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Editorial

43 is a bumper issue with meaty articles and interesting reviews. Read, enjoy and get back to your editor with comments. The deadline for copy for the next issue is Monday the 6th of September.

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Articles

Poems of Science

John Cartwright

John Donne (1572-1631)

John Donne was born to Catholic parents in 1572. At the age of 12 he left London to study at Oxford. He must have left aged about 16 without the formal award of his degree since as a Catholic he would have been unable to take the Oath of Supremacy to the English monarch. Sometime in the 1590s, however, he converted to Anglicanism and later in life was awarded, by royal mandate and against some opposition, a Doctor of Divinity degree from Cambridge.

In 1601 John Donne secretly married Anne More without her father's consent. Anne was just 16 and her father did all he could to ruin Donne – amongst other measures he had him imprisoned whilst he tried without success to annul the marriage. The next few years were hard for Donne and his young wife and to gain employment Donne gradually drifted towards the Anglican Church. In 1610 he published an attack on Catholicism called *Pseudo-Martyr* that so impressed King James that he insisted that Donne enter the ministry. He was ordained in 1615 and rose so quickly that by 1621, aged 49, he was made Dean of St Paul's. He remained there for the rest of his career and proved to be a sensational speaker. He delivered his last sermon, the appropriately titled "Deaths Duel", on 25th February 1631 a month before his death.

John Donne is now known as the prime exemplar of the Metaphysical Poets. The poetry of this group, which included George Herbert, Henry Vaughan and Andrew Marvell, was much admired in the twentieth century for its originality, its clever use of paradoxes, puns and conceits and its playful use of ideas that lay below a more serious purpose. It is interesting to note, however, that the term metaphysical began as a term of rebuke. John Dryden in his "Discourse of Satire" (1693) wrote of Donne that:

> "He affects the metaphysics, not only in his satires, but in his amorous verses, where nature only should reign, and perplexes the mind of the fair sex with nice speculations of philosophy" (quoted in Bewley, 1966, p.xii)

It was then Dr Johnson, who was even more dismissive of Donne's work, that applied the term to all those seventeenth century poets who wrote like John Donne. For Johnson it was the *avant garde* nature of the poems that were at fault: their modulation was imperfect and their juxtaposition of ideas too forced. For John Dryden FRS it was that they concerned themselves with metaphysical philosophy rather than nature. Dryden was here speaking as a representative of the new scientific approach to philosophy that advocated the study the natural world and not what his colleagues in the Royal Society regarded as the barren disputes of mediaeval philosophy.

In many ways Donne is a microcosm of some of the European debates in the seventeenth century. As a Catholic, Donne's early education would have brought him into contact with the *Summa Theologica* of Aquinas. This work, unfinished at the death of Aquinas in 1274, argued that human reason could, by and large, successfully comprehend the world. It was reason after all which distinguished us from other animals. In scholasticism faith is above reason but not contrary to it and reason should when properly exercised lead to faith. Against this confident assumption that had given medieval thinkers good service for centuries, the renaissance threw up a revival of classical scepticism stemming from the Greek philosopher Pyrrho of Elis and his disciple Empiricus, that suggested our sense perceptions may be unreliable. The growing popularity of Copernicanism also suggested that things are not what they seem. Donne was caught up in this scepticism and it affected him deeply. He knew reason was limited but desperately hoped it would prove compatible with his faith. But what type of God did faith lead to? The God of Aquinas where man had a choice between good and evil, or the Calvanist monster in the sky who had already created the saved and the unsaved?

It is known that Donne kept himself informed about new scientific discoveries and he was remarkably quick in exploiting their poetic potential. In 1610 Galileo published his *Starry Messenger* and Donne is known to have read it. The year 1610 was remarkable other ways, and several political events of that year shaped the destiny of France and England. On May 14th the French King Henry IV (Henry of Navarre) was murdered by a Jesuit zealot on the streets of Paris. Henry had been a wise and tolerant ruler and planned measures to enable Protestants and Catholics to live in harmony. The outpouring of grief was enormous, comparable to that in modern times following the assassination of President Kennedy in November 1963. In England the heir to the throne, Henry Prince of Wales, wept openly and took to his chambers for days. A few months later the Prince himself died – possibly of tuberculosis and succession passed to his younger and less able brother the future Charles I.

On a lesser scale, 1610 also saw the death of Elizabeth Drury just before her fifteenth birthday. Elizabethan was the daughter of Sir Robert Drury, an aristocratic courtier with a large fortune. At the time Donne was still seeking patronage and it was the event of the girl's death that led him to write two of

his most difficult works, *An Anatomy of the World* (1611) and *Of the Progress of the Soul* (1612). The death of Elizabeth may have prompted the works but the subtitle of the first shows that Donne had a much wider agenda: "*An Anatomy of the World Wherein, By occasion of the untimely death of Mistress Elizabeth Drury, the frailty and the decay of this whole world is represented"*. In effect, Donne uses the event to discuss everything he thinks is wrong and worrying at the time.

An Anatomy of the World:
John Donne on the death of Miss Elizabeth Drury.

The two *Anniversaries* were among the very few poems to be published in Donne's lifetime; indeed the Dean of St Paul's would have been mortified to know that his sensual love poems were ever published at all. At the time the *Anniversaries* caused some controversy. Ben Jonson declared them to be "profane and full of blasphemies". Modern critics have been kinder. Both poems are quite long and we will only deal with the several sections relevant to science in this article. The most interesting passage, as far as Donne's attitude to science is concerned is also one of the most quoted:

> "And new philosophy calls all in doubt,
> The element of fire is quite put out;
> The sun is lost, and the earth, and no man's wit
> Can well direct him where to look for it.
> And freely men confess that this world's spent,
> When in the planets, and the firmament
> They seek so many new; they see that this
> Is crumbled out again to his atomies.
> 'Tis all in pieces, all coherence gone;
> All just supply, and all relation:
> Prince, subject, father, son, are things forgot.
> For every man alone thinks he hath got
> To be a Phoenix, and that then can be
> None of that kind, of which he is, but he."(*First Anniversary*, l. 203-218)

At first it looks as if Donne is worried about the impact of new scientific discoveries. The 'new philosophy' is both Copernicanism and the work of people like Galileo, Kepler and Tycho. We also know that Donne had read *De Subtilitae* (1551) by Jerome Cardan in which it was questioned whether there really was a sphere of fire overhead. We recall that in Aristotelianism the four elements were arranged hierarchically in the ascending order of earth, water, air and fire, with each element occupying its proper place. Kepler had also made the point (obvious to the modern mind) that if there was a region of fire how come star light seemed to pass through it unaffected? Hence, for Donne, the element of fire is "quite put out". Copernicus moved the sun to the centre of the cosmos and the earth as a planet and so to Donne they both seem "lost". We

also have reference ("in the firmament they seek so many new") to the observations on the new stars of 1577, 1600 and 1604 as well as Galileo's work with the telescope of 1609 that had revealed the Milky Way to consist of thousands of stars hitherto not seen separately. Donne is also concerned with the revival of atomism. He then moves to express concern that old values that bonded together prince and subject, father and son are crumbling in face of a new individualism.

