

No 44

October 2004

Education Forum

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Editorial

For those readers who are teachers, the new academic year provides another fresh start for the introduction of the history of science into your teaching. For those in informal education, in museums and science centres, there is a chance to revitalise the way the history of science is incorporated into activities for your visitors. For those of you who are retired, there is the chance to start a new project to bring the history of science to others. Whatever your station in life, the BSHS education committee would be pleased to hear from you about your activities. As editor of Education Forum, I would be pleased to both publish accounts of your past efforts and advertise future ones. Keep in touch.

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Articles

Poems of Science

John Cartwright

John Milton (1608-74) and Paradise Lost

According to a variety of surveys of secondary school exam howlers in both the UK and the USA a common reference to Milton runs something like "Milton wrote Paradise Lost, then his wife died and he wrote Paradise Regained". But although Milton's first marriage was indeed unhappy, the dates of composition don't quite tie up to lend any credence to this rather cruel and sexist pun.

What is more certain is that Milton was one of a number of central figures in the mid-seventeenth century debates concerning forms of government and the role of the monarchy in England. For one of these figures, Thomas Hobbes, only a powerful central state (the Leviathan) could ensure that man did not revert to his natural state of egoism and competitive selfishness. In contrast to Hobbes' atheism and materialism, Milton restated the doctrine of the Fall: it was disobedience to God that led to the fall of both Satan and Adam, but ultimately man could find redemption in Christ. It is his theological outlook that explains his treatment of science.

From an early age Milton seemed conscious that he was destined to become a poet and he prepared himself for his vocation. Milton graduated from Cambridge in 1632 and returned to his father's house in Buckinghamshire to continue his long programme of self-study. In 1638 Milton left for a European tour to complete his education in the traditional gentlemanly fashion. He travelled through France, on to Italy, and returned after 15 months in 1639. During his travels, he met a number of important European scholars including Galileo. Milton recorded his meeting with

Galileo, then nearly blind and under house arrest near Florence, in his *Areopagitica* (1644), a pamphlet championing freedom of the press:

“There it was that I found and visited the famous Galileo grown old, a prisoner to the Inquisition, for thinking in astronomy otherwise than the Franciscan and Dominican licensers thought”

Milton was obviously aware of the political significance of Galileo’s imprisonment and also understood the scientific importance of his work. There is a reference, for example, to Galileo’s use of the telescope in *Paradise Lost* as part of a description of the moon (Book I, l.287-9). The importance of Galileo for Milton, however, is not that a great scientist had made a major step in understanding the real structure of the universe, but rather that here was a martyr in the cause for free speech and thought against religious and political dogma.

Similarly, is Milton’s Puritan conscience that determined his treatment of science in *Paradise Lost* (1667). Milton began his great epic around 1658, but from the start he faced an almost insoluble cosmological dilemma. By the middle of the seventeenth century most intellectuals were coming round to accept that the Copernican hypothesis did accord with reality and that the earth really did revolve on its axis in orbit around the sun in a heliocentric universe. But Milton was composing a religious story: the rebellion of Satan, the fall of man, the expulsion from Eden and the hope of salvation through Christ. His ambitious intention was, as he said at the start of *Paradise Lost*, to “assert eternal Providence/ And justify the ways of God to man” (Book I, l 25). For this purpose, the medieval view of the cosmos - the package deal of a fallen world at the centre of a closed finite universe that was theologically, metaphysically and scientifically consistent - was obviously more conducive to his artistic intentions. Milton’s dilemma then was this: to accept the views of the astronomers and so find new ways of imaginatively adapting the Christian story to a heliocentric universe, thereby possibly alienating some of his readers who may not yet have accepted Copernicanism; or to frame his poem in a Ptolemaic setting and risk the whole work looking archaic and medieval. His solution, which was not altogether satisfactory, was to keep the Ptolemaic framework but update it aesthetically by conveying the vastness of space that the new cosmology entailed. As a further prop to his archaic structure, he inserted a section arguing that cosmological theories and disputations are not that important anyway.

It is in Book VIII where rival cosmologies are discussed. Here Adam quizzes Raphael, an angel sent down to Eden to warn Adam that Satan is on the loose, about the motion of celestial objects. Adam wonders why the earth remains stationary, with everything revolving around it, when, given the enormous distances to the planets and the stars, this must entail immense speeds of movement to enable them

to complete their diurnal rotations. Adam suggests that moving the earth would have been a much simpler solution to the need to give the earth day and night and the seasons, and wonders why it was created like this (Lines 25-35). Raphael replies that he does not blame Adam for asking such questions but suggests that Adam should not trouble himself with such thoughts and should content himself with admiring the handiwork of “the great Architect” (lines 70-73).

In the next passage Milton may reveal his impatience with the complexities of Ptolemaic astronomy since the Creator looks on with amusement at the disputations of the astronomers and their efforts to “build, unbuild, contrive,/To save appearances” (lines 77-84). Raphael then describes the Copernican system: “What if the sun/ Be center to the world..and other stars,..dance around him”, but tells Adam not to trouble his thoughts “with matters hid” and asserts that “heav’n is for thee too high” (lines 160-172). Faced with this put down, Adam gives up and accepts that he really ought only to seek useful knowledge.

Book VIII of Paradise Lost is virtually the only place in any of Milton’s works where he confronts Copernican cosmology, and here only to dismiss it. Milton does, however, exploit aesthetically the enormity of the universe that the new cosmology required. The universe in Paradise Lost is not infinite – in the poem God marks it out with a pair of compasses- but it stretches across a canvass of space never before seen in literature. Unlike Dante, for whom Hell was the frozen centre of the earth, Milton placed hell outside the earth but when Satan looks down from its gates the earth is not even visible. Instead he sees

“a dark/Ilimitable Ocean, without bound/
Without dimensions, where length, breadth, and highth
And time and place are lost” .

