BOOKS & ARTS

Keeping up scientific standards

A journalistic account of the case of data manipulation by physicist Jan Hendrik Schön is rich in detail but draws the wrong conclusions about the self-correcting processes of science, argues **Martin Blume.**

Plastic Fantastic: How the Biggest Fraud in Physics Shook the Scientific World
by Eugenie Samuel Reich
Palgrave Macmillan: 2009.
272 pp. £15.99, $26.95

BELL LABORATORIES

Jan Hendrik Schön's case raised the need to educate researchers about ethics.

Jan Hendrik Schön first came to New Jersey's Bell Laboratories from his doctoral work at the University of Konstanz, Germany, as an intern in 1997. A year later he became a postdoc and staff member. Over the next few years he published apparently groundbreaking research in materials science. His results appeared in major research journals, and his co-authors and supervisors included highly respected researchers. Scientists worldwide tried to replicate his findings — but were unable to do so. Mounting complaints about inconsistencies in his work led to allegations of scientific misconduct being made against Schön. He was investigated by the management at Bell Labs, first internally and then by a select external committee in 2002. This committee found compelling evidence of manipulation and misrepresentation of data. Schön was fired from his position and has not worked visibly in research since.

Journalist Eugenie Samuel Reich pursues this affair in depth in *Plastic Fantastic*. Holder of a bachelor's degree in physics and philosophy from the University of Oxford, UK, Reich is fascinated by scientific conduct. Her investigation is the result of several years of research, during which she interviewed 125 individuals who interacted with Schön, attended meetings and visited the laboratories where attempts were made to replicate his 'discoveries'.

> "The possibility of scientific misconduct cannot be eradicated."

The introduction and first chapter can be understood by any reader. Reich explains the strange title of the book — "plastic fantastic" was a phrase used by the media to describe Schön's claims of finding superconductivity in a plastic material, and it played into her quest to contact him. She discusses how her interest in the story arose from her reading of "the most riveting piece of technical writing I have ever come across" — namely the final investigation report into Schön's conduct by the external committee chaired by Malcolm Beasley, a physics professor at Stanford University in California.

Later chapters of the book place Schön's work in context; basic research at Bell Labs was in decline at that time because of restructuring, and its researchers were under pressure. Reich also focuses on the peer-review process at the journals *Science* and *Nature*, in which Schön published many prominent articles. She describes the science behind the recondite fields in which Schön worked, including 'MOSFET' electronic chips and superconductivity in plastics. Here the writing becomes too technical and the book's layout, with some 200 footnotes, distracting. Surprisingly there are no acknowledgements. Although some interviewees are mentioned, we do not learn which experts' views contributed the most. Nevertheless, the book will interest physicists and materials scientists working in related fields, and those who strive to prevent scientific misconduct.

Reich does an excellent job of dealing with the facts of the Schön case, but less well with their interpretation. She tends to describe issues in black-and-white terms and uses strident language unnecessarily. An acerbic tone creeps into judgements of the individuals involved, such as one editor being "opinionated", and this distracts from her central points.

More important is Reich's conclusion that the self-correction process of science failed in this case and should not be trusted: "It seems like little more than blind faith to insist that all activity carried out in the name of science will always be self-correcting." Yet Reich doesn't say where this assumption comes from. No scientist who has thought about how science works would "insist" on this; nor can it "always" be true. It is likely that fabrication of data in a significant discovery will be uncovered because close attention will be paid to it. But fabricated data in a more obscure article may not be corrected.

Reich understands how data fabrication may arise. She admits that she made up experimental data while a student working as a research assistant. Seeing a pattern emerging in her measurements, she entered values that fitted a trend rather than recording objectively what she saw. Her supervisor did not notice. Reich remarks that she had not been educated on the sanctity of data beforehand, only realizing its importance after recalling the incident when writing this book. Harm might have been done if she had missed a change in the pattern that signalled a new discovery. This example of a student seeking the expected answer rather than new clues shows how important it is to educate researchers. Reich's late recognition of this issue should also have made her pause before drawing strong conclusions on the processes of science.

Although the detection of data fabrication is not inevitable, we can increase the probability of detection by remaining vigilant at each stage in the scientific process. Steps include attempting to replicate important results and encouraging the alertness of managers, journal editors and referees, and of knowledgeable scientists who read and evaluate publications. In the Schön case, two scientists in particular played a key part — Paul McEuen of Cornell University, New York, and Lydia Sohn, then of Princeton University, New Jersey. Combing through Schön's papers, they found inconsistent and repeated figures that pointed to serious problems, which were brought to the attention of Bell management. Reich sees the need of individuals to intervene as illustrating science's failure to cope with misconduct; but their vigilance is part of the correction process, which culminated in the Beasley report that Reich so admires.