But later in the poem we begin to realise that it is not just the new sciences that have brought about Donne's angst. Indeed he applies his pessimism to the whole of astronomy, ancient and new, as the following lines show

> "We think the heavens enjoy their spherical,
> Their round proportion embracing all
> But yet their various and perplexed course
> Observ'd in diverse ages, doth enforce
> Men to find out so many eccentric parts.
> Such divers downright lines, such overthwarts,
> As disproportion that pure form: it tears
> The firmament in eight and forty shares,
> And in these constellations then arise
> New stars, and old do vanish from our eyes" (*First Anniversary*, 251 – 260)

The tearing of the firmament into forty eight parts dates from the time of Ptolemy as does the use of eccentric parts to account for the retrograde motion of the planets The new stars are again those observed by Tycho and Kepler, but the old that "do vanish" probably refers to Tycho's catalogue of stars where he listed 777 compared to the 1022 of Ptolemy. In the lines that follow this extract Donne goes on to note how the sun is impaled in a zodiac of twelve constellations and how the precession of the equinoxes is another sign of the world's decay. Now most of this is nothing to do with the new science: these are ancient observations and conventions. This tends to confirm that for Donne it was not just the new science that called all in doubt but that the very use of reason to solve nature's puzzles was deeply problematic. The overall tone of Donne's lament is deeply conservative, pessimistic and quasi medieval. So much so that Toulmin (1990) calls him one of the voices of the "counter renaissance".

The *Second Anniversary* (1612) (written, of course, two years after the death of Elizabeth Drury) confirms his pessimism. About halfway through this poem Donne, almost gleefully, lists several medical and biological problems that remain unsolved:

> "Know'st thou how the stone doth enter in
> The bladder's cave, and never break the skin?

Know'st thou how blood which to the heart doth flow,
Doth from one ventricle to the other go?
And for the putrid stuff, which thou dost spit,
Know'st thou how lungs have attracted it?
……
Why grass is green, or why our blood is red
Are mysteries which none have reach'd unto
In this low form poor soul, what wilt thou do?
When wilt thou shake off this pedantery?
Of being taught by sense, and fantasy?
Thou look's through spectacles; small things seem great
Below; but up unto the watchtower get,
And see all things despoil'd of fallacies." (*Second Anniversary* 270-295)

Clearly, Donne is no modernist. For a Baconian (Bacon had published his *Advancement of Learning* in 1605) the movement of the blood, the formation of gallstones, mucus in the lungs, the greenness of grass and the redness of blood would all be problems to be solved. In Donne's own lifetime, William Harvey had demonstrated the circulation of the blood, and with 400 years of science behind us we could now confidently answer Donne on all these points. One suspects though that Donne would be unimpressed. His faith dismissed science as trivial and futile. Why trouble ourselves with the natural world when in heaven and the next life (the "watchtower") all will be revealed? Renaissance scepticism had shown that human reason was a limited tool, but instead of following Bacon's advice and turning this imperfect instrument on the natural world to improve the human condition, Donne despaired of scientific rationality altogether and took refuge in faith, something his scepticism never touched. As one of his biographers, John Carey notes:

> "He belongs.. to a dying tradition, not to the brave new Baconian world. A medieval sense of the futility of human endeavour was always at hand"
>
> (Carey, p. 248)

It is a London tradition that all those born within earshot of the great bell of the Church of St Mary-le-Bow can call themselves cockneys. In the early days of March 1631 John Donne heard the bell as he lay dying in his rooms in the Deanery. Eight years earlier during a serious illness he had heard that same bell toll for the funeral of an unknown individual. Donne survived this earlier illness and to celebrate his own deliverance had wrote one of his most moving meditations, containing lines that were to become famous:

> "No man is an Island entire of itself; every man is a piece of the Continent, a part of the maine. Any man's death diminishes me, because I am involved in Mankind. And therefore never send to know for whom the bell tolls; It tolls for thee"

(1624, *Devotions upon Emergent Occasions, Meditation, 17*)

But on this second occasion there was to be no recovery. According to his first biographer, Isaac Walton, the good Dean, knowing he faced certain death, sent for a "choice painter" to capture his last moments. Several fires were lit in his study and with ever an eye for the theatrical (he had after all been fond of the theatre and was a lifelong friend of Ben Jonson) in he walked carrying his own winding sheet. He had the sheet tied about him at head and foot, turned his face to the east ("from whence he expected the second coming of his and our saviour Jesus") and the painter began. Once finished, the portrait remained at his bedside until he died on 31st March 1631. Soon after his death, a marble sculpture based on the picture was commissioned and placed in the cathedral. The old cathedral of St Pauls burnt down in the great Fire of 1666 but remarkably the statue survived and was placed in Wren's new cathedral where it still stands today in the south transept. Perhaps from his watchtower Donne's questions have been answered.

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The past and future of world farming.

Prophetic warnings about science and economic growth?

Clive Sutton

Will the growth of human population, depletion of natural resources and pollution of the environment lead to a catastrophic collapse in human numbers? Or can we so organise our industry, agriculture and lifestyles that we achieve some kind of self-regulating balance before we are strangled by our own activities?

Big questions like this tend to be touched on only lightly in science classrooms, and there is usually an unexamined assumption that knowledge of science is bound to contribute to human well-being. For example, when we teach chemical details of the Haber Process for making ammonia, fertilisers appear in the books as yet another illustration of the useful application of science. As between pessimists and optimists about the human future, science teachers are nearer to the latter, seeing science as contributing almost entirely to a better future.

Yet outside the school, the suggestion is made more loudly nowadays that big science in association with big business has unintentionally been creating problems for our future. Is it sensible for the public to expect unending 'progress', and is that a proper interpretation of what science offers? And are there no limits to economic growth? Issues of this kind have exercised many thoughtful writers in the last three decades, especially since 1972 when the economic analysis called *Limits to Growth* was published[i]. It offered a rather pessimistic prognosis which was welcomed by some as a timely warning but bitterly contested by other readers.

At the moment, it is the optimists who retain the practical initiative in the worlds of big science and company investment. Since many politicians regard economic growth as essential, there is strong support for this group of **Confident Innovators**. In the best traditions of pioneers everywhere, they anticipate that our methods will go on improving, and if problems arise, science will solve them. To support their optimism, they point out that some previous predictions of doom have been negated by successful science. For example in the 1960s there were Malthusian predictions that the growing world population could not be fed, but within a decade the breeding of semi-dwarf varieties of maize, wheat and rice reduced that concern markedly in South Asia in what was called the 'Green Revolution'.

