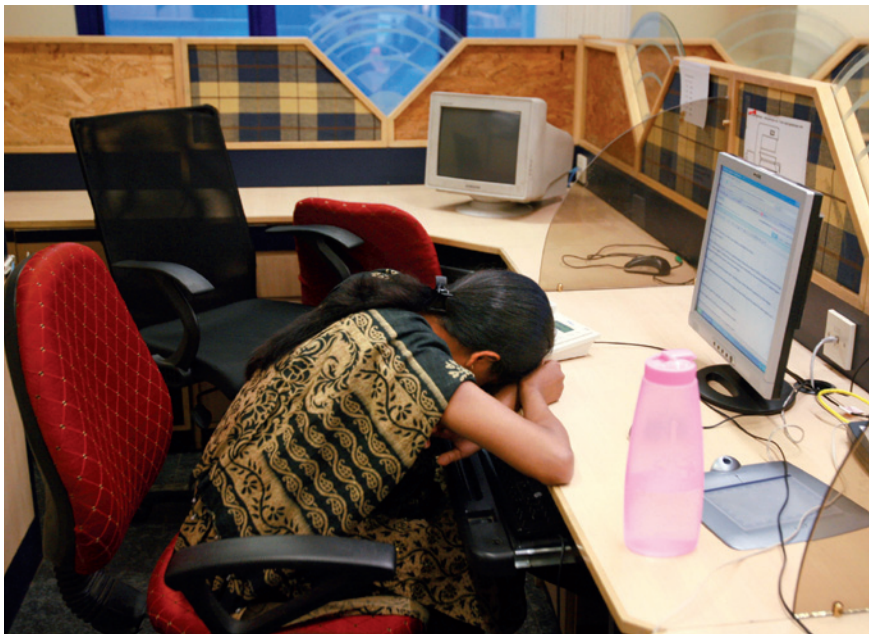
subject–verb–predicate image for each card. For example, the king of diamonds: Dad riding a tricycle or, using the book's title, Dad moonwalking with Einstein. In tournaments, cards are turned over three at a time. A new image is then constructed to represent all three cards (images ABC, DEF and GHI are converted into the single image AEI). This new image retains a trace of each card's identity, which can be placed in a room of the memory palace for later retrieval. To support memory of a 52-card deck, the expert needs 17 images plus one additional image.

Because a collection of images typically includes a number of titillating acts, difficulties can arise when combining them results in images of family members engaged in socially unacceptable practices. As he prepared for competition, Foer worried that he was being distracted by the indecent acts his mother had to commit "in the service of my remembering the eight of hearts". His coach knew the problem: "I had to excise my mother from the deck. I recommend you do the same."

After gaining his trophy, Foer retired from competition and now rarely uses the techniques. They are effortful and hardly vital in an age of external memory in which remembering information may be less important than knowing how to find it. Also, ordinary memory works at cross-purposes with memory-training techniques. We are best at generalizing, abstracting and assembling general knowledge, not at retaining a literal record of events: we forget the particulars and thereby can retain the main points. Studies show that people will remember the meaning of sentences but forget whether the sentences were presented in the active or passive voice. Freud wrote: "Normal forgetting takes place by way of condensation. In this way it becomes the basis for the formation of concepts."

Influenced by these realities of memory, current pedagogy has minimized rote memorization and drills, emphasizing instead problem solving and independent thinking. Yet, if it is true (as stated in the book) that two-thirds of US teenagers cannot locate the Civil War within 50 years, or that 20% cannot identify the adversaries in the Second World War, perhaps there is a place in education for the skill of memorizing. Foer tells of an inner-city history teacher, an enthusiast of memory training, who introduced the techniques rigorously, comprehensively and with considerable success. As Foer writes, "even if facts don't themselves lead to understanding, you can't have understanding without facts." ■

Larry R. Squire *is professor of psychiatry, neurosciences and psychology at the University of California, San Diego, and research career scientist at the Veterans Affairs Healthcare System, San Diego, California 92161, USA.*
e-mail: lsquire@ucsd.edu



U. SINAI/GETTY

The time difference with the West takes its toll on a web tutor at an Indian-based company.

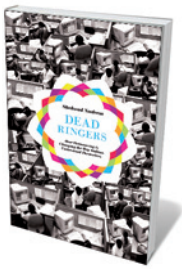
GLOBALIZATION

Behind India's technological boom

The rise of outsourcing by Western companies stifles local innovation, learns **Andrew Robinson**.