The problems with Schön's work should have been detected earlier. Although his co-authors

NATURE|Vol 459|4 June 2009

and supervisors were all cleared of misconduct in the final report, they could have been more curious about his results. Similarly, when Schön applied for patents, he was not required to show or have others sign his laboratory notebook — his use of which is questionable.

It must also be noted that an accusation of misconduct is not a finding. And an incorrect or false accusation can ruin reputations or destroy careers, even if the accusation is later recognized as wrong. This puts a burden on institutions that requires thought and investigation before public disclosure, which slows the process.

Reich opines that the memory of this particular affair will fade. But the possibility of scientific misconduct cannot be eradicated. Many people are involved in educating scientists at all stages of their careers to keep the possibility of scientific fraud, plagiarism, conflict of interest and other unethical behaviour before them. For example, at a 2003 workshop that I convened in London, more than 70 international participants, including publishers, editors and working scientists, discussed aspects of unethical behaviour, as well as the Schön affair. The result was a set of guidelines that was adopted, after minor modification, by the council of the International Union of Pure and Applied Physics (see http://tinyurl.com/iupap-ethics).

Scientific associations, such as the American Physical Society (APS) and the Council of Science Editors, have developed and updated codes of behaviour and educational programmes before and since this landmark case. The APS policy (http://tinyurl.com/aps-policy) includes a report on ethics education, which is vital to define and promote ethical behaviour by all scientists. Reich herself references the Beasley report using a link on the website of the APS. I was responsible for posting it there, with permission from Bell Labs' owners Lucent Technologies, following the retraction of six articles co-authored by Schön in the APS journals for which I was then editor-in-chief. It is fortunate that this stable link keeps the report accessible years later (see http://publish.aps.org/reports).

The prevention and uncovering of scientific misconduct requires vigilance, education and humility on the part of scientists, managers, editors, journals and journalists to maximize the probability of correction. In the Schön affair, several of these elements combined to raise that probability enough so that correction occurred. It is unfortunate that Reich did not draw fairer conclusions, despite her hard work in reporting the facts. ■

Martin Blume is editor-in-chief emeritus at the American Physical Society and senior physicist emeritus at Brookhaven National Laboratory, Upton, New York, USA.
e-mail: blume@post.harvard.edu

F. SOLTAN/SYGMA/CORBIS

An Indian history of numbers

Mathematics In India
by Kim Plofker
Princeton University Press: 2009. 394 pp. £28.95

In a world divided by culture, politics, religion and race, it is a relief to know one thing that stands above them — mathematics. The diversity among today's mathematicians shows that it scarcely matters who invents concepts or proves theorems; cold logic is immune to prejudice, whim and historical accident. And yet, throughout history, different families of humans have distilled the essence of the cosmos to capture the magic of numbers in many ways.

Mathematics in India shows just how different one of these ways was, and how culture and mathematical development are intimately connected. This carefully researched chronicle of the principal contributions made by a great civilization covers the earliest days of Indian history through to the beginning of the modern period. Regrettably, it stops short of the legendary mathematician Srinivasa Ramanujan (born 1887), whose name is still seen in today's research papers.

Kim Plofker's book fulfils an important need in a world where mathematical historiography has been shaped by the dominance of the Greco-Christian view and the Enlightenment period. Too little has been written on the mathematical contributions of other cultures. One reason for the neglect of Indian mathematics was Eurocentrism — British colonial historians paid it little attention, assuming that Indians had been too preoccupied with spiritual matters to make significant contributions to the exact sciences. Another reason is that many ancient Indian mathematical texts have long been extinct; often, the only indication that they existed comes from scholars who refer to the work of their predecessors. As Plofker wryly notes, two historians of Indian maths recently published articles in the same edited volume, wherein the estimates of their subject's origins differed by about 2,000 years.

Still, surviving Sanskrit texts reveal a rich tradition of Indian mathematical discoveries lasting more than 2,500 years. In the Early Vedic period (1200–600 BC), a decimal system of numbers was already established in India, together with rules for arithmetical operations (*ganita*) and geometry (*rekha-ganita*). These were encoded in a complex system of chants, prayers, hymns, curses, charms and other religious rituals. Cryptic phrases called *sutras* contained arithmetical rules for activities such as laying out a temple or arranging a sequence of sacrificial fires.

Large numbers held immense fascination. Acclamations of praise to the air, sky, times of day or heavenly bodies were expressed in powers of ten that went to a trillion or more. Reputedly, the young Prince Buddha successfully competed for the hand of Princess Gopa by reciting a number table that included names for the powers of ten beyond the twentieth decimal place.

