B. KAPOOR/SYGMA/CORBIS

Indira Gandhi at the site of India's first nuclear test, part of her vision for the country's development.

expected to ban the sale of such equipment to India. Parthasarathi also discusses his own role in the investigation of Monkombu Sambasivan Swaminathan, the distinguished agricultural scientist known for developing high-yielding Indian wheat varieties. He describes how Swaminathan was exonerated after being accused of falsifying scientific claims.

Occasionally, there are glimpses reminiscent of the British sitcom *Yes Minister*, when decisions approved by the cabinet or the prime minister were stalled in the corridors of power. The administration was even divided between the technocrats and those who came through the regular channel of the administrative service. I recall that during my tenure as member of the Science Advisory Council to prime minister Rajiv Gandhi, the exasperated leader once asked the council: "Tell me, how am I to get this recommendation implemented by my administrators?".

Excellent though this account is, there are serious gaps. Important political events such as the war leading to the formation of Bangladesh, the declaration of emergency with draconian powers assumed by Mrs Gandhi, her loss of the post-emergency election, and her return to power nearly three years later are mentioned only fleetingly. How did science and technology, especially the prime minister's secretariat, fare during these traumatic events? Even in a purely scientific context, there is no discussion of the 1974 peaceful nuclear test. How much did the secretariat staff know of it? There is frequent mention of Purshottam Narayan Haksar as an important decision-maker whose views were greatly respected by Mrs Gandhi. Yet there is no discussion of why and how he was sidelined during the state of emergency declared in 1975.

A comparison with a political biography of Mrs Gandhi, such as the one by Inder Malhotra, would make this book seem a somewhat dry and oversimplified account of how she functioned and how she ran science and technology in a big emerging nation. *Technology at the Core* is eminently readable as an eyewitness account. But it could have been even more so had the political ambience not been filtered out. ■

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The learning revolution

Opening Up Education: The Collective Advancement of Education Through Open Technology, Open Content, and Open Knowledge
Edited by Toru Iiyoshi and M. S. Vijay Kumar
MIT Press: 2008. 500 pp. $24.95, £16.95

Education is changing. The ethos of openness that increasingly pervades activities from journalism to software to finance is being adopted by the educational community. The series of essays in *Opening Up Education* offers examples, opportunities and thoughts on the use of shared and freely available resources in education. The book is arranged in three sections: software, content and pedagogy.

Educational software, as in other areas serving a specific need, has both open-source and commercial versions that exist in parallel. Learning management systems, which enable teachers to deliver online content to students and to manage the educational process, are no exception. Projects and open-source software described in the book include the Visual Understanding Environment project at Tufts University, Massachusetts; the University of Oxford's adaptation of the Bodington software developed at the University of Leeds, UK; and iLab and OpenCourseWare from the Massachusetts Institute of Technology (MIT). The book does not compare specific commercial products against open-source alternatives, nor does it give an inventory of common open-source educational software; in its essays, leaders in the field discuss high-level design and implementation issues, such as ease of adoption by teachers and students, and management of user-access policies.

The authors discuss current open resources in education and their possible future. The section on open content, in addition to MIT's OpenCourseWare, covers the Multimedia Educational Resource for Learning and Online Teaching, Connexions and the Open Learning Initiative, all of which offer free, online educational materials in formats ranging from small learning modules to entire courses also taught as traditional lectures. A major theme is the management of intellectual property, such as with Creative Commons licences, investigated in detail by David Wiley. Quality control of the educational materials is important, whether mediated by peer-review or other means. Many essays repeatedly discuss the merits of top-down versus bottom-up approaches to the creation and management of open content.

The growing availability of high-quality open content is colliding with traditional academic business models, particularly textbook publication. Diane Harley explores the barriers preventing the adoption of digital and open content by faculty members. These include time, cost, access to support structures and the nature of current academic culture, raising a need to integrate traditional reward systems with new forms of educational materials and scholarship.

Richard Baraniuk tries to predict the future of open education by extrapolating from the evolution of the Internet. Using the terminology of web-publishing firm O'Reilly, the first open content was disseminated through the direct mechanisms of 'Web 1.0', when creating content was difficult and a broadcast model emerged. With the rise of the more interactive 'Web 2.0', content creation and remixing has become easy using social-networking sites and intuitive interfaces such as blogs and wikis. Now that students can also create content, the role of the teacher is changing. We are currently observing the rise of this phase against a backdrop of traditionally taught courses. Most students can no longer expect a homogenous style of education across the curriculum. The future promises 'Web 3.0', in which the semantic web will allow further opportunities for automation and artificial intelligence. Increased efficiencies in learning and measuring learning might lie ahead, yet what is worth learning could also change significantly.

