John von Neumann led US efforts to develop an early electronic computer, in parallel with similar projects in the United Kingdom.

COMPUTER SCIENCE

Digital dawn

Thomas Misa ponders a history of computing that focuses firmly on John von Neumann and the 'Princeton crowd'.

In *Turing's Cathedral*, George Dyson gives us a personal history of computing's early years. A science historian and son of physicist Freeman Dyson, he recounts a boyhood spent in 1950s Princeton, New Jersey, poking around the forgotten detritus of an early digital computer in the Institute for Advanced Study (IAS). He gives us, too, the engaging tale of how Hungarian mathematician John von Neumann built a computer at the institute. But this is just one of the origin stories of the digital age. Perhaps, at the time, Princeton seemed to be the centre of the Universe.

The IAS was founded in 1930 by Louis Bamberger, a department-store magnate who cashed out just before the Great Depression. Dyson relates how its first director, Abraham Flexner, decided to focus on mathematics and theoretical physics at a historic moment, when pre-eminent Europeans such as Kurt Gödel, Albert Einstein and von Neumann were moving to the United States. Princeton became a clearing house for Jewish scientists, with IAS mathematicians and physicists housed in Princeton University's Fine Hall for the first years of the IAS's existence.

To this intellectual crucible came Alan Turing, an English graduate student who had solved the 'decision problem' set out in 1928 by David Hilbert, a mathematician at the University of Göttingen in Germany. In 1931, Gödel's incompleteness theorems had ended Hilbert's decades-long quest for a logically complete and consistent arithmetic, and by 1936 Turing and Princeton University mathematician Alonzo Church had independently proved that there were numbers that could be specified but never calculated. Church recognized Turing's paper to be, remarkably, more general than his own, and invited the young man to study at Princeton for two years. In tackling the problem, Turing had created a hypothetical machine that could compute anything that could be computed. This device, later named the Turing machine, became a central conceptual model for computing. Turing's 1936 paper *On Computable Numbers* was consulted so often that Princeton's copy fell apart.

Although Dyson's title anticipates the Turing centennial this June, the book revolves around von Neumann. Dyson says little about their direct interactions; von Neumann admired Turing's work sufficiently to offer him a fellowship at Princeton in 1938, but Turing returned to England. Also left offstage is Turing's wartime work on code-breaking and early computing, which brought him substantial fame beyond mathematics.

Instead, *Turing's Cathedral* relates von Neumann's effort to build an early electronic digital computer. Dyson's account, based on the IAS archives and access to oral histories from von Neumann's family and many close

Turing's Cathedral: The Origins of the Digital Universe
GEORGE DYSON
Pantheon/Allen Lane: 2012. 432 pp. $29.95/£25

TURING AT 100
A legacy that spans science:
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colleagues, is compelling. Much of the story is known, but Dyson devotes attention to the phenomenal physical task involved: getting thousands of vacuum tubes to behave and keeping cooling units from icing over, the responsibility of chief engineer Julian Bigelow.

Dyson also emphasizes von Neumann's position in the top-secret US military research community, from the Manhattan Project onwards. He suggests that von Neumann's work on meteorology "offered both a real problem and a perfect cover for the work on bombs". Handwritten computer logs pinpoint midnight runs of weather-forecasting and weapons-designing computer code.

The military funded more than three-quarters of the IAS computer project. Alarmed by such traffic with the real world, IAS scholars relegated the computer engineers to the basement of the mathematics department, next to the men's toilets.

The heyday of the IAS machine was brief: from 1951, when it became operational, to 1954, when von Neumann left for a board position with the US Atomic Energy Commission. He died three years later, aged 53.

The book evokes vivid details of life in Princeton and the personalities of von Neumann and his colleagues, including Willis Ware, Gerald Estrin, Arthur Burks and Herman Goldstine, who between them helped to create much of computer science. But the spotlight on von Neumann will infuriate many students of these complex years.

Dyson overlooks the computing efforts across the Atlantic at the University of Manchester, UK, where a 'stored-program computer' was in operation at least three years before the IAS machine; he also neglects the original programming at the University of Cambridge, UK. Genetic metaphors mislead when he describes a generation of computers as clones of the IAS machine. And Dyson, who covered much of this terrain in his *Darwin Among the Machines* (Basic Books, 1998), over-reaches in asserting that "the entire digital universe ... came into existence in 1951 ... at the end of [Princeton's] Olden Lane".

