

Skyscrapers such as New York's Citigroup Center must contend with complex wind dynamics.

## ENGINEERING

# Turbulent genius

Allan McRobie enjoys a life of the audacious engineer who pioneered the windproofing of bridges and skyscrapers.

Siobhan Roberts' *Wind Wizard* is an unlikely gem, a biography of both a man and a field. It tells the story of Alan Davenport and the 50 years he spent creating the discipline of wind engineering to span the gaps between fluid dynamics, meteorology, structural engineering and architecture. The book reveals the backstory to many

of the world's more iconic structures. Here, for instance, are the World Trade Center; the Sears, CN and John Hancock Towers; the Citicorp Center; and a comparable compendium of epic bridges, all from the perspective of their ability to withstand windstorms. Early wind-tunnel tests of the World Trade Center revealed the need for more realistic

wind modelling, spurring Davenport to establish the Boundary Layer Wind Tunnel at the University of Western Ontario in London, Canada. This facility was designed to replicate the turbulent conditions of the lower atmosphere.

Such projects are massive investments, often of billions of dollars, with thousands of lives at risk when extreme winds hit. The

physics is complex and uncertain, the mathematics intractable and the definitive experiment — building the full-scale structure and seeing what happens — cannot be done. It is a difficult problem, and the book describes how Davenport pieced together pragmatic theory and painstaking model testing to give rational, reliable predictions of performance.

Roberts charts how each challenge led to improvements in procedure and theory. For example, in her descriptions of the young Davenport's meetings with Leslie Robertson, the World Trade Center's structural engineer, as early as 1964, you detect both the creation of a prudent yet record-breaking design and the emergence of a field. Davenport replaced rudimentary rules of thumb for static pressures with a discipline. This tackled the complexities and uncertainties of the atmospheric boundary layer and the dynamic complications of wind flows such as galloping, vortex shedding, buffeting and wake buffeting. It was from that design process — which inevitably makes for poignant reading given the events of 11 September 2001 — that the Boundary Layer Wind Tunnel emerged. It went on to become central to all such studies.

Two of the projects studied in the tunnel show the potential for disaster posed by skyscrapers. In 1978, a phone call from an inquisitive student to the structural engineering firm behind the 59-storey Citicorp Center (now the Citigroup Center) — already built, and balancing on four huge columns high above mid-town Manhattan — prompted the shocking realization that the supporting calculations had omitted to take into account 'quartering' winds, which hit the building at 45 degrees.

This story, well-known in structural-engineering circles, represents one of the nightmare scenarios. Roberts captures the heart-thumping horror of the moment, and the parts played by Davenport and Robertson in the testing and emergency remedial action to strengthen the bracing that followed. Perhaps my



**Wind Wizard: Alan G. Davenport and the Art of Wind Engineering**

SIOBHAN ROBERTS  
Princeton University  
Press: 2012. 288 pp.  
\$29.95, £19.95

➔ [NATURE.COM](http://NATURE.COM)  
For *Nature's city* special, see:  
[nature.com/cities](http://nature.com/cities)

only criticism of the book is that the student who telephoned is not named. I believe her to be Diane Hartley, who was then studying under David Billington at Princeton University — a surprising omission for that institution's own press.

The other difficult case is the John Hancock Tower in Boston. Its problems were more subtle, although equally alarming. Again, the issue involved wind forces from directions that had not been considered, and required the retrofitting of stiffening and dampers, at great expense, to make the structure safe. From now on, I shall refer students and professors alike to Roberts' clear account.

I did begin to wonder whether the ultimate outcome of Davenport's life-long effort was allowing financiers to inhabit lofty eyries without overly endangering the people below. But the last chapter focuses on his determined efforts at disaster mitigation for the vulnerable. For example, in the Caribbean, he has worked on hurricane-resistant houses and was involved in numerous international initiatives that worked on disaster mitigation at a human scale.

Roberts has written a largely equation-free book in which technical subtleties such as aeroelasticity and Davenport's statistical description of turbulent buffeting are set out clearly, engagingly and accurately. Her precise, vivid phrases, such as vortices "pushing and shoving the structure this way and that like a gang of bullies", will enliven my future lectures.