The book's final section examines initiatives that explore how learning happens. The Carnegie Academy for the Scholarship of Teaching and Learning, the Visible Knowledge Project, the KEEP toolkit and the Learning Activity Management System are cited as examples. They do not necessarily involve much technology but use alternatives to the standard lecture format, such as discussions in small student groups. Peer review of research is standard practice, and some argue that teaching should also undergo this process. As these activities require time and effort, new teaching methods need to be given greater priority in the academic reward system before we can expect their widespread adoption. Bernadine Chuck Fong, a former president of Foothill College, California, describes the college's pioneering work in online and open education. She says that leadership is key to supporting such new initiatives: it must be made clear to faculty members that honesty, trust, integrity and forgiveness are highly valued across the institution. Many authors mention that a strong sense of community is important for the sustained sharing of teaching experiences.

For anyone interested in the openness movement or in changes to the educational system, *Opening Up Education* is worth perusing. The book is freely available online with links to individual chapters, making it easy to cite and share. It is not an exhaustive review of the field — more examples can be found in the blogosphere — but this valuable book highlights the leading authors on openness in education who we should follow as the field evolves. ■

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Rare books in the flesh

Beautiful Science: Ideas that Changed the World
Huntington Library, San Marino, California
Permanent exhibition

Unravelling the fabric of the body using Andreas Vesalius's drawings from 1543.

THE HUNTINGTON LIBRARY

Authentic books, documents and models provide an inspirational introduction to the development of science. One of the world's major rare-book collections is held by the Huntington Library in San Marino, California, which has set up its first permanent exhibition about the history of science.

Beautiful Science, which opened in November, displays classic manuscripts and other artefacts relating to astronomy, biology, medicine and physics in four rooms. The original Huntington collection, which now includes the astronomy holdings of the Observatories of the Carnegie Institution of Washington, was bolstered in 2006 by the addition of 67,000 books from the Dibner family's Burndy Library. Curator Dan Lewis has selected about 100 major scientific works from the hundreds of thousands in the collection.

The astronomy room opens with two thirteenth-century manuscripts: *Almagest*, Ptolemy's astronomical treatise originally written in the second century AD, and an Arabic manuscript covering similar material. Edwin Hubble's own copy of Nicolaus Copernicus's *De Revolutionibus*, alas only the second edition from 1566 instead of the first (1543), is on show. Censored by order of the Inquisition in the early seventeenth century, the book reveals the original Sun-centred diagram. Isaac Newton's *Principia Mathematica* (1687) is alongside, a copy that was owned by first Newton himself and then Edmond Halley. The exhibition combines the new with the old: computer animations contrast the Ptolemaic and Copernican views of planetary orbits, and an audio stream quotes from a letter from Hubble explaining the expanding Universe. Also here is Hubble's 1923 logbook that he used at the 2.5-metre Mount Wilson telescope near Pasadena, California. A mark shows his discovery in the Andromeda galaxy of the variable star — later found to be a supernova — that sparked our understanding of the Universe's expansion.

In the biology and natural history section lies a first edition of Charles Darwin's *On the Origin of Species*, with 251 editions of the book in various languages along the wall. Robert Hooke's detailed engraving of a flea in his *Micrographia* (1665) is accompanied by a replica microscope of the time, through which visitors can look at a real flea. Similarly displayed are Antonie von Leeuwenhoek's complete works from 1664 to 1718. Diagrams of the human body in Andreas Vesalius's oversized anatomy book from 1543 are paired with hands-on plastic versions. An unusual, small ivory model from 1540, about 15 centimetres long, shows a pregnant woman with a removable front torso.

The room devoted to physics and light hosts a collection of strangely shaped light bulbs and filaments, three labelled in Thomas Edison's handwriting. Newton's own copy of the second edition of his *Opticks* (1717) is accompanied by a metre-square display of his 1664 experiment: one prism breaks up white light into a rainbow of colours, and a second prism, which can be moved with a lever, recomposes it. Three spectral atlases are displayed, including Josef Fraunhofer's own from 1816, with his labelling of the strongest absorption lines in the solar spectrum with capital letters, a notation still used today. This atlas belonged to George Ellery Hale, founder of the California Institute of Technology in Pasadena and the Palomar and Mount Wilson Observatories, and who encouraged Henry Huntington to buy the extensive grounds in which the Huntington Library now stands.

The exhibition is a delight. The Huntington's botanical gardens, which are resplendent during the Californian winter, provide the ideal setting to reflect on the great moments of science collected in this fascinating exhibition. ■

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