When Raphael flies from heaven to earth (and Raphael tells Adam that he is not slow) it takes him all morning, a “distance inexpressible/By numbers that have name”(VIII, l. 113). Even Adam knows that in comparison to the universe the earth is tiny: “this earth a spot, a grain,/ An atom, with the firmament compared”(VIII, l. 18). Hence when Mammon, one of the rebel angels siding with Satan, falls from heaven, his trajectory is dramatic:

“..from morn
To noon he fell, from noon to dewy eve,
A summer’s day; and with the setting sun
Dropt from the Zenith like a falling star” (Book I, l. 742-745)

Yet intellectually the compromise that Milton aims to achieve between the old and new frameworks is surely unconvincing. A digression telling Adam not to meddle and to be “lowly wise” does nothing to further his overall narrative purpose. The journeys in space taken by Satan and the other angels are breathtaking but ironically only conceivable in the light of the new astronomy - the main conclusion of which (heliocentrism) Milton rejects. In short, Milton’s poetic use of astronomy is inconsistent with the world picture he adopts to frame his epic. In Book VII, for example, where Milton describes the creation of the world, he notes how the sun acts as a source of light for the moon and the other planets. In passing, he incorporates Galileo’s discovery of the phases of Venus: “And hence the morning planet gilds her horns” (VII, l.366). The term “horns” of Venus (the morning planet because it is often seen in the morning in the eastern sky before daybreak) refers to the crescent shape that Galileo observed through his telescope. Like the moon, the planet Venus passes through phases, but the phases observed are impossible in an Aristotelian or Ptolemaic framework. (In these Venus should never appear more than a very thin crescent. When in 1610 Galileo showed that Venus passes through a variety of phases it meant that the Aristotelian and Ptolemaic systems were untenable)

Overall, in contemplating Milton’s treatment of science, one is tempted to agree with A.E. Houseman who, writing 300 years later on the subject of food and drink, observed:

“Oh many a peer of England brews
Livelier liquor than the Muse,
And malt does more than Milton can
To justify God’s ways to man” (A Shropshire Lad, LXII, Collected Poems)

The Text: Paradise Lost Book VIII Lines 15 – 178.

To assist reading the names of the speakers have been inserted thus (Adam:)

(Adam:) When I behold this goodly frame, this World,
Of Heaven and Earth consisting, and compute
Their magnitudes - this Earth, a spot, a grain,
An atom, with the Firmament compared
And all her numbered stars, that seem to rowl
Spaces incomprehensible (for such
Their distance argues, and their swift return
Diurnal) merely to officiate light
Round this opacous Earth, this punctual spot,
One day and night, in all their vast survey
Useless besides - reasoning, I oft admire

How Nature, wise and frugal, could commit
Such disproportions, with superfluous hand
So many nobler bodies to create,
Greater so manifold, to this one use,
For aught appears, and on their Orbs impose
Such restless revolution day by day
Repeated, while the sedentary Earth,
That better might with far less compass move,
Served by more noble than herself, attains
Her end without least motion, and receives,
As tribute, such a sumless journey brought
Of incorporeal speed her warmth and light:
Speed, to describe whose swiftness number fails."

So spake our Sire, and by his countenance seemed
Entering on studious thoughts abstruse; which Eve
Perceiving, where, she sat retired in sight,
With lowliness majestic from her seat,
And grace that won who saw to wish her stay,
Rose, and went forth among her fruits and flowers,
To visit how they prospered, bud and bloom,
Her nursery; they at her coming sprung,
And, touched by her fair tendance, gladlier grew.
Yet went she not as not with such discourse
Delighted, or not capable her ear
Of what was high. Such pleasure she reserved,
Adam relating, she sole auditress;
Her husband the relater she preferred
Before the Angel, and of him to ask
Chose rather; he, she knew, would intermix
Grateful digressions, and solve high dispute
With conjugal caresses: from his lip
Not words alone pleased her. Oh, when meet now
Such pairs, in love and mutual honour joined?
With goddess - like demeanour forth she went,
Not unattended; for on her as Queen
A pomp of winning Graces waited still,
And from about her shot darts of desire
Into all eyes, to wish her still in sight.
And Raphael now to Adam's doubt proposed
Benevolent and facile thus replied: -

(Raphael:) "To ask or search I blame thee not; for Heaven
Is as the Book of God before thee set,
Wherein to read his wondrous works, and learn
His seasons, hours, or days, or months, or years.
This to attain, whether Heaven move or Earth
Imports not, if thou reckon right; the rest
From Man or Angel the great Architect
Did wisely to conceal, and not divulge
His secrets, to be scanned by them who ought
Rather admire. Or, if they list to try
Conjecture, he his fabric of the Heavens
Hath left to their disputes - perhaps to move
His laughter at their quaint opinions wide
Hereafter, when they come to model Heaven,
And calculate the stars; how they will wield
The mighty frame; how build, unbuild, contrive
To save appearances; how gird the Sphere
With Centric and Eccentric scribbled o'er,
Cycle and Epicycle, orb in orb.
Already by thy reasoning this I guess,
Who art to lead thy offspring, and supposest
That bodies bright and greater should not serve
The less not bright, nor Heaven such journeys run,
Earth sitting still, when she alone receives
The benefit. Consider, first, that great
Or bright infers not excellence. The Earth,
Though, in comparison of Heaven, so small,
Nor glistening, may of solid good contain
More plenty than the Sun that barren shines,
Whose virtue on itself works no effect,
But in the fruitful Earth; there first received,
His beams, unactive else, their vigour find.
Yet not to Earth are those bright luminaries
Officious, but to thee, Earth's habitant.
And, for the Heaven's wide circuit, let it speak
The Maker's high magnificence, who built
So spacious, and his line stretched out so far,
That Man may know he dwells not in his own -
An edifice too large for him to fill,
Lodged in a small partition, and the rest
Ordained for uses to his Lord best known.
The swiftness of those Circles at'tribute,