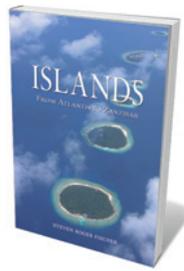
**Two of the projects studied show the potential for disaster posed by skyscrapers.**

Before opening the book, I had decided to look out for two potential pitfalls. First, would the book acknowledge the alternative to Davenport's statistical theory of buffeting — the rapid distortion theory developed by Julian Hunt? It does. Second, would the story of the famous 1940 Tacoma Narrows Bridge collapse in Washington state fall back on the lazy and inaccurate 'resonance' description that most physics textbooks adopt? It does not. Instead, Roberts gives faultless coverage of work by engineers Robert Scanlan and, more recently, Allan Larsen to explain the physics of what actually happened.

This is my field, but I learned much from Roberts' admirable book, and emerged with great respect for both Davenport and his chronicler. ■

**Allan McRobie** is a Reader in Structural Engineering at Cambridge University, UK. e-mail: jam@eng.cam.ac.uk

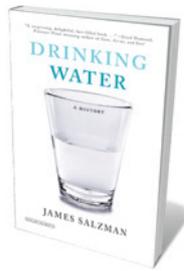
## Books in brief



### Islands: From Atlantis to Zanzibar

Steven Roger Fischer REAKTION BOOKS 352 pp. £22 (2012)

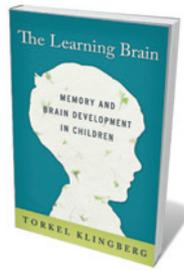
From Charles Darwin's moment in the Galapagos to the cultural efflorescence of Minoan Crete, islands are "crucibles and cradles" — laboratories, havens, touchstones. In this tour of their biology, geology and culture, linguist Steven Roger Fischer offers a taste of the million or so mini-biomes studding Earth's rivers, lakes and oceans. He is a brilliant guide, whether discussing the anti-cancer properties of the Madagascar periwinkle, Papua New Guinea's 500 languages, the imagined isle where Shakespeare's Prospero abjured his 'rough magic', or the very real threat climate change poses to many islands.



### Drinking Water: A History

James Salzman OVERLOOK 320 pp. \$27.95 (2012)

Potable water permeates humanity's past and is set to dominate its future. The United Nations estimates that by 2030, more than half of us will live in water-scarce areas. Environmental-policy specialist James Salzman goes with the flow in this absorbing chronicle of our complex relationship with H<sub>2</sub>O. He negotiates multiple currents: the 'cures' ascribed to sacred waters; the ongoing struggle to eradicate microbes and dicey chemical compounds; urban waterworks and politicized availability; scarcity and bulk water transfers; and today's search for water — a quest awash with uncertainty.



### The Learning Brain: Memory and Brain Development in Children

Torkel Klingberg OXFORD UNIV. PRESS 200 pp. \$24.95 (2012)

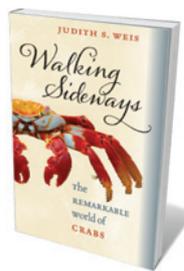
In this pragmatic treatise on how children learn, neuroscientist Torkel Klingberg homes in on working memory. Klingberg has marshalled swathes of research and pertinent case studies to show how gaps in this form of memory can lead to educational failure, and how training the young in tested techniques can help. Enriching his argument with findings — from the role of white matter to the corrosive effects of stress — he concludes that key pedagogic tools include 'memory training' to boost cognitive function, aerobic fitness, reduced anxiety and regular sleep.



### Watching Vesuvius: A History of Science and Culture in Early Modern Italy

Sean Cocco UNIV. CHICAGO PRESS 336 pp. \$45 (2012)

Historian Sean Cocco looks anew at Vesuvius to reveal how early responses to it shaped modern volcanology. Now monitored closely — as befits a looming risk to at least a million people — in Renaissance and Baroque Naples the volcano was just becoming a focal point for scientific appreciation. Cocco argues that a combination of the city's cultural traditions and the chain of eruptions that kicked off in 1631 helped to avert the early modern scientific eye from sky-gazing to the earthly wonders of geology.



### Walking Sideways: The Remarkable World of Crabs

Judith S. Weis COMSTOCK PUBLISHING ASSOCIATES 256 pp. \$29.95 (2012)

Stalked eyes, formidable claws, sidling gait: crabs are found around the globe and in environments ranging from deep-sea vents to bromeliad plants growing in trees. Biologist Judith Weis explores this crustacean cosmos with verve, touching on evolution, species, habitats, anatomy and functions, behaviour, ecology and fisheries. From the spotted orange Japanese spider crab (whose leg span can measure more than 3.5 metres) to the shell-swapping hermit crabs of Belize, this is a gripping overview of a remarkable family.