It is now an everyday experience to phone a large US- or UK-based company with a technical, financial or administrative enquiry and end up talking to someone in Bangalore or Mumbai. India's ready supply of well educated, English-speaking and relatively cheap workers has made the country a top destination for many Western companies, from banks and airlines to big pharma and information technology (IT) firms. Yet the outsourcing of labour has had unforeseen local impacts on science and innovation — and on the technologically gifted young people of India.

Dead Ringers, by US sociologist Shehzad Nadeem, is the first academic field study to explore what turns out to be an occupational dead end for hundreds of thousands of Indians working for Western corporations. As well as the multitude who man telephones, this vast group includes an army of software programmers, accounting specialists and interpreters of medical scans. Nadeem interviewed more than 125 workers, managers, employers and trade unionists in India and the United States, mainly in 2005–06. He offers concrete and important insight into the world of outsourcing, but in highlighting the downsides, he downplays the undeniable successes and the homegrown roots of India's research and development sector.



Dead Ringers: How Outsourcing is Changing the Way Indians Understand Themselves
SHEHZAD NADEEM
Princeton University Press: 2011. 288 pp. £24.95

India's IT boom, which started in the mid-1990s after the liberalization of the Indian economy in 1991, has generated headlines and hyperbole in both business and politics. As Nadeem readily accepts, outsourcing has provided many young Indians with comparatively well-paid opportunities and it has boosted India's reputation internationally. In 2004, the boom even contributed to the electoral slogan of the ruling Bharatiya Janata Party (BJP), "India shining".

But the BJP's controversial phrase turned out to be ill chosen. The party lost

the general election, and the IT boom began to lose its shine, especially after admissions of false accounting in 2009 led to the collapse of Satyam Computer Services, which in 1999 was one of the first India-based IT companies to be listed on the NASDAQ stock market. It is now widely recognized that the 1990s dream of Indian development led by outsourcing was, in Nadeem's words, "wildly oversold".

The offices of India's glamorous IT companies may look "like twinkling towers of innovation", says the author. But he contends that "like plastic fruit, they are imitations". Nadeem backs up this view with skilfully told stories from his Indian sources (some named, most anonymous). But when he tries to uncover the reasons why India's IT industry has generally failed to innovate at home, despite prominent individual successes among Indians in California's Silicon Valley and Western academia, his conflation of outsourcing with research and development blurs his analysis and conclusions. The book is also heavy on academic jargon.

CREATIVITY CURTAILED

What does he think is stalling homegrown innovation? A lack of emphasis on individualism in Indian family life and a widespread deference to authority may be part of the reason, says Nadeem. But much more important, he says, is the global economic system. Outsourcing managers, both in India and the United States, are "locked in a contradiction", he notes. They want their workers to mature into professionals who show initiative and take responsibility for projects. But simultaneously, they want to migrate easily replicable, standardized tasks rather than whole projects to India. Farming out tasks generates a reliable stream of revenue while ensuring that control of the process remains based in the United States and Europe. The core work requiring creativity therefore stays in the West.

Nor have these elite industries been effective in alleviating India's massive poverty, Nadeem argues, despite generating impressive economic growth. Between 1994 and 2008, India's export revenues in IT and IT-enabled services (ITES) grew from less than US$0.5 billion to $40.4 billion, and are predicted to reach $71 billion in 2011. Between 2004 and 2008, the number of workers employed in the sector — most of whom are male and in their twenties — more than doubled, to an estimated two million. Their average entry-level salary in IT in 2006 was $5,715 a year (compared with $46,194 in the United States). By 2007, India's IT and ITES industry accounted for 5.2% of the country's gross domestic product. Yet, the IT and ITES

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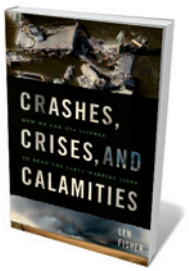
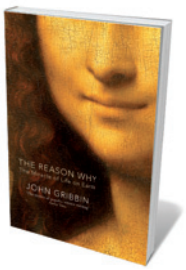
Books in brief



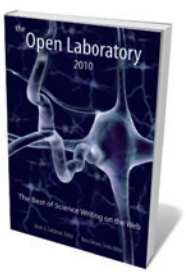
Crashes, Crises, and Calamities: How We Can Use Science to Read the Early-Warning Signs
Len Fisher BASIC BOOKS *256 pp. £13.99 (2011)*
From earthquakes to the collapse of civilizations and economies, why do systems suddenly break down? Physicist and writer Len Fisher gives an accessible explanation of the mathematics of catastrophes in his latest book. Drawing on physics, ecology and biology, he highlights four tools that scientists and engineers use to forecast rapid failure: stability, catastrophe, complexity and game theory. By applying these concepts, he explains, we can predict and manage impending crises.