Though numberless, to his Omnipotence,
That to corporeal substances could add
Speed almost spiritual. Me thou think'st not slow,
Who since the morning - hour set out from Heaven
Where God resides, and ere mid - day arrived
In Eden - distance inexpressible
By numbers that have name. But this I urge,
Admitting motion in the Heavens, to shew
Invalid that which thee to doubt it moved;
Not that I so affirm, though so it seem
To thee who hast thy dwelling here on Earth.
God, to remove his ways from human sense,
Placed Heaven from Earth so far, that earthly sight,
If it presume, might err in things too high,
And no advantage gain. What if the Sun
Be centre to the World, and other Stars,
By his attractive virtue and their own
Incited, dance about him various rounds?
Their wandering course, now high, now low, then hid,
Progressive, retrograde, or standing still,
In six thou seest; and what if, seventh to these
The planet Earth, so steadfast though she seem,
Insensibly three different motions move?
Which else to several spheres thou must ascribe,
Moved contrary with thwart obliquities,
Or save the Sun his labour, and that swift
Nocturnal and diurnal rhomb supposed,
Invisible else above all stars, the wheel
Of Day and Night; which needs not they belief,
If Earth, industrious of herself, fetch Day,
Travelling east, and with her part averse
From the Sun's beam meet Night, her other part
Still luminous by his ray. What if that light,
Sent from her through the wide transpicuous air,
To the terrestrial Moon to be as a star,
Enlightening her by day, as she by night
This Earth - reciprocal, if land be there,
Fields and inhabitants? Her spots thou seest
As clouds, and clouds may rain, and rain produce
Fruits in her softened soil, for some to eat
Allotted there; and other Suns, perhaps,
With their attendant Moons, thou wilt descry,

Communicating male and female light -
Which to great sexes animate the World,
Stored in each Orb perhaps with some that live.
For such vast room in Nature unpossessed
By living soul, desert and desolate,
Only to shine, yet scarce to con'tribute
Each Orb a glimpse of light, conveyed so far
Down to this habitable, which returns
Light back to them, is obvious to dispute.
But whether thus these things, or whether not -
Whether the Sun, predominant in heaven,
Rise on the Earth, or Earth rise on the Sun;
He from the east his flaming road begin,
Or she from west her silent course advance
With inoffensive pace that spinning sleeps
On her soft axle, while she paces even,
And bears thee soft with the smooth air along -
Solicit not thy thoughts with matters hid:
Leave them to God above; him serve and fear.
Of other creatures as him pleases best,
Wherever placed, let him dispose; joy thou
In what he gives to thee, this Paradise
And thy fair Eve; Heaven is for thee too high
To know what passes there. Be lowly wise;
Think only what concerns thee and thy being;
Dream not to other worlds, what creatures there
Live, in what state, condition, or degreed-
Contented that thus far hath been revealed
Not of Earth only, but of highest Heaven."

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Outreach at CHSTM in Manchester

Emm Barnes and Angela Cassidy

This year, the Wellcome Trust have funded a new three-year post in History of Medicine Outreach at the Centre for History of Science, Technology and Medicine at Manchester University, filled by Dr Emm Barnes. We aim to stimulate interest in and increase understanding of the development of science, technology and medicine through engaging audiences in explorations of their histories. Since starting in 2003, Emm has instituted a wide range of activities, drawing in the help of both staff and students at CHSTM, alongside external bodies such as exam boards and museums in the North West. Outreach is not something to be delegated to one member of staff, but a commitment from a research body and professional group. We would also like to encourage more historians of HSTM to try and reach non-professional audiences, both adults and children. Although this kind of work may seem daunting to academic historians, we should remember that many of us have extensive teaching experience with non-specialist undergraduates, and of writing pieces for scientific or medical societies, which necessarily are more populist in tone.

See our website <http://www.chstm.man.ac.uk/outreach.htm> for outreach news and links to partner organisations.

HSTM and Education

At present, there are some excellent opportunities available to historians of science, technology and medicine, while science education is being re-imagined by the UK government and awarding bodies. It has become obvious to these institutions that a major overhaul in science education is required if Britain is to empower citizens in scientific debate and decision making, and to be able to recruit young adults into training courses for careers in science, technology, engineering, and medicine. Some historians of medicine and science have been preaching the need to teach science in its social context for years. Now that the institutions developing school curricula are listening, it is crucial that we do not step back and leave others to define the content. Since 2000, education post-14 has been changing markedly to include historical and philosophical studies of science and medicine alongside the traditional knowledge-based science teaching specified in more established exam courses. New courses necessitate additional teacher support. Many universities fund departments, which aim to support schoolteachers of science and the humanities.

The AS level in “Science for Public Understanding,” developed by the Nuffield Foundation and The University of York, has been growing in popularity since its inception in 2000. A need has been recognised for more teaching resources to help

science teachers deliver this radically new form of curriculum. To help meet this need, we are creating a series of lesson activity plans, available on our website, and on the course's website at www.scpub.org. We have two of these complete thus far, one exploring the 'precautionary principle' and issues of risk through the case of mobile phones. A second lesson plan addresses the issue of evolution / creationism controversies, which has become of increasing concern in the UK science classroom. As well as providing several suggestions for class activities, the plan provides background information and resources for teachers, exploring the different kinds of evolutionary and creationist positions that people hold. A major aim of this project is to introduce a less confrontational approach to the issue, which can at the same time engage more closely with the issues at hand, and provide reflection upon the nature of science at the same time. The Nuffield/York partnership is also currently engaged in a much larger project, that of revising the GCSE science syllabus. For the latest on this project, see www.21stcenturyscience.org/home/.

We are consulting on the development of a second, and in some ways similar, A/S level in "Perspectives on Science: History, Philosophy, and Ethics of Science," with support from the Royal Society, the British Society for the History of Science, the Leeds Learning and Teaching Support Network, and the Wellcome Trust. We are in discussion with the Schools History Project concerning the possible revision of the specification for their popular GCSE in the history of "Medicine Through Time." It would be marvellous to see the state of humanities education at secondary level receive the same degree of attention and funding as received by science, but until then, the best way to promote the study of history of science, technology and medicine at schools level seems to be through stressing its value in delivering the Science for Citizenship component of the national curriculum.

CHSTM Outreach, Museums and Science Centres

We have a good working relationship with the Eureka! children's museum in Halifax, Yorkshire, since holding our inaugural Outreach event for schools on the 29th and 30th March this year. Over the two days 90 students from science clubs came from the local area to the museum to enjoy a morning of events run by staff and postgraduates from CHSTM. The day was called 'Getting on with Disability', and sessions were designed to raise awareness of disability and to make the children appreciate alternate ways of looking, getting around, communicating and playing.

Activities included introducing children to disability sports through the game of blind football; 'Communicating Without Sound', where they were taught some simple sign language and other ways of passing messages to each other without verbal communication; and 'Design Your Own Body Part', looking at medical prostheses.