A balanced account could not ignore William Aspray's *John von Neumann and the Origins of Modern Computing* (MIT Press, 1990), and would fully use Andrew Hodges' insightful biography, *Alan Turing: The Enigma* (Burnett Books, 1983). Turing and Church's early work on logic is documented well in Charles Petzold's compelling *The Annotated Turing* (Wiley, 2008).

Read this book for its memorably told stories of the famous Princeton crowd. But beware its flights of fancy. ∎

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Books in brief

The Righteous Mind: Why Good People are Divided by Politics and Religion
*Jonathan Haidt* ALLEN LANE *448 pp. £20 (2012)*
Morality, above all else, is behind human success, says psychologist Jonathan Haidt. But why do individuals and societies disagree so violently about what morality is? The answer, he says, is that humans are tribal creatures, with minds designed for "groupish righteousness". Haidt discusses how morals arise from intuitions, not reason, and how this leads to both nobility and hypocrisy. He argues that right-wing politicians have a built-in advantage when they appeal to those intuitions by invoking liberty, loyalty and sanctity.
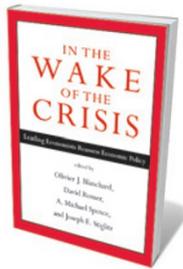
In the Wake of the Crisis: Leading Economists Reassess Economic Policy
Edited by Olivier J. Blanchard, David Romer, A. Michael Spence and Joseph E. Stiglitz MIT PRESS *174 pp. £13.95 (2012)*
Why did the global economy melt down in 2008? And how can it be fixed? Here, 23 economists, including three Nobel prizewinners, seek the causes of the crash and the feeble recovery, and suggest policy responses. They focus on macroeconomic issues such as the control of inflation and financial-sector regulation. The hunt for an answer will take years, says Olivier Blanchard, chief economist at the International Monetary Fund, but it is clear that we are in a "brave new world".
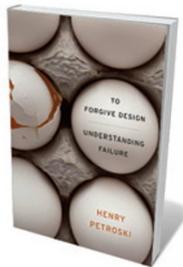
To Forgive Design: Understanding Failure
Henry Petroski BELKNAP PRESS *408 pp. $27.95 (2012)*
When a plane crashes or a bridge collapses, faulty engineering is the usual suspect. But in seeking the roots of failure, we should look beyond design, says engineer Henry Petroski. We must probe the political and economic imperatives that shape purposes and use. In this follow-up to his influential *To Engineer is Human* (Vintage, 1985), Petroski argues that accidents such as the Deepwater Horizon oil spill are the result of faults as much in "human machinery" as in mechanical devices. He praises software developers for learning from structural engineering about how to report and analyse mishaps.
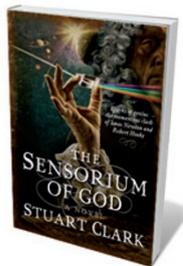
The Sensorium of God: A Novel
Stuart Clark POLYGON *272 pp. £12.99 (2012)*
In 1679, astronomer Edmond Halley seeks out Isaac Newton to help him decipher planetary motion. But the great physicist has less lofty preoccupations: natural philosopher Robert Hooke is demanding recognition for ideas that Newton has passed off as his own. Stuart Clark's novel, the second in a projected trilogy about the giants of physics and astronomy — the first, *The Sky's Dark Labyrinth* (Polygon, 2011), starred Tycho Brahe and Johannes Kepler — sets collaborations and disputes in Britain's Glorious Revolution of 1688. The supporting cast includes John Locke and Robert Boyle.

American Genesis: The Evolution Controversies from Scopes to Creation Science
Jeffrey P. Moran OXFORD UNIVERSITY PRESS *216 pp. $29.95 (2012)*
When historian Jeffrey Moran began teaching in Kansas in 1998, he thought the 1925 Scopes 'monkey trial', in which a Tennessee teacher was prosecuted for teaching evolution, was a curiosity. Yet in 1999, his state's education board removed evolution from its curriculum. Moran discusses how US anti-evolutionism has persisted. Attitudes towards evolution touch on every point of social friction, he says, including gender, race and the North–South divide.