[i] ***Limits to Growth*** was published in 1972 by economists and scientists who called themselves The Club of Rome. It brought to prominence the concept of positive and negative feedback loops in the economic and natural worlds.

Meanwhile amongst the general public, the notion that science is always applied for good ends is viewed with some scepticism, and the convenient pretence that science is pursued for 'knowledge only', uninfluenced by other concerns such as commercial interest, is widely rejected. But members of this same public still support the idea that science is the means to a good future. They have benefitted from a host of technological innovations and they confidently expect more. Should we support or question those expectations?

Nowhere are these issues clearer than in relation to world farming, and that is the topic of a thought-provoking if lengthy discussion by **Colin Tudge**[ii] entitled ***So shall we reap***. His particular mix of hope and pessimism is captured in his rather unwieldly sub-title:

> *How everyone who is liable to be born in the next ten thousand years could eat very well indeed; and why, in practice, our immediate descendants are likely to be in serious trouble.*

I recommend parts of Tudge's analysis to any teacher who wants to think about science and technology in their human context. He dares to tangle not only with history and culture, politics and economics, but also with the 'moral maze' we encounter whenever there is technological change and we are faced with side effects and unexpected outcomes. Of course, it might be easier not to think about such complications, and confine ourselves to teaching the chemical equations. If you want that approach then this book is not for you, but for those with broader educational goals, here are a few of the many important themes which he explores:

1. The history of farming over more than ten thousand years - first as a set of crafts, but in the last three centuries greatly affected by systematic science and capital investment. Together those created a positive feedback loop of more and more successful growth that might seem capable of going on forever.
2. The politics and economics of farming when new technologies are introduced on an ever increasing scale. How they contribute to the positive feedback loop.
3. The biology of farming - the detail of how humans use and modify particular plants and animals; how those interact with each other; *what we know* and the *essential uncertainty* of such knowledge.

[ii] Colin Tudge (2003) ***So shall we reap***, Penguin books. ISBN 0-713-99640-4. Trained in zoology, the author is an established writer on topics to do with farming and with food.

4. Human values and the moral aspects of innovation (That is the territory in which he goes further than other writers) How finding morality as a basis for policy choices seems to conflict with other pressures in the political and economic system

What is science, and what do we think it is for?

Running through the whole book is the author's disquiet about ***trends in the public understanding of science***. What kind of an activity is it, and what is it for? He expresses this concern with some passion - writing about the 'the corruption of science' when people take it to be mainly a tool of unending economic growth, a means for human beings to solve any problem. For himself, he puts more emphasis on tentativeness, recognition of uncertainty, and science as an aesthetic pursuit to enhance our appreciation of the world, rather than to control it.

That is clearly a personal value stance for him, since both aspects *have* featured in the pursuit of science, but his protest is the key to understanding the book. He has a scientific training himself but he has got fed up with those who will not recognise the inherent limitations of scientific knowledge, or the likelihood of mistakes when partial understanding is translated rapidly into technical innovation (DDT for example). He also sounds exasperated with the 'bullish' attitudes of the **Confident Innovators** who think that with science and technology human beings can achieve anything they like and that they can with impunity adjust the rest of the biological world to their convenience. His polemic against such arrogance develops gradually but is eventually fierce. His transitions from cool analysis to angry polemic are not always very clear, so some readers may in turn become impatient with him. Others, like Jonathon Porritt and Crispin Tickell, have already applauded the book as a bold attempt to weave together history, culture, science, morality and politics!

Historical resources for the classroom

Useful material for youngsters can be found in his historical account of the early development of science-based technologies in farming (pp 188-198). Some of that has already found its way into school science books - for example about the development of the Haber Process before the First World War, but Tudge's account is richer. He traces the influence of Liebig in the 1840s over adding phosphates to the soil, then the influence of the Rothamstead plant research station, and later the growth of Haber-based nitrogen fixation to its present status, where it supplies half the turnover of nitrogen in world crops. He makes a useful distinction between technologies in general and '*high technologies*' which require systematic science, and are bound in with systems for financing that science. It seems to me that a careful study of these earlier times makes a better preparation for discussing the ethics of science than we can get by leaping directly to modern concerns over pesticides, herbicides and genetically modified crops.

There are also excellent sections on the history of animal and plant breeding which could be used in the same way - thought-provoking case studies from the past.

From past achievements to present dilemmas

To consider present-day agricultural science, we will need the later parts of Tudge's book and his arguments for not being carried along by present trends. He discusses genetically modified plants and animals, urging caution and restraint, but he does not regard himself as a Luddite because he thinks that a careful use of genetic modification is likely to be very helpful. What he is against is the drive towards the use of such organisms on an industrial scale, and anyone who regards that as just inevitable 'progress' to be powered by the economics of world free trade. He has some sympathy with protesters who agitate about the World Trade Organisation, but he is not against capitalism in any simplistic way, for he explains how farming and capital investment have gone hand in hand. He does however reject the current influence of what he calls 'hyper-capitalism' as an engine of further, hasty, change.

Substantial industrialisation of agriculture has of course already occurred. Farming in the first world is characterised by large-scale monoculture of crops and livestock, with high yields obtained by methods that are not labour intensive. The 'bullish', proponents of 'progress' think that this should now happen in the third world too. However, large-scale production generates new dangers in the growing influence of large corporations dedicated to finding cost-cutting techniques (e.g. antibiotics as growth promoters). For some animals this cost-cutting priority has already brought about dangerous patterns of feeding and medicating the animals. Monoculture also carries its own risks e.g. of catastrophic epidemics. There are also other factors that Tudge argues should be taken into account alongside the financial criteria that are currently dominant. One of these is the effect that industrialising farming has on employment. Farming, he says, has more functions in human life than simply the production of (cheap) food. There are social as well as environmental costs to consider and it is a mistake to treat agriculture as 'a business like any other business', costed only on input/output margins.

Instead of further industrialisation of food production, he argues for an 'Enlightened Agriculture' with much more mixed farming and mixed horticulture, with short supply chains between producer and consumer. This, he argues would be safer for the security of food supply, safer for the consumers who eat it, and safer for the ecosystems on which the whole thing depends. The case he builds up includes many factors, and his section on nutrition is another important part of it. So are his analyses of population growth and of the causes of famine.

Warnings from three prophets?

Towards the end of the book, Tudge casts himself as something like an Old Testament prophet, issuing warnings while fools rush on. If we call his work the ***Lamentations of Colin Tudge*** it could be seen as a natural sequel to the ***Lamentations of Rachel Carson*** - i.e. another set of warnings from within the science community[iii]. Tudge seems particularly sad that science should be used in pursuit of cost-cutting strategies. Can we not, he asks, have a better *sensibility* in our science - a fuller awareness of possible impacts on the quality of human life as well as on the intricate ecosystems that surround us? He also urges sensitive awareness of our own limitations as animals who are ourselves a part of the systems we try to control. *'A powerful theme of modern Western culture'* he writes *'is that we human beings are very much in charge'* (p51). It is not a sentiment he shares: *'We have allowed ourselves to believe that with science and technology we can put our stamp on nature. That is a very big mistake.'* (p102) This is surely an issue worth discussing with youngsters in order to consider the impact of science in our time.