*Duncan Wilson
instructing students
in the rudiments of blind football
at the Eureka!
Museum for Children*

In April, the Manchester Science and Industry Museum opened its new 'Manchester Science' Gallery, and we are working with their education group to develop packs for use by school groups visiting the new gallery. Early next year, the People's History Museum in Manchester will be staging a special exhibition, "Occupational Hazards," on the history of occupational health in the UK. We are working with COEH and the museum in the collection of resources for this exhibition, including teaching materials for use by schools when visiting the exhibition.

Other projects

We are supporting moves to set up Junior Café Scientifique in the North of England: www.cafescientifique.org. The existing network of cafés is sponsored by the Wellcome Trust, and is proving very popular. Increasingly school groups are asking for additional events specifically for a young-adult audience. The guiding principles of this project are that schoolchildren should organise these events themselves, and that meetings should take place elsewhere than the classroom, in order that participants get the most out of a café.

We are holding an open day to showcase the Medical Archives project at John Rylands University Library on the 16th October. There will be a demonstration of how to use the new web-based catalogue of documents in the archive, and speakers from the university will be recounting the treasures they have discovered within the archive. We hope this will be of value to retired medical practitioners interested in researching their local antecedents, as well as established historians of medicine.

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Code-breaking and Bletchley Park

Martin Monk

I have to let you into a secret. Gatsby, the Sainsbury Family's Charitable trust - for whom I work – which concerns itself with science, mathematics and technology education, has put money into supporting educational activities at Bletchley Park. Bletchley Park was the site of the British code-breaking operations during the Second World War, a task now taken over by, and housed at, GCHQ in Cheltenham, where my nephew did his industrial placement whilst studying computer sciences at Imperial College London.

Why am I telling you all this? Because at the heart of encipherment and code-breaking, too coldly mathematical by half, lie stories of human hopes, fears, passions and persuasions.

“The Code Book: the secret history of codes and code-breaking” by Simon Singh. Published by Fourth Estate (2000). 402 pages including a Cipher Challenge, appendices, further reading and index. £8-99. ISBN 1-85702-889-9.

Simon Singh starts his book with Mary, Queen of Scots: she of the catholic persuasion. If ever there were a lady caught up in a tangle of human hopes, fears and passions, this is the one. At Mary's trial for treason, evidence of her knowledge and support of a treasonable plot was presented. Amongst the evidence there were enciphered documents. Simon Singh shows us, step by step, how the cold logic of ciphery and code-breaking, is intimately linked to Mary being led to the block and beheaded.

In successive chapters stories of mathematics and probability, chance and history are intertwined in a very readable manner. Occasionally there are show-stoppers which verge on the melodramatic: as when a curtain comes down in the final bars of an opera. Here are some from chapter 4 on Cracking the Enigma.

From there [Paris], on the 16th of August, one of the enigma machines was forwarded to London. It was smuggled across the channel as part of the baggage of the playwright Sacha Guitry and his wife, the actress Yvonne Printemps, so as not to arouse the suspicion of the German spies who would be monitoring the ports. Two weeks later, on the 1st of September, Hitler invaded Poland and the war began.

Page 160.

Over the next two years he [Turing] became severely depressed, [following conviction on a charge of Gross Indecency and having his security clearance revoked] and on 7th June 1954, he went to his bedroom, carrying with him a jar of cyanide solution and an apple. Twenty years earlier he had chanted the rhyme of the Wicked Witch: ‘Dip the apple in the brew, Let the sleeping death seep through.’ Now he was ready to obey her incantation. He dipped the apple in the cyanide and took several bites. At the age of just forty-two, one of the true geniuses of cryptanalysis committed suicide.

Page 189.

Turing, he of the homosexual persuasion, is probably most popularly known through the successful play “Breaking the Code”. The film “Enigma” starring Kate Winslet and Jeremy Northam presents a somewhat wider view of Bletchley Park during the war. On Thursday 10th of June 2004, I attended the opening of a new exhibition wing at Bletchley Park. At the buffet lunch I sat next to people who had worked at Bletchley during the war. I was told the mysterious blond woman - played by Saffron Burrows in the film - was based on fact. People like the blond woman were placed to draw-out any German spy that may have infiltrated the system.

Early on in chapter 5 I read the Americans used Navajo Indians as code talkers during the Pacific campaign. People I have discussed this with have often said, “Of course, didn’t you know that?” No, I didn’t.

Chapter 6, Alice and Bob Go Public, tells the story of public-key cryptography, both in the UK and the USA. Some of that story took place at GCHQ. It turns out that James Ellis, who was employed at GCHQ, worked out how to achieve effective public key cryptography several decades before rival teams of American academics published their solutions. Again, Singh can’t resist the operatic curtain fall. He writes,

On 18 December 1997, Cocks [a GCHQ employee] delivered his talk. After almost three decades of secrecy, Ellis, Cocks and Williamson received the acknowledgement they deserved. Sadly, James Ellis had died just one month earlier on the 25 November 1997, at the age of seventy-three. Page 292.

I am sorry to say my interest waned as I read on through chapters 7 – Pretty Good Privacy, and 8 – A Quantum Leap into the Future. It all got too much for me. Chapter 8 left me in a state of disbelief, as quantum mechanics often does.

This book is a must-read for mathematics teachers. It provides lots of little bits of information that can be used to give mathematics a human face. Certainly the book should be of interest to undergraduates and even A' level students.

“Churchill’s Secret Passion: the OFFICIAL inside story by the people who worked there.” Video produced by Bletchley Park and Exploring Britain Productions (2004). £15-99. Copies from telephoning (00-44) 1908-640404.

I bought this video at the Bletchley Park shop on the day of the June buffet lunch. It covers much the same ground as chapter 4 of Simon Singh’s book. Robert Hardy is the narrator and the presentation has an introduction by HRH the Duke of Kent. It is important to fast-forward through the introduction. There is a similar issue with the end of the tape where Christine Large, the current director of Bletchley Park, talks about the use of Bletchley today. So, having topped and tailed the tape, the bulk of the presentation is clear, straightforward and easy to follow.

People who know of Bletchley Park usually know of the Enigma machine. Few know the Enigma machine was invented by Dutchmen and initially a commercial failure. The German military saw its potential and started to make extensive use of enigma machines before the Second World War. They added extra wheels and plug-boards to achieve even higher security. The idea that the enigma machine was British and decodes encrypted messages is completely wrong.