As in other early agricultural civilizations, Indian mathematics probably emerged in forensic photography does not lend itself to fame. As legal evidence, the photographs that Reiss took in the service of the law would have fallen foul of that same law had they been published at the time, and until now the images in this exhibition have remained inaccessible to the public. Now, the authorities have decided to release them, even though a grandchild of one of the victims — or of one of the perpetrators — could still wander innocently into the exhibition and have a fright.

Seeing the photos alongside Reiss's notes — on the importance of recording the precise position of the corpse, for example, or on people's susceptibility to autosuggestion when it comes to judging physical resemblance — you are struck by how modern his thinking was. At the time, when the science of photography was still developing, many of the Swiss houses to which he was called had no electricity. A section on the usefulness of tattoos in identification is a powerful reminder of this contrast: the naked torsoes of ex-soldiers are photographed decorated with Edwardian ladies sporting wide-brimmed hats, fully clothed and revealed only from the neck up.

Rodolphe Reiss pioneered the use of forensic photography for recording crime scenes in the early 1900s.

The methods for reading a crime scene may have evolved since Reiss's time, but the reasons for committing murder and the information contained in those scenes have not. Were Reiss to come back to life today, he would no doubt quickly find his feet in any forensic laboratory. ■

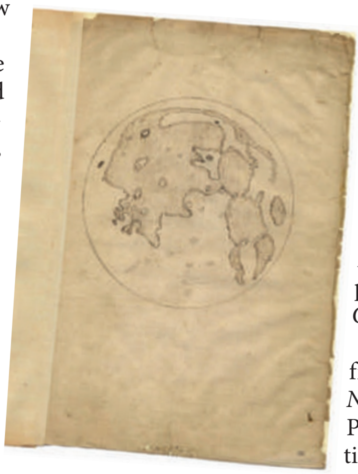
Laura Spinney is a writer based in Lausanne, Switzerland.

Earliest sketches of the Moon

Cosmos and Culture: How Astronomy Has Shaped Our World
Science Museum, London
Until 30 December 2010

Amid the commemoration of the Apollo landings, another lunar anniversary has just passed quietly. Four centuries ago, on 26 July 1609, the English scholar Thomas Harriot pointed his recently acquired 'Dutch trunke' at the Moon and drew what he saw.

He thus became the first person to record astronomical observations through a telescope, a few months before Galileo Galilei did the same. But unlike Galileo, who was struggling to feed a family on a lecturer's salary and angling for the patronage of the Medicis, Harriot had made his fortune and had no need of fame. He was already a distinguished mathematician — a renowned algebraist who had corresponded with Johannes Kepler on the physics of rainbows and who had produced a body of work on the physics of motion.


LORD EGREMONT/WEST SUSSEX RECORD OFFICE
Thomas Harriot's magnified map of the Moon.

By 1609 Harriot had other reasons to avoid the limelight. His patron, Henry Percy, Earl of Northumberland, was a cousin of one of the gunpowder plotters who had sought to blow up the English Parliament in 1605, and Harriot himself was imprisoned and interrogated for his connection. His papers were lost after his death in 1621 and not rediscovered until 1784, still at Percy's estate. So he remains little known.

Two of Harriot's drawings of the Moon, one of which shows its seas and craters, plus his notes on the moons of Jupiter, are on display in London's Science Museum until the end of 2010 as part of the exhibition *Cosmos and Culture*.

They are accompanied by a first edition of Galileo's *Sidereus Nuncius* of 1610, a 1496 edition of Ptolemy's *Almagest* and first editions of Nicolaus Copernicus's *De Revolutionibus Celestium Orbum* (1543), Kepler's *Astronomia Nova* (1609) and Isaac Newton's *Principia* (1687). Other highlights include Chinese astrological figurines, made during the Tang dynasty in the first millennium BC, and the 2-metre-long telescope through which William Herschel discovered the planet Uranus in 1781.

The exhibition's subtitle is 'How Astronomy Has Shaped Our World'. But any compelling stories that could be told about the way that astronomy forges links between artisan and genius, amateur and professional, royal patron and government agency or pure science and popular culture are lost here through poor display. The fine Harriot drawings cannot be viewed close up, and labels are provided through a touch-screen display that is situated far from the pieces it describes.

Because everything is thrown together in an arbitrary fashion — those mighty books rub shoulders with a pile of sci-fi paperbacks, and the Tang-dynasty figures sit near an astronomical edition of the board game Monopoly — this exhibition is both a must-see and a missed opportunity. ■

John Whitfield is a writer based in London.
e-mail: ja_whitfield@hotmail.com

Correction
In the book review 'Keeping up scientific standards' by Martin Blume (*Nature* **459**, 645–646; 2009), we inadvertently omitted the author's declaration of competing interests, submitted before he was engaged to write the review. This has been restored online at http://tinyurl.com/mwserz.