Tudge's book has some affinity with an earlier one which I will call the ***Lament of Brian Appleyard*** [iv]**.** Writing as an historian, Appleyard questioned the long term effects of successful science and technology on human beings' sense of who they are and what they can do. Like Tudge, he had discerned relentless trends in modern society about which he wanted to protest. He complained that science has become such a dominant way of thinking now that it pushes aside other sensibilities. He was also worried about a gradual slippage in which all value questions are gradually turned into technical questions not requiring human judgement. He found that trend morally and aesthetically unacceptable, and felt that some 'humbling of science' is necessary. (I take that to mean a better recognition of the limitations of scientific knowledge, and abandoning the idea that science can solve all problems.)

It is difficult to make such protests without sounding curmudgeonly, and both Tudge and Appleyard do sound like that. They are disenchanted; and angry; and both come to the rather sad conclusion that at the moral level their concern is not something which can be entirely a matter of rational argument. At bottom Tudge finds his personal conviction that: 'This is not a direction in which humanity should be going'. He quotes David Hume to the effect that morals are

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[iii] Rachel Carson's book ***Silent Spring*** was published in 1962 . Her careful analysis of the persistence of pesticides and their concentration in food chains made her book a founding document in relation to environmental concerns.

[iv] Brian Appleyard (1992) ***Understanding the Present*** Pan books. ISBN 0-330-32013-0
subtitled: *Science and the soul of modern man.* An historian's attempt to trace the rise of scientific ways of thinking in our culture, and to cast a critical eye over their influence on the totality of that culture.

always a matter of feeling rather than rational argument. Appleyard makes much the same point. In any moral dispute over whether to use a new technology, rational arguments are put forward by different protagonists but what really matters is the beliefs behind them that are held because of the irrational demands of temperament. In modern society convictions like his own always sound rather weak, and a technical argument prevails, or some form of uneasy compromise. Yet behind the technical arguments (certainly as regards farms) there are in fact the other unexamined convictions which he rejects - e.g. that unlimited economic growth is possible, or that a technical fix will always be possible if trouble arises.

Neither writer is comfortable with the idea that if something can be done it should be done, but both see that is what tends to happen now. As science generates new possibilities (e.g. in new cloning) there is nearly always some group that will be keen to exploit it for a mixture of commercial and altruistic motives. Appleyard grumbles that our society seems to have no room now for the kind of moral judgement he sometimes feels bound to make. Changes come about for the convenience of distributors and consumers without anyone being able to say ' Hold on, we should not do that'. Tudge is certainly saying that about future farming on both moral and practical grounds.

Personal voice and personal judgement about complex issues

Both authors write very personally about their own convictions. They are not just reporting information and argument, but rather trying to express a 'voice within themselves', an intuition which can be defended only in part by reason. Tudge even sees himself as 'a voice crying in the wilderness'. Are such people to be ignored, or do their intuitions represent some kind of inner wisdom that is available to human beings if they will stand back from currently fashionable thought? Certainly they have a point which could be helpful to teachers in eroding the oft-repeated but now discredited assertion that scientists need not concern themselves with questions of value.

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Newton : Genius

Patrick Gavin

A characteristic of genius is to be prolific: witness Shakespeare, Mozart, Newton, and to give a recent example, the Russian Physicist Lev Davidovich Landau. Teachers, and students, hardly need to be told that Newton is considered to be one of the great creative geniuses, but it might be worthwhile putting together Newton's contributions to science in the context of the A-level Physics Syllabus. Thus we encounter Newton's contributions in several parts of the syllabus:

1 Laws of Motion
2 Gravitation, including the inverse square law. (He might have received a suggestion from Hooke about the inverse square law.)
3 Mathematics : a) calculus (independently conceived by Leibniz)
b) formula for acceleration in circular motion
c) binomial theorem; and expansion for 'e'.
4 Coefficient of Restitution, linking relative velocities before and after impact
5 Velocity of Sound in Air. Strictly speaking Newton's formuala is for isothermal conditions (which might obtain in a trombone or French Horn); Laplace later corrected it for the more usual adiabatic conditions
6 Viscosity
7 Newton's Law of Cooling
8 Light:
a) prism and spectrum; and the approach to setting up a 'crucial experiment.
b) Newton's Rings
c) Reflecting Telescope
d) Corpuscular Theory : in a sense it re-appeared, after the success of Huygen's
Wave Theory, in Einstein's interpretation of the Photo-Electric Effect.

Newton's two books, the 'Principia' and the 'Opticks', are very different in style. In the 'Principia' the structure is rigorously logical: the axioms are stated and the conclusions deduced. In explaining how, say , a Planet's motions may be calculated , Newton is showing how Mathematical Physics is to be done and also showing that the same laws apply to the 'heavens' as to bodies on Earth. Newton is aware that he has not given a model for any mechanisms for gravitational attraction.

In the 'Opticks' the experiments are carefully done and described, but the results cannot be put into equations. His conclusions are tentative and at the end he gives a list of 'Queries'. His statement "Hypotheses non fingo" perhaps

indicates his reluctance to speculate; but without some speculation one would never get started.

There is a saying of Goethe, “In der Beschrankung zeigt sich erst der Meister”.(In recognising his limitations the Master reveals himself.) Newton is clearly a Master.

Recently books, articles and a television programme have emphsised Newton’s interests in Alchemy, Numerology and Religion. These interests of Newton in no way detract from his acknowledged greatness in Maths and Physics. The Astrophysicist Chandrasekhar has worked through the ‘Principia’ and expresses his unbounded admiration for Newton’s genius (1).

In his later life, as a very efficient and foresighted Master of the Mint, Newton may well have helped to lay the economic foundations for England’s future prosperity.

References

1 Newton’s “Principia” for the Common Reader, S.Chandrasekhar, 1995
2 Truth and Beauty, S.Chandrasekhar, 1987 (Collected Essays).
3 Scientific American, March 1994, p. 16 and 17. (A summary of reference 1)

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News items

Robert Boyle for the 21st Century:
An Initiative for Schools

Robert Boyle was arguably the most influential scientist in late 17th-century England, who did more than anyone else to pioneer the experimental method. In recent years, scholarly understanding of Boyle has been transformed through the cataloguing of his huge archive and the publication of definitive editions of his *Works* (14 vols., 1999-2000) and *Correspondence* (6 vols., 2001). In addition, since 1997 there has been a website devoted to Boyle at Birkbeck, University of London.

Now, thanks to a grant from the Heritage Lottery Fund, with ancillary funding from the Wellcome Trust, various steps are being taken to bring Boyle to a broader audience, particularly through the internet.