Encrypted messages had to be decoded with the aid of a codebook that detailed the settings of the wheels and plugs for the day the messages were sent. Each day new settings were used. Without the codebook, each day the code had to be broken yet again. The Poles had been deciphering German enigma messages long before the war.

The British took over the task of regular decoding just as the war started. It was necessary to adopt and expand the Polish decoding machines, called Bombes, so as to decode the German messages. Of course, once decoded, the messages were in German and so linguists and mathematicians worked at Bletcheley cheek by jowl, but in isolation. The isolation was insulation: an attempt to reduce security risks.

What was uniquely British was the making and use of Colossus. Colossus was built by Post Office engineers at the Dollis Hill research station. Colossus was the first fully electronic computer ever built. Colossus was necessary because towards the end of the war the Germans increased the sophistication of the enigma machines by adding yet more wheels and plugs. This meant the number of possible codes increased tremendously. The electro-mechanical Bombes simply couldn’t work fast

enough to break the code within a day, and thereby provide valuable intelligence. The code-breaking had to be done with the higher speeds that could be achieved by a purely electronic machine. What is amazing, is that amidst all this sophistication, German messages to sub-marines still started in the morning with, "This is the weather forecast." Thereby providing the British intelligence at Bletchley with an immediate crib to help break the code faster. But even then, every day of the war, it all started all over again, as the code settings were changed ready for that days new code. It was heroic work in its tediousness.

This video is a fascinating watch and should be of interest to students from Yr 6 upwards. Younger pupils will need to be shown edited clips and talked through some of the ideas. But the history and personal testimony should interest all.

Website: www.bletchleypark.org.uk

If you want to visit Bletchley, or just find out more, then visit the Bletchley web-site. The web-site has pages on the Enigma machines, the shop, historical events throughout the war on a month by month basis, organising a visit pages, kids pages, pages on code-breaking, corporate pages, links to other sites like GCHQ, a press room with latest news and pages on how to get involved and help.

Visiting Bletchley Park

Entry to the site is £10 for adults and £8 for children between 8 and 16. Children under 8 are free. Weekdays the park is open from 9:30 to 18:00. There are 2¹/₂ hour tours of the site starting at 11 am and 2 pm. At the weekend the park is open from 10:30 to 17:00 and there are 1 hour tours every hour. To park your car at the site costs £5 but there is free parking at the Bletchley Park station, which is 5 minutes walk away.

Visit the web-site before you go to get travel directions for car or train travel.

Theatre and Cinema

Breaking the Code: script by Hugh Whitmore and starring Derek Jacobi as Turing.

Enigma: screenplay by Tom Stoppard and starring Dougray Scott, Kate Winslet and Saffron Burrows.

Report

The BSHS annual conference

held at Liverpool Hope University,
Friday June the 25th to Sunday the 27th.

Patrick Gavin

The campus was close to the city centre and was convenient and compact, the accommodation being next to the meeting rooms. 75 attended, 20 from abroad. Most participants were directly involved with Teaching or research in HoS. The Conference commenced at 2pm on Friday and the closing session was at 2pm on Sunday. Saturday afternoon was free and a sight-seeing tour of the Albert Dock area was arranged. Sessions of 2 hours duration, with 4 talks, ran in parallel. Many speakers used Power-Point and the standard of presentation was good.

The education section's day

This year the education session was longer and started at 9.30 am on Friday. This involved staying overnight on Thursday, or making an early start on Friday, and also, unfortunately, missing the other sessions on Friday afternoon.

Peter Fowler (the ed. sec. chair) started the day with the first session. He reported on his own work 'Turning the Heat on HoS' as an example of teaching HoS to gifted and talented pupils at Key Stage 3. Clearly presented details were given of an impressive attempt to introduce an explicit HoS topic. The topic chosen was the interpretation of Heat and Temperature in terms of the Caloric Theory and the Kinetic theory. Peter reported how his students worked in groups on initial ideas, experiments and interpretations. Through the activities pupils are led to see that the Kinetic Theory offers a better explanation of phenomena. A summary of pupils' feedback on their learning experiences, mainly favourable, was given.

John Cartwright led on the second morning session with his presentation of 'Retrospective Nobel Prizes' as an example of teaching HoS in further education. John introduced the booklet he had prepared and used: The Discovery of Oxygen: A students' guide to case studies in a chemical revolution. The interesting and stimulating idea behind this approach is to try to evaluate the claims to priority by different chemists: Hales, Cavendish, Black, Scheele, Priestly and Lavoisier. The booklet gives references and puts the chemical research into historical context.

In an afternoon session, Graeme Gooday led a discussion on 'Teaching History of Technology in Higher Education'. Several teachers from HE reported on their own experiences with programmes of study, which sadly do not enjoy universal popularity amongst undergraduates who are very single minded about their studies. Issues of an established canon, syllabi and examinations were raised and discussed. Points in drawing a distinction between History of Technology and History of Science were also reviewed in discussion. For instance, how much should medicine be viewed as technology. Teaching, using other areas of endeavour for the HoT, were suggested, including warfare, shipping, radio/electricity, nuclear power, and aviation.

It was pleasing that Janet Browne and Peter Bowler (the retiring and present BSHS presidents) were able to attend the education section day. They particularly made informed contributions to our discussion, led by Angel Cassidy, on aspects of the teaching of evolution and biblical fundamentalism.

It is a great pity that there were no local teachers or lecturers from the local universities and teachers' training colleges present or representatives from the science editors of newspapers, radio and television, and indeed more teachers from our own society.

Main sessions

There were 15 sessions, starting with Ancient and Early Modern Science and finishing with Science as Tactics, so that with such a wide variety of titles there was something for everyone. In meetings like this it is always interesting to listen and learn about things one knows little or nothing about. Thus in session 6- Science and Culture, I found Michael Rand Hoare, on Strindberg's Chemistry, and James Kennaway, on aspects of Wagner's music, very interesting and informative.

Sessions 10 and 12 were devoted to 'Evolutionary Thought in Society'. Ken Valente reported on a Victorian clergyman who was also a Mathematician, George Salmon, thereby showing that there were Mathematicians, as well as naturalists, among the clergy.

The Keynote Speaker was Steven Shapin, from Harvard University, who gave a witty lecture on 'A little of what you fancy does you good: the Atkins diet in Cultural Historical Perspective'.