Science-Mart: Privatizing American Science
Philip Mirowski HARVARD UNIVERSITY PRESS *464 pp. $39.95 (2011)*
Since the 1980s, commercial companies have become the largest funders of scientific research in the United States. Economist and historian Philip Mirowski analyses in detail the impact of this shift away from public funding. Owing to the rise of patents and intellectual property, knowledge and discovery are now perceived as a commodity; the fruits of scientific investigations are no longer considered a public good but are seen as products with monetary value. But, the author argues, American science should be more than just a cash cow.

Nightwork: A History of Hacks and Pranks at MIT
T. F. Peterson MIT PRESS *232 pp. $22.95 (2011)*
Every university has its canon of creative pranks, which usually involve a degree of technological know-how. The finest practical jokes played at the Massachusetts Institute of Technology in Cambridge are documented in this illustrated volume (first published in 2003), which has been updated for the institution's 150th anniversary. Recent 'hacks', as they are known, include the cross-country theft of a cannon from the California Institute of Technology in 2006, and the hoisting of a solar-powered subway car and a fire engine onto the roof of the university's Great Dome.



The Reason Why: The Miracle of Life on Earth
John Gribbin ALLEN LANE *240 pp. £20 (2011)*
A series of one-off cosmic events and flukes of physics represent the lucky breaks that made our planet the oasis it is today, argues best-selling writer John Gribbin in his latest book, which examines the origin of life on Earth. From the giant collisions of early Solar System bodies that forged our planet to the geochemical reactions that make it habitable, our world is special. Even though planets are common in the Milky Way, Gribbin argues, intelligent life capable of building technological civilizations will turn out to be rare. So the future of humankind is of universal significance.



The Open Laboratory 2010: The Best of Science Writing on the Web
Edited by Jason Goldman & Bora Zivkovic LULU *284 pp. £11.91 (2011)*
Last year saw the eruption of Iceland's Eyjafjallajökull volcano, the deep-water oil spill in the Gulf of Mexico and the announcement of arsenic-based life. It was also, according to Jason Goldman, editor of this collection of 2010 blog posts, the year when blogging went mainstream. Thanks to the extra boost of Twitter, online diarists were sought out to comment on all the big science stories. Their insights are shared in this annual selection of the best of the blogosphere.

workforce — which is frequently located in deregulated special economic zones that are cut off from their surroundings — constitutes less than 0.5% of India's total workforce of some 450 million, 92% of whom survive as labourers, farmers and street vendors. According to a 2007 Indian government report, 77% of Indians live on less than 50 cents a day. In 2010, only 366 million Indians had access to modern sanitation (for comparison, India has 564 million mobile phones).

Nadeem gives vignettes of life in four unnamed outsourcing companies in Bangalore, Mumbai, Chennai and New Delhi, where long hours, graveyard shifts and stressful monitoring regimes without doubt damage the workers' health. These snapshots, combined with the start-ups that have failed to live up to their promise, and widespread corruption in Indian business and politics, give the 'dead' in *Dead Ringers* — which initially refers to call-centre workers' dubious mimicry of Western accents — a more ominous significance as the book progresses.

Nadeem concludes that outsourcing is a new form of colonialism, with an insidious appeal for young Indians in thrall to American mass consumerism. Although that is essentially true, his simple explanation skirts the internal impetus that has been given to Indian technological innovation. After India became independent in 1947, its first prime minister, Jawaharlal Nehru, did much to establish the country's scientific higher-education system, including the Indian Institutes of Technology, and to build up its technological sector, on which the success of the IT industry rests. Nadeem neglects this crucial background and seems to endorse an unnamed Indian executive's dismissive comment: "The only thing that Nehru gave us was education. That allowed people to be in a good position when the knowledge boom came."