The Boyle website is being completely redesigned. For the first time, it will have a section specifically aimed at teachers and students in schools. The primary emphasis will be on Key Stage 3 of the National Curriculum and on the GCSE course, 'Medicine through Time', and provisional lesson plans and other materials relating to Boyle will be made available. In addition, it is hoped to provide pathways to the research material on Boyle available on-line for students doing project work for the new Edexcel AS level in History, Philosophy and Ethics of Science.

All this is currently in preparation, and input would be welcome from teachers and others who would like to be involved - either through helping to design materials, or through testing them and commenting on them. Please contact the project director, Professor Michael Hunter, on m.hunter@bbk.ac.uk. The new website is due to be launched at the start of July.

Later in the summer, the Boyle website will be further enhanced by the inclusion of digitised versions of the core volumes of the Boyle Papers, accompanied by a full on-line catalogue. In addition, a revised edition of Boyle's 'workdiaries' – the notebooks in which he recorded his experiments and observations, and information he received from others – is being made available on the website of the AHRB-funded Centre for Editing Lives and Letters at Queen Mary, University of London. This will contain a complete set of colour images of the original manuscripts, and the edition has also been revamped to make it more user-friendly, with full search facilities, improved links to apparatus, etc.

- For further information, see the Boyle website (www.bbk.ac.uk/Boyle) or the CELL website (www.livesandletters.ac.uk), or e-mail m.hunter@bbk.ac.uk.

The BSHS 2004 conference
is to be held at Liverpool Hope University between the 25th and 27th of June. You should have already booked by the 1st of May for residential accommodation. *There is a day rate of £25 for non-residential attendance. Sunday, as a half-day is only £18.* Here is what the Education Section will be offering on Friday the 25th.

9.00-9.30	*Registration*
9.30-10.45	Introduction (Peter Fowler)
	Peter Fowler Turning the Heat on History of Science: an example of teaching history of science to gifted and talented pupils
	Discussion: analysis and evaluation (all participants)
10.45-11.15	*Break*
11.15-12.30	**John Cartwright** Retrospective Nobel Prizes: an example of teaching history of science in further education
	Discussion: analysis and evaluation (all participants)
12.30-13.00	Evaluation so far (all participants)
	Introduction to group activities (Peter Fowler)
13.00-14.00	*Lunch*
14.00-15.30	Groups: preparation of individual/group resources
15.30-16.00	Closing feedback on work done (all participants)
	Setting-up of e-mail network (Peter Fowler)
16.00-16.30	*Break*
16.30-18.00	**Graeme Gooday and others** Teaching the History of Technology
18.00-18.30	**Janet Browne and Peter Bowler, Presidents, BSHS** Closing remarks
18.30-	*Wine reception in the Atrium*

Reviews

Television programmes

"Great Scientists" presented by Allan Chapman,
Broadcast on Channel 5**,** January to February 2004.
Reviewed by Patrick Gavin

Allan Chapman has followed up his three programmes on 'Gods in the Sky' (Channel 4, and accompanying book) with a series of five programmes, each devoted to a single scientist. Given only 25 minutes, Dr Chapman has had to identify the key features of the life and work of each of the chosen five very carefully, and this he had done very well. Teachers will note that 25 minutes is comfortably within the time of a lesson .The presentation by Dr Chapman, as ever exuding enthusiasm, is assisted by rapid theatre sketches in cartoon style, reminiscent of the Keystone Cops. Further embellishment is given in several cases by filming on location , where the presenter wanders round Cambridge or glides serenely along Venetian canals in a gondola.

Aristotle is introduced as "the first scientist" and it is his Biology which is emphasised. Aristotle was an excellent observer (as Darwin appreciated) and saw that there was order, not just chaos and lack of permanence, in the universe or cosmos.

With Galileo we have experiment and mathematical analysis as well as observation. Dr Chapman leads us from the pendulum to a good demonstration in a lab of a ball accelerating down a slope. The time-squared relationship is not derived. The improved telescope and the observations of the Moon and Jupiter are shown. Galileo's troubles with the Church were due, at least in part, to his argumentative personality. The Philosophers who opposed Galileo were arguing on the basis of Aristotle's inadequate Physics: perhaps a clearer link could have been made to Aristotles's positive approach in biology.

Dealing with Newton's vast output Dr Chapman sensibly selects the experiments on the spectrum, which he demonstrates, and the construction of the reflecting telescope, and then discusses Gravitation and Motion. The pace is rapid, but for anyone with some grasp of the details, the presentation is illuminating. Newton's religious convictions and his interest in Alchemy are mentioned.

Darwin, like Einstein, was certainly not an ideal pupil at school of University. Dr Chapman emphasises that he was from an early age an avid collector. Lyall's 'Principles of Geology' was an important influence, and of course, the voyage of the Beagle. 'The Origin' is readable, a claim that could not be made for Newton's 'Principia', and sold well. Mention is made of later developments of "Darwinism" and its adoption by Communists and Nazis.

In dealing with Einstein Dr Chapman concentrates on Relativity. A fleeting mention is made of the Photo-Electric Effect, but not of Brownian Motion nor of Specific Heat. Special Relativity deals with the consequences of the absolute value for the speed of light, $3x10^8$ m/s, however it is measured. A demonstration of ordinary relative velocity using racing cars is given and compared with the strange effect obtained for light. $E=mc^2$ is stated and a picture of an atomic explosion given to show its significance . General Relativity is introduced with a model demonstrating the warping of space-time, and Eddington's supporting results in 1919 are shown.

Dr Chapman has again given us an imaginatively produced and inspiring set of programmes on the History of Science and has conveyed, despite the severe constraints imposed, the flavour of the scientific endeavour.

A set of five small sheets summarising each programme is available from Channel 5, ISBN 0870-555-5055

"Hawking" Writer Peter Moffat; Producer Jessica Pope; Director Philip Martin.
Broadcast on BBC2 on Tuesday 13th April 9 to 10:30pm.
Reviewed by Martin Monk

Cast: Stephen Hawking *Benedict Cumberbatch*; Fred Hoyle *Peter Firth*; Roger Penrose *Tom Ward*; Arno Penzias *Michael Brandon*; Bob Wilson *Tom Hodgkins*; plus others.

Few scientists in modern Britain have their name on the tip of the tongue of Joe Public. Stephen Hawking is probably the only one that most people, youngsters and adults alike, can name as a contemporary scientist. His fame has been spread through his best selling book "A brief history of time" in which he set out to give an account of cosmology that would be accessible, interesting and illuminating. In writing that text, he realised the stock-in-trade by which cosmologists convince each other of the acceptability of their ideas – mathematical equations – had to be banished from the book. He was successful: both in his aim and financially.