In their presentations several speakers made connections to Irish scientists. Peter Skelton talked on the physicist John Tyndal. Elizabeth Neswald talked on 'The Galway Mechanics Institutes', showing that in Ireland before the famine of 1845,

when the population was about 9 million, there was a lively interest in scientific matters – and not just the Earl of Rosse’s ‘Leviathan’ telescope.

As always, the informal discussions over meals were both interesting and enjoyable and in some ways are the most valuable aspect of attending.

Our thanks must go to Geoff Bunn for organising the conference at his home base, Philip Crane for the attention to detail in the administration and to Peter Fowler for organising the education section day. The publishers Elsevier gave a copy of ‘Endeavour’ to all participants. Unfortunately, as at York, some people had problems with the trains.

Sophie Weeks, Peter Fowler
(ed. sec. chair)
and Graeme Gooday
relaxing between sessions



Behind Steven Shapin’s back
Sandro Caparrini receives the 2003 Slade prize
from Peter Bowler (BSHS president)

News items

Einstein Year

To celebrate Albert Einstein and his achievements, the centenary year of 2005 has been declared the World Year of Physics. To support activities the Institute of Physics is offering awards of up to £1500 through the Einstein Grant Scheme. The closing date for the second round of funding will be 25th February 2005.

Apply now rather than delay and forget. Application forms and further information for funding are now available at www.einsteinyear.org/get_involved/funding . Or, contact Caitlin Watson, the Einstein Year project manager on Caitlin.Watson@iop.org

Wellcome Trust study grants

Wellcome have grants of up to £12,000 for projects that:

- produce a body of work using the Wellcome Library's historical collections;
- communicate ideas about medicine and science to the public;
- stimulate thought and debate about the wider social impact of medicine and science.

Projects must span historical, social, ethical or cultural topics relating to medicine.

Successful applicants will receive:

- £2,000 per month for a minimum of three months and a maximum of 12 months;
- extended access to Wellcome library and collections.

Applications can be made at any time of the year.

Visit <http://library.wellcome.ac.uk/alchemy>

Or contact Sam Cairns 0207-611-8659

e-mail s.cairns@wellcome.ac.uk

Eighth IHPST Group International Conference

The eighth conference of the International History, Philosophy and Science Teaching Group will be held in Leeds, England, July 15-18, 2005. The conference is being held in conjunction with the British History of Science Society conference. Sessions of both conferences will be available to participants, and there will be some shared social events.

Deadline for submission of 500 word Abstracts is the end of January 2005 (email to: ihpst2005@blueyonder.co.uk).

Details about conference can be found at web site: www.ihpst.org, or by contacting the conference secretary, Mick Nott (ihpst2005@blueyonder.co.uk).

Ideas and evidence: science, citizenship and history of the holocaust.

At the Imperial War Museum

A workshop for teachers - and others - on 20th November, from 10.30 until 3pm,

For science teachers with liberal sensibilities the Imperial War Museum (IWM) may not be the first choice for a trip out. However, the IWM is not a place that glorifies war, rather it aims to represent the experiences of all those who were touched by conflict, particularly those of the last century. As such the IWM stands as one of the major museums of social history in the world.

Even a cursory glance around the museum reveals a lot of science. What one sees immediately is the museum's collections, the hardware of war. But these can be only half the story. The other half is the 'software': the ideas that scientists engaged in war work trade in, the ideas, theories, and evidence that sustain their intellectual efforts. This 'software' has to be accessed other than by just looking and touching. It requires discursive activities, either through reading commentaries written by others or talking through ideas with friends and colleagues.

One permanent exhibition at the museum contains artefacts and testimony of survivors of the Holocaust. Paul Salmons is the Education Officer attached to the Holocaust Exhibition at the IWM. Paul has been keen to develop work looking at how racial science in general and social Darwinism in particular, which was by no means peculiar to Germany, underpinned Nazi ideology and how this had been promulgated to the extent that the Holocaust had been allowed to happen.

The workshop day starts off with a presentation, using artefacts and archive material, considering the way in which the imagery of science and the rhetoric of *survival of the fittest* had been used by the Nazis to give a rationality to their politics of hate. The session is interactive and intends to help participants think about the underlying social milieu. The second part of the day is given over to viewing the Holocaust exhibition in a more purposeful way. There will also be time to consider how to use the IWM Holocaust exhibition with your own students and pupils.

If you would like to come along to develop your teaching of biology, ethics, citizenship etc, contact Neil Herrington n.herrington@uel.ac.uk or Paul at psalmons@iwm.org.uk

Reviews

Television programmes

“Pagans: (2) Magic Moments”, presented by Richard Rudgley, directed by Chris Malone and produce by Liz McLeod. Broadcast on Channel 4, Monday 26th of July 9 to 10pm. **Reviewed by Martin Monk.**

When does knowledge and technique take on the appellation of Science? Indeed, can we draw a line between scientific knowledge and non-scientific knowledge? What value do we put upon knowledge held by the ancients? These are questions that were suggested, but not explored at length, by the second programme in the series on Pagans.

The first programme in the series had explored the way Christians had adopted, adapted and rubbished the knowledge of the northern European pagans they sought to convert to Christianity. The second programme, entitled “Magic Moments”, explored Pagan knowledge of metallurgy, astronomy and pharmacy. We were treated to: an explanation of how the Arthurian legend of a future king drawing a sword from a stone may have come about; how much Pagans in northern Germany knew about predicting the solstices, rising and setting points of the sun and moon, changes in season, and cycles of moon and sun juxtapositions across the sky; how those pagans made that knowledge portable as they encoded it on gold covered bronze discs and gold pointed hats; the usual story of how a detailed knowledge of plants led to successful pharmacy; a ‘beserk’ account of how the use of fly-agaric (recognised by its red cap with white excrescences) by shamans may have led to the ho-ho-ho of a father Christmas in red garb trimmed by white fur. I thought it fascinating stuff.

There can be little doubt that ancient pagans knew a lot more about how to negotiate their way through, make use of, and control the properties of the natural world than the average Joe Public would think possible. It is very easy to slip into the onwards and upwards view of knowledge and science itself. The programme sought to show how pagan knowledge was integrated into daily life, rituals, festivals and stories. The presentation suggested knowledge and technique were held/used holistically and how this is no longer the case in modern society. After the programme I mulled over the similarities the programme ignored. Both pre-christian pagans and modern societies equally: held/hold in awe those who can fix things; held/have an uneven social distribution of knowledge and technique; held/have their own rituals of initiation that accompany the passing-on of knowledge and technique; celebrate and blame *cognoscenti*, as events require.