"The brave new IT world documented in Nadeem's interviews disturbs more than it shines."

There is more variety and originality in Indian IT than *Dead Ringers* implies. Nonetheless, for all the wealth and political prestige that outsourcing has brought to India, one cannot help agreeing with the author that the brave new IT world documented in his interviews disturbs more than it shines. ■

Andrew Robinson *is a London-based author. He is the biographer of Indian film-maker Satyajit Ray and Nobel laureate and writer Rabindranath Tagore.*
e-mail: andrew.robinson33@virgin.net

ASTRONOMY

Finding other worlds

A survey of exoplanetary research shows how the field has come in from the cold, finds **Chris Tinney**.

When I began my career as a graduate student in astronomy in the late 1980s, it was clear which fields were considered hot, which were not, and which were outré. Cosmology and infrared astronomy were hot. Galactic dynamics and most stellar astronomy were staid. And the search for planets and brown dwarfs — the class of objects intermediate in mass between planets and stars — was definitely outré. How things have changed.

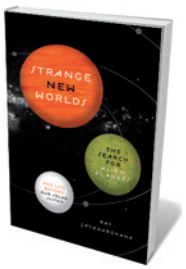
In *Strange New Worlds*, astronomer and one-time journalist Ray Jayawardhana surveys how 15 years of exoplanet discovery has changed astrophysics. From a small base, in terms of personnel and funding, exoplanetary science — the search for and study of planets orbiting other stars — has grown rapidly and now sits at the core of modern astrophysics. Its findings have overturned many established ideas.

To show how far we have come, Jayawardhana relates a telling incident from the late 1980s: a distinguished astronomer strode out of the room when a pioneer of exoplanet searches, Gordon Walker, rose to speak about his work. As Walker remarks, it "seems hard to believe now".

Nonetheless, a few brave souls continued to work in the field. Advances in astronomical detectors, instrumentation and analysis techniques meant that in 1995, hundreds of years of observations finally bore fruit and the signatures of orbiting planets were discovered in the spectra of other stars. In the years since, hundreds of exoplanets have been found. The change in the landscape of astronomy and planetary science has been profound.

Entirely new fields have come into being or come into their own: exoplanetary science, and astrobiology, which explores the possibility of life elsewhere in the Universe. New research groups have popped up around the globe, backed by governments through major scientific strategies. The first sentences of the executive summary of the 2010 US National Research Council's astronomy decadal survey highlight this shift: "Our view of the universe has changed dramatically. Hundreds of planets of startling diversity have been discovered orbiting distant suns." Astronomy's old hierarchies have been overturned.

The title of Jayawardhana's book reflects the major scientific finding of all this activity: exoplanets are much stranger than we expected. Very few of the planetary systems found around other stars resemble the architecture of our own Solar System. Most exoplanet orbits are highly elliptical and near-circular orbits are rare, occurring only when gravitational tidal effects make them so. Gas- and ice-giant planets are located in places where they could not originally have formed, indicating that they have moved great distances since formation. This migration seems to be the dominant driver of the exoplanet architectures we observe.



Strange New Worlds: The Search for Alien Planets and Life Beyond Our Solar System
RAY JAYAWARDHANA
Princeton University Press: 2011. 288 pp. £16.95, $24.95

Some exoplanets are much denser than expected; others are much less dense. Some systems host many ice-giant planets in tight orbits, whereas our Solar System has only one tiny terrestrial planet (Mercury) so close. Others host no giants at all. Evidence is beginning to emerge that Earth-like, or terrestrial, planets might not be the norm. The Copernican principle — that Earth is not special or unusual — may not hold after all.

Jayawardhana's presentation of the research is remarkably even-handed. This is a fast-moving field in which groups have often clashed. Nonetheless, he provides a survey of the subject without giving the protagonists anything to complain about. His lucid and effortless prose makes for an engaging read.

Strange New Worlds anticipates the major results that can be expected in exoplanetary science in the coming decades: the imaging of exoplanets orbiting nearby stars; finding the first habitable Earth-like planets; the detection of biomarkers that suggest the existence of life outside the Solar System. These and much more will continue to make this field not just fashionable, but very exciting. No one is walking out of the room any more. ■

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For more on the search for exoplanets:
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Chris Tinney *is professor of exoplanetary science at the University of New South Wales, Sydney, Australia.*
e-mail: c.tinney@unsw.edu.au