So people who know of Stephen Hawking were likely to be persuaded to switch on their television sets, sit down and watch a drama documentary about his life and work. For ninety minutes we watched the deterioration of Stephen Hawking's body, due to motor- neurone disease, and the progressive acceptance and vindication of his ideas. The fact that he is still alive now, forty years after being diagnosed as having only two years to live, adds to an aura of almost sainthood: saint Stephen.

The programme makers must of realised this was a pit-trap into which they did not wish to fall (too much). Different threads were woven together to create the drama documentary. The most puzzling for those watching with me was the occasional appearance of Penzias and Wilson being interviewed in Stockholm, in evening dress, just prior to receiving their Nobel Prize. Who were these people and what were they doing in a story about Stephen Hawking? Only those who already knew how the story ended could make immediate sense of their interrupting the story of saint Stephen. Even the outburst by Fred Hoyle to Hawking about, if Hawking's theory were correct, which it wasn't according to Hoyle, then there should be a low hum of radio noise left over from the Big Bang, which Hoyle said there wasn't, came too late, to weakly in the programme to make sense of Penzias ands Wilson. But for those of us in-the-know, at that point I saw the programme makers alerting us to the nature of justified belief; theory and practical; and even Popperian falsification. Here was Hoyle making the prediction, on Hawking's behalf, that could be falsified. I thought this was great stuff. My companions, not so schooled in the history and philosophy of science, saw Hoyle as reacting appropriately to an upstart who didn't have the social skills to raise objections and put forward alternatives in a socially acceptable way.

For all this sophistication in the history and philosophy of science, the programme makers still need a moment of inspiration to portray the ah ha-Eureka experience which is part of the mythmaking of all great science stories. Remember Newton had his apple. In our programme, Hawking had his Penrose-at-the-station moment. Hawking is shown getting onto a train. Due to the relative motion of a parallel train he realises that what Penrose had used to describe gravitational collapse could be put into reverse. This provides Hawking with his ah ha moment and an explanation of the expansion of the universe from the Big Bang. I thought this was a very affective moment in the story – no matter how much it bent the truth. The pathos of the physically crippled body containing what was, at that one moment, the most brilliant of ideas, was very – if you'll excuse the pun – moving.

Altogether, my companions and I were satisfied with what we had seen. We felt we knew more about the biography of the man. We knew more of the context of his ideas. We knew more about why these ideas are now thought correct. We learnt more about ourselves as human beings fitting into the Cosmos.

Benedict Cumberbatch, as Stephen Hawking, gave a performance that can only be compared with that of Daniel Day Lewis as Christie Brown in My Left Foot. The progressive deterioration of motor control was handled incredibly well, and Benedict deserves a BAFTA if anyone does.

“Stephen Hawking - Profile.”
Broadcast on BBC4 on Tuesday 13th April 10:30 to 11:00pm.

The drama documentary on BBC2 was immediately followed by a piece of reporting on BBC4. “Stephen Hawking – Profile”, treated us to the real people talking for themselves. We heard from Isobel Hawking, from Roger Penrose and others. This was the most amazing stuff to put on immediately after the docu-drama.

The only other time I can recall being so knocked-out was at the end of the Australian film Rabbit Proof Fence, when the very people whose lives we had just watched, whose courage we had re-lived, appeared on the screen. I sobbed for quite a while – along with many others – in that darkened cinema as the credit titles rolled. This addendum to the docu-drama had the same effect on me. And yet.

And yet, I heard Stephen’s mother say Stephen was difficult to get on with, and became more difficult as his disease progressed – to an outsider it looked as though his first wife had been the saint, he the sinner. Roger Penrose commented on how Stephen had successfully built on others ideas and had been exceedingly lucky in getting the final chapters of his book written. This was not hagiography. And there, popping up at odd intervals, was Stephen himself, grinning like some impish monkey. Whatever had happened over the years, Stephen Hawking appears to be enjoying himself now in a way he never did in the past. For all the difficulties of his daily life, he appears to be one of the happiest people alive.

“Life Story.” broadcast on BBC4 on Tuesday 13th April 11:00 pm to 12:50 am on Wednesday the 14th.

In the immortal words of Magnus Magnusson, “ I have started, so I will finish.” To make a night of it I sat on in front of the tele’ and watched a re-broadcast of the story of the construction of the model of DNA by Crick and Watson using the data obtained from the X-ray crystallography of Wilkins and Franklin. In fact I had never seen the whole thing before, only clips and extracts. I thought this was brilliantly written, beautifully played and a real treat. By the end of the evening I felt like a glutton who had just eaten a whole box of chocolates in one go.

Who says science is neglected on the television.
In the words of Oliver Twist, “Please Sir, I want some more.”

Book reviews

"The Rise of Early Modern Science – Islam, China and the West" by Toby E. Huff. Second edition published by Cambridge University Press 2003. £22-95 pbk. ISBN 0521-529-948.
Reviewed by Patrick Gavin

Professor Huff is a Sociologist and in this thoroughly researched book he provides an alternative and interesting perspective for those of us whose reading has been mainly confined to the writings of scientists and Historians of Science. Sociologists such as Weber, Durkheim and Merton are cited and in particular Huff acknowledges the special influence of Benjamin Nelson. However Huff is clearly familiar with the work on Medieval Science of Duhem, Crombie, Grant, Numbers and others. The thesis is that the Medieval universities , in fostering debate and discussion and especially in the notion of a 'corporation' as it arose in the Law Schools, provided the intellectual climate for the breakthrough from technology to modern science which took place in the West about 1600. Thus on p.11 : " One might say that the critical elements of the scientific world view were surreptitiously encoded in the religious and legal presuppositions of the European West."

Huff examines in detail the scientific and technological achievements in China and throughout the Islamic countries, paying particular attention to Medicine and Astronomy. The level of scientific accomplishment in these two civilisations was at times comparable, or indeed more advanced, than that in the West, but in the Islamic world, by the year 1200, the scientific impetus was waning. Monotheism is common to Islam and the Christian West, but in Islam the tendency was to emphasise the Quran as containing all the knowledge required.

In 1277 Bishop Etienne Tempier of Paris condemned 219 propositions from the works of Aristotle, eg, that the World is eternal, and the impossibility of a plurality of Worlds. Huff follows others in interpreting the condemnations positively, in that open discussion of ideas relevant to science was thereby encouraged. He notes that the Condemnation was revoked in 1325.

The role of religion in fostering the development of science has been studied by R.Hooykaas in 'Religion and the Rise of Modern Science' (1972) and by S.L.Jaki in 'Science and Creation' (1974). Hooykaas, from the University of Utrecht, provides a continental perspective on the discussion , and on p.161 he summarises his conclusions : "The confrontation of Graeco-Roman culture with biblical religion engendered, after centuries of tension, a new science. This science preserved the indispensable parts of the ancient heritage (mathematics, logic, methods of observation and experimentation), but it was directed by different social and methodological conceptions, largely stemming

from a biblical world view. Metaphorically speaking, whereas the bodily ingredients of science may have been Greek, its vitamins and hormones were biblical." Jaki, like Huff, follows Duhem in stressing the importance of Tempier's Condemnation of 1277, and considers that the Judeo-Christian notion of a Creator was an important factor in establishing the belief in a rational universe, while the Chinese and others were distracted by the idea of a cyclic universe with inexorable returns.