Book reviews

“The Measure of Reality: quantification in Western Europe 1250-1600” by A.W.Crosby. Published by Cambridge University Press (1997). 257 pages. £45, new hardback. £7, second hand from Amazon. ISBN 0521554276.

Reviewed by Patrick Gavin.

In Forum (43) I reviewed ‘The Rise of Early Modern Science’ by Huff, in which stress is laid on the influence of the teaching of Law in Medieval Universities. Mention was made of the work of other authors who have tackled this broad theme such as Hooykaas, Jaki and Chapman. This theme is also the subject of the first Chapter of A.N. Whitehead’s classic of 1925 ‘Science and the Modern World’.

Crosby has come to this topic via his thoughts and writings on European imperialism and its success. The Westerners’ advantage, he proposes, lay at first not precisely in science and technology as such, but in the habits of thought, which were quantitative, so that the pervading “mentalité” was numerate. The flowering of modern science occurred at the same time as the rapid advances in many fields such as commerce and banking, navigation, printing, industry, and military organisation.

About 1300 important changes in “mentalité” arose in Western Europe whereby people perceived time, space and the material environment in a more visual and quantitative way. Crosby embarks on a broad survey, which clearly involved him in reading widely. Notions of time were markedly affected by the introduction of mechanical clocks. Maps, navigation and astronomy disseminated new ways of thinking about space. In Mathematics the vital step in adopting the Hindu-Arabic numerals was generally made by about 1520. Luca Pacioli (a Franciscan) introduced modern methods of bookkeeping.

In discussing visualisation the author refers to Breugel’s “Temperance” and notes that all the characters are doing something visual: measuring, reading, calculating, painting and singing (from scripts). Music developed: timing was made more precise with bars. In Painting Piero della Francesca, influenced by Mathematics, emphasised the principles of perspective. Dürer developed techniques for assisting drawing.

The final word is given to Galileo “ ...a skilled lutenist whose father was a musician and one of the most prominent music theorists of the 16th c”:

“...this grand book, the universe, cannot be understood unless one first learns the language – Mathematics.”

The topic, *The Origins of Modern Science*, is an important and intriguing one and plausible explanations are likely to be multi-faceted. Crosby has provided us with a broad, but detailed, sweep which covers many components which have contributed to the rise of Science.

“Fabulous Science: fact and fiction in the history of scientific discovery.” By John Waller. Published by Oxford University Press (2002). 308 pages with index and notes on sources. £9-99. ISBN 0-19-860939-6. **Reviewed by Martin Monk.**

The fabulous in John Waller’s title is really confabulation. He tries to show us, on a case-by-case basis, how the textbook description of science is a confabulation - a dream, a fantasy – that is a caricature in its simplicity and simple mindedness. Waller wants to convince us that scientists are all too susceptible to the human foibles of deceit, jealousy, self-promotion, self-delusion, prejudice, patronage, vindictiveness and just plain stupidity. So much of the cleaned-up, sanitised accounts that pass for the history of science are therefore confabulations. If one looks carefully at how people behave as they engage in making new knowledge there may not be very much disinterested seeking after truth, collegial sharing of information or openness to new ideas. Instead, Waller shows us how naked ambition often has a greater role to play than technical virtuosity. Few scientists in the case studies followed a straight and narrow path to Popper’s ‘open society’.

The book is divided into two parts. Part 1 is entitled “Right for the wrong reasons” and part 2 is “Telling it as it was”. In part 1 Waller’s searching spotlight is turned on Pasteur, Millikan, Eddington, Frederick Winslow Taylor (the father of scientific management) and the Hawthorne effect as researched at the Western Electric Co.’s Hawthorne works at Cicero, Chicago between 1927 and 1932. Each case study adds to Waller’s growing evidence that although, with hindsight, we now see the originators as being correct at the time they were working, they were pursuing the path to wisdom for entirely, what we would now judge to be, the wrong reasons.

“With hindsight” and “what we would now judge to be” are issues with which Waller wishes to confront us. Being able to look back is indeed a privileged position to be in. I am slightly surprised that Waller doesn’t indulge himself at any point with Oscar Wilde’s observation that “If I had known then what I know now, I would have been a monster.” For Waller, the saintly view of the sanitised scientist is in fact a monstrous creation.

Part 2 looks at what we now might call revisionism: how the historical record is re-written to suite the purposes of the writers. Waller takes us through accounts written about the work of John Snow, Gregor Mendel, Joseph Lister, Charles Darwin,

Charles Best, Alexander Fleming, Thomas Huxley and James Young Simpson. Some of the revisionist accounts are auto-generated, auto-biographical. The worst example of self-serving delusion being the revisionist claim by Charles Best that he, virtually single-handedly, found the cure for diabetes. In reading this section I was reminded of the saying that history is the story the winners tell about the wickedness of the losers. In Best's case it was the tale told by the survivor: Best himself.

In the task of education, which is one of persuasion, in what Reichenbach called the context of justification, cleaned-up sanitised accounts of discovery present novices with the struggles of the heroes of science. Waller turns to the classics, and particularly to the story of Horatio's defence of the bridge over the Tiber, to show us how confabulation is a common problem in historiography. He could equally well have taken us on a walk around the ambulatory of any catholic church to the chapels of the saints.

I can see a distorted U-shaped response curve to the ideas Waller offers. I suspect that bone fide scientists in research institutes could read Waller's book and earnestly pray to be delivered from such sins. I can see some science teachers throwing the book in the bin for being worthless muck-racking. I can see the anti-science lobby rubbing its hands together with glee saying, "I told you so." So here is a challenge. Read Fabulous Science and place yourself.

"A short History of Nearly Everything" by Bill Bryson. Published by Black Swann (2004). 687 pages including an index, bibliography and notes. £8-99. ISBN 0-552-99704-8. **Reviewed by Martin Monk.**

Bill Bryson is such a successful author that he has even had his own television series. So I bought my copy of "A short history of nearly everything." expecting an entertaining and easy read. It had to be, as the text runs to over 570 pages. In fact it took me more than a month to get through it.

