t help but believe that our knowledge becomes more complex, refined and complete as

“Reality seems increasingly complicated as we make better measurements of it.”

time goes on. We revise, we reassess, we revisit — but always in the interest of comparing our ideas against physical reality. And although that reality also seems increasingly com-

licated as we make better measurements of it, that forces our theories and experiments to keep pace. All too often, it forces our equipment and funding to keep pace, as well.

I grew up in a small farming town, and know exactly what it’s like to be passionately interested in science, making do without many of the resources needed to explore it. If I saw some unusual creature under my microscope, no one could tell me what it was. I would have loved to have seen Comet West when it passed through the inner Solar System in 1976, but the local newspapers never mentioned it. I am very sympathetic to ‘makers’ and basement experimenters. But no matter how appealing the prospect might be, I think that the chances of revolutionary experiments happening with simple materials are dwindling by the year. ■

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No. 348. *Candid Portrait of a Woman on a Street Corner* by Trent Parke (2013).

EVOLUTIONARY PSYCHIATRY

Foundations of mental illness

Adrian Woolfson weighs up a study on the role of evolution in conditions such as depression and anxiety.