The religious milieu , described by Hooykaas and Jaki, which fostered the rise of science, also, in Huff's presentation, fostered the development of the legal framework which then led on to Science.

The vital heliocentric idea of Copernicus and the methodology of Galileo did not just suddenly appear: there were antecedents. Quite what these were is an intriguing topic. For many the late medieval period is vividly symbolised by the great Gothic Cathedrals, like Salisbury; the expertise refined by the advancing technology developed in constructing these magnificent edifices might also have played some part.

Also see: Concerning Islamic Science, BJHS 37(1), March 2004, 1-28
The heavens of the sky and the heavens of the heart: the Ottoman cultural context for the introduction of post-Copernican Astronomy, by Avner Ben-Zaken

"Placebo: Mind Over Matter in Modern Medicine" by **Dylan Evans**
Published by Harper Collins, London, 2004. 224 pages. £8.99. ISBN 0-00-712613 1
Reviewed by Emm Barnes

Dylan Evans has written an infuriating book. Infuriating, because it is well-reasoned and highly plausible in parts, which was not what I wanted or expected. I was seeking a popular science book at which I could shout for its poor history and blatant reader manipulation. But "Placebo" has far too much merit to fall into this category. Yet there are parts of the book which clearly aim to provoke, and succeed in so doing. For these reasons – easy writing style and deliberately controversial content – I think this book could appeal to and stimulate a sixth-form age audience.

The argument in "Placebo" has, as proposition one, that there has been a woeful shortage of properly conducted clinical trials which would enable researchers to confirm and quantify the supposed 'placebo effect' of receiving a medically inert alternative to some potentially efficacious therapy under test. That this is indeed the case is well demonstrated in the initial chapter, and this could stand alone as reading for any sixth formers contemplating a career in the biomedical sciences, or for students taking either of the recent AS levels in

science (for Public Understanding, and Perspectives in) which ask them to assess science in its cultural context. It constitutes an engaging introduction to the history of the clinical trial, and of 'evidence-based medicine,' while pointing out the practical, historical, philosophical, and ethical limits to use of the double-blind randomised controlled trial in medical practice. Keen or able students might enjoy a more sustained argument with or against the points put forward in this book; it would make an interesting choice for the review of popular science component of the AS level in Science for Public Understanding.

The placebo seems to have snuck into the tenets of evidence-based medicine through the back door. Henry Beecher's chance observations, during the Second World War, that salt water could relieve pain as well as could morphine when the latter was in short supply, led doctors to begin to look at placebos in a different way. No longer were they seen as the marks of fraudulent practice, as the tools of a lazy doctor wanting to appease a patient for whom nothing could be done, or of a quack out to sell sugar for vast profit. When Beecher published his results in 1955, in a much cited paper called *The Powerful Placebo*, he provided the evidence-base for their use in clinical trials. But this and the other early studies on the placebo effect had no proper control group, no group receiving *no* treatment, against which could be measured the actual effect of the placebos administered.

Beecher played a big part in persuading medical institutions and practitioners that clinical trials should not compare one treatment against another or against no treatment as before, but against a placebo, on grounds that the response rate was known and stable, and that giving placebos was ethical given their powerful effects on some percentage of recipients. He also argued that in order to measure medical efficacy, researchers would need to test a treatment against a placebo so that the effect of the latter could be subtracted from the former. The present-day acceptance that placebo effects are large and substantial, and need to calibrated for in this way, has become axiomatic in medicine, though the foundations on which the evidence rests are deeply flawed.

After this historical introduction to the placebo effect, Evans defines exactly in what it consists, outlines which conditions are susceptible to relief from placebos, and suggests a mechanism through which this relief might be brought about – this last is contentious argument number one. Evans characterises the placebo response as "a rapid readjustment of the body's own natural healing mechanisms to a surge of hope." The hope is that the treatment received will be efficacious in relieving the symptoms of illness, and the response is to turn down pain, inflammation, and to some degree depression and anxiety, all aspects of the "acute phase response," the primary reaction of the immune system to suspected invasion. The "belief effect," as he calls it, results in a surge of dopamine flooding the brain, which then halts the primary responses, allowing the more sophisticated secondary immune response to be launched

sooner. Whether his biological explanation is sufficiently compelling is perhaps less at issue here than the service to which he puts it: challenging the historical and ongoing construction of clinical trials around measuring treatments' suitability against something in itself poorly understood and inadequately measured, the placebo effect.

Evans offers an evolutionary argument as to why it would be an advantage to be susceptible to placebos – contentious argument number two – which could be said to result in a reclassification of placebos as *socio*biologically active treatments. He discusses placebo effects seen in other healthcare settings. His chapters on complementary medicine and psychotherapy illustrate the healing potential of placebos: alternative forms of medicine are for some patients more powerful than conventional treatments, through a "mega-placebo effect." He goes on to discuss the implications of his claims – that psychotherapy and acupuncture have no effect except that brought about by belief in their power to heal – for the economics of healthcare: if an untrained practitioner of these complementary therapies can help bring about patient outcomes as good as their more expensive professional counterparts, what is the justification for paying for expertise? And if these alternative forms of medicine are for some patients more powerful than conventional treatments through their triggering of the side-effect-free placebo effect, why then offer drugs for depression or swelling with all their associated risks and costs?

The book concludes with the author asking whether it is ever ethical to offer as a treatment option something which the offerer knows to be without intrinsic medical activity. At this stage, Evans can be argued to be contradicting himself, since he has attempted to show that placebos *are* physiologically active for some symptoms. Evans is careful to demarcate the proper illnesses for which placebos might serve as good treatment, from those which will not be touched through the belief effect. He argues persuasively and savagely against best-selling present day quacks who write on the supposedly unlimited healing powers of the mind.

Evans poses hard ethical questions about experimenting on patients' belief systems, in particular thereby refreshing the subject of informed consent. A reading of this chapter could lead to an excellent class debate about the persistent practical and ethical conundra in medicine, as all of us are moved by thoughts about our own health, even immortal teenagers.

"Putting psychology in its place: a critical historical overview" by Graham Richards. Published by Routledge (2002). 368 pages including glossary, name and subject indices and time-line from 1855-1981. £16-50. ISBN 1-84169-234-4.

Reviewed by Martin Monk.

Surely, teachers have to be somewhat more interested in psychology then non-teachers. For their professional practice relies on understanding, no matter how tacitly, the way in which their students learn. An "historical overview" of psychology appeared to offer a distinctly different approach from the usual textbook presentation to psychology. And it does.

Obviously, part of any discussion on the history of psychology has to include how the positivistic view of science that dominated in the early part of the twentieth century had a marked effect on those working on psychological topics as they struggled to make psychology a science. The chapter on Behaviourism is preceded by chapters on:

- Before psychology: 1600 – 1850;
- Founding psychology: evolution and experimentation;
- William James and the origins of American psychology.

Chapters on Gestalt Psychology and Cognitive Psychology follow the chapter on Behaviourism. These two, together with that on Behaviourism, are standard textbook fayre, but here they have a more marked historical slant than the usual conceptual one. The conceptual coverage is therefore much reduced: this is not a textbook. Graham Richards is aware of this and points to it.

A further part of the book looks at selected topics: perception; the brain; memory; personality; social psychology and applied psychology. Although, these are standard psychology textbook headings, each is treated from an historical perspective. A third part of the book deals with psychology's most popular subjects: animals, children, the mad and females(!). A fourth deals with two general issues – measurement and language, while the fifth and last looks at Three Cultural Entanglements: religion, 'race' and war.

Throughout the text the emphasis is on how ideas developed and changed through a succession of new evidence and new researchers taking up the topic. I particularly liked pages 180/181 where Graham Richards discusses the history of the Hawthorne effect. In case you do not know, the Hawthorne effect is a well known bit of psychology and concerns the idea that the people who are the subject of psychological investigations modify their behaviour because they are being investigated, rather than because of any treatment. Richards directs us to the work of R.Gillespie (1988, 1992) on the archival records of the work carried out at the Western Electric Company's Hawthorne (Chicago) plant by researchers from the Harvard University Graduate School of Business

Administration. For Richards, “Gillespie’s work is an excellent example, with wider implications, of in-depth historical research disclosing how something publicly displayed as objective scientific discovery was gradually forged over time from the social, psychological and political transactions between, in this case, managers, workers, academic researchers and company employed researchers.” It is this sort of writing and topic that makes Graham Richard’s text distinctly different from a standard psychology book.

This text is of direct value to those who teach psychology. They will learn more about the history of their discipline. For teachers who use psychology and have an interest in it, rather than teach it, the book is illuminating. For those interested in the history of science, here is a text that goes beyond the usual history of physics or medicine. If you are interested in specific topics in psychology, then the references at the end of each chapter can provide a starting point for your own enquiry.

References for the history of the Hawthorne effect

Gillespie, R. (1988) The Hawthorne Experiments and the Politics of Experimentation. In J.G.Morawski (ed.) *The Rise of Experimentation in American Psychology*. New Haven: Yale University Press, 114-137.

Gillespie, R. (1992) *Manufacturing Knowledge: a history of the Hawthorne experiments*. Cambridge: Cambridge University Press.

“Into the Blue: boldly going where Captain Cook has gone before”

by Tony Horwitz. Published by Bloomsbury Publishing 2003. 480 pages including notes on sources, selected bibliography and an index. £7.99. ISBN 0-7475-6455-8.

Reviewed by Martin Monk.

Eating the fruit of the tree of knowledge brings about expulsion from the Garden of Eden. This book makes that plain. It does so by mixing sections that re-tell the history of Captain Cook’s three Pacific voyages with a modern travelogue. From section to section, how Pacific Islanders lead their lives now is contrasted with how they led their lives, seen through the eyes of Cook and his co-explorers. Having read to the end of the book, one is left in little doubt that the social arrangements on numerous Pacific Islands have been irrevocably changed from their discovery by Europeans, of whom Cook is the best known. But the expulsion has been a two-way affair. Not only have Islanders lost their Eden through contact with Europeans, Europeans have lost the Eden that initially entranced them.

Where is the science in all this? One aspect of a science has to be in the more detailed knowledge of the Pacific coastline that came from surveying, charting and mapping. With those maps other travellers were able to set sail with more certainty of where they would arrive. The map is as much a model of reality as

our mental models of matter, atoms, or the algebraic equations that enable us to predict effects before doing experiments. So Cook was a scientist in that he was both a discoverer and documenter. Some of his companions also built scientific reputations for themselves. None more so than Joseph Banks – the plantsman and then president of the Royal Society for over forty years, who paid a considerable proportion of the costs of Cook's first Pacific voyage out of his own pocket.

Cook's death (I wrote murder and thought better of it) occurred on his third Pacific voyage on Sunday the 14th of February 1799: Valentine's day. It now occurs to me that Cook's death has something of the road accident about it. The driver of a car has ways of negotiating the road. A child that runs in front of the oncoming car - has ways of playing. In our society, the resulting death is commonly accorded the status of an accident. One can see Cook's death as an accident. Cook had built up a repertoire of how to negotiate his way amongst the Islanders he encountered. When some property had been removed without sanction and not been returned, Cook had successfully, in other circumstances, held hostage a senior member of the local community. On Hawaii, axe heads and then a small boat were taken. Beforehand the Islanders had shown their way of offering generous hospitality, particularly for those they initially took to be gods. The return of Cook's ship to Kealakekua Bay broke with their way of negotiating what had earlier been a most unusual occurrence: the actual human embodiment of Hawaiian gods. The resentment felt by the local Hawiians matched that felt by the crew of the Discovery. Cook's death played out a Greek tragedy of Popperian falsification as mental models of appropriate action failed both sides. My interpretation can be challenged. Tony Horwitz takes us through his own views and points to how other, different, interpretations of Cook's death are also contested.

Long before Hawaii, Tony Horwitz's narative takes us to Vancouver, Tahiti, New Zealand and Australia, the Alaskan coast, Fiji and Tonga. He criss-crosses the Pacific in Cook's trail and provides segments of travelogue juxtaposed with segments of history. Once I had got past Cooktown, on the Queensland coast, in my reading, I realised what was going on and stopped being irritated by what had seemed diversionary tales. From then on, it became a bit of a page-turner for me. I wanted to know both what happened to Cook and also what had happened to the places he had visited. I found it a thought provoking read.

"Objects of Culture: ethnology and ethnographic museums in imperial Germany" by H. Glenn Penny. Published by The University of North Carolina Press (2002) 281 pages including abbreviations, footnotes, bibliography and index. £19-50.
ISBN 0-8078-5430-1.
Reviewed by Martin Monk

What am I doing reviewing a book on cultural artefacts housed in museums in imperial Germany? Good question. Well I saw the title in the list of Books Received section of the BSHS journal number 130, and thought it might be an interesting diversion. H Glenn Penny documents the expansion of ethnology museum collections in Berlin, Munich, Hamburg and Leipzig throughout the last quarter of the nineteenth century. Those museums rapidly collected, and then overflowed with large numbers of objects: the Objects of Culture in the title of the book.

Following the Franco-Prussian war and the unification of Germany, the 1870s saw Germans travelling further across the globe and more frequently. Some travel was motivated by trade, some by imperial