In reading the early chapters I occasionally felt it would probably be better for me to go out and slit my wrists. These were the chapters that detailed apocalyptic catastrophes due to meteor impacts, exploding volcanoes and the death of the Sun.

Bryson returns to this theme in the last chapter entitled "Goodbye", where at one point he writes, "It's an unnerving thought that we may be the living universe's supreme achievement and its worst nightmare simultaneously." My opinion on Bryson's book was crystalised in the last chapter, which is the shortest. I think Bryson has written a text that places our responsibility for the care of the planet in our own human hands. He quotes the much mis-understood and mis-maligned

Edward O. Wilson from his *The Diversity of Life*, as writing the unimprovably brief “One planet, one experiment.”

The kernel of Bryson’s truth is we only have ourselves to look to for our own salvation. I can’t be alone in spotting this because in the reviews of the book quoted at the beginning, *The Christian Science Monitor* is reported as having printed, “There are lots of laugh out loud moments in this book” and then somewhat puzzlingly “...he has given us a book that might even turn people on to this thing called science.” (Could that have been a knowing partial quote of Alan Chalmers title?) The bulk of the book is a layman’s interpretation of what evidence there is for believing that God will not save us. We are material creatures, living in a material world (Thank you Madonna, just sit over there) and our fate is in our own hands as the only consciousness we can count on. Now you might see why those who read the *Christian Science Monitor* could be expected to laugh out loud quite a lot as they read Bryson’s book.

The Short History of Nearly Everything carries a cover illustration that is misleading. For there is a picture of a globe together with a nut, washer, screw and Allan key. (As Allan is Welsh for exit, this may be more cryptic than I have allowed.) What the book is not about, is the history of technology. What the book is about, is the evolution of the Earth and living things. The structure of the book itself echoes, somewhat imperfectly, the chronology of the formation of the Earth and life on it. So pages concerned with humans account for only 11 of the 574. Bryson does rehearse the popular conceptual aid that if you stretch out your arms to represent the span of the Earth’s history, the time human beings have existed, can be represented by a shaving from a nail, by a medium nail file.

So where is the history of science in Bryson’s trot through a *Short History of Nearly Everything*. Well, it is in trying to present as fairly as possible what evidence there is for the beliefs held by scientists and how such beliefs were arrived at. In presenting this history Bryson does not shirk from the task of showing how incomplete and fragmented that knowledge is, or how the path to consensus amongst scientists is littered with people whose ideas/contributions were not properly acknowledged in their lifetimes. Again you can see how readers of *The Christian Science Monitor* might find “laugh out loud moments” in what I take to be a dark text.

Bryson is a layman attempting to present science to laymen. There are odd spots where the more experienced might wince. One such place is on page 157 where he unfortunately writes, “..for half the year the Earth is travelling towards the Sun and for half the year it is moving away from it.” Such slips call into question Tim Flannery’s review from *The Times Literary Supplement*, “It represents a wonderful

education, and all schools would be better places if it were the core science reader on the curriculum." In the words of my aunty Doris "Gawd 'elp us."

Resources

The Emmanuel Kaye Gallery: Science, technology and business.

In room 38, on the ground floor, of the National Portrait Gallery in London.

How many times have you been asked to name a scientist of today? How many times have you thought, "oops, er, Stephen Hawking." Well the Emmanuel Kaye Gallery at the NPG can help you.

Two small rooms are filled with portraits of scientists – mostly. As exceptions, there is an overlarge painted portrait of John Sainsbury – he of supermarket fame, and a larger than life-size silver head of Norman Foster - architect. There are also three bronze heads: Arthur Koestler (journalist and novelist), Ove Arup (civil engineer) and Graham Clark (archaeologist) and a video installation of Susan Greenfield – the director of the RI. Everything else is a picture.

In the first room there are paintings of:

Stephen Hawking,	mathematician and theoretical physicist	born 1942
Frederick Sangar	molecular biologist	born 1918
Janet Vaughan	pathologist	1899-1993
Richard Doll	epidemiologist	born 1912
Robert Winston	fertility pioneer	born 1940

Emmanuel Kaye	businessman, co-founder of Lansing Bagnell, Kaye Ent. Hart Ent. And director of the Thrombosis Research Institute as well as sponsor of the gallery	1914-1999
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In a second, inner room, there are photographs. The people whose pictures look across from the walls are:

Paul Nurse	biologist	born 1949
Harry Kroto	chemist	born 1939
John Burland	civil engineer	born 1936
John Sulston	molecular biologist	born 1942
Martin Rees	astrophysicist	born 1942
Ian Liddell	structural engineer	born 1938
Susan Gibson	synthetic chemist	born 1961

Ann Dowling	mechanical engineer	born 1952
Catherine MacDonald	mechanical engineer	no date of birth
Wilson Poon	physicist	born 1962
Jim Al-Khalili	theoretical nuclear physicist	born 1962
Lesley J. Yellowlees	chemist	born 1953
Julia Higgins	chemical engineer	born 1942
Christopher J Budd	mathematician	born 1960
John Roberts	structural engineer	born 1948
Tsou Sheung Tsun	mathematician	n.d.b.
Jim Feast	polymer chemist	1938
Hilary Davies	geologist	n.d.b.
Martin Sweeting	communications engineer	born 1951
Allan Bradley	molecular geneticist	n.d.b.
Angus Lamond	biochemist	n.d.b.

I suspect that for the average 11-to-19 year old there is little difference between a scientist being born in 1948 rather than 1648. For a bit of schadenfreude, it might be comforting to those who do not appear on the Kaye Gallery walls to think that those who do... will someday be history.

Education Forum is published three times a year, in February, June and October, and circulated with the BSHS Newsletter to members of the Education Section. It is also sent to Science Advisers and Inspectors by courtesy of the Association for Science Education. The Editor will always be pleased to consider contributions.

Enquiries regarding circulation or membership of the Society should be made to the BSHS Executive Secretary at the address below. It is stressed that any views expressed in Education Forum are those of the Editor or named contributor and that the BSHS accepts no responsibility for omissions or errors.

The British Society for the History of Science is a limited Company without Share Capital and registered in England No.562208. It is also a Registered Charity, No.258854. The Registered Office is 31, High Street, Stamford in the Vale, Faringdon, Oxon, SN7 8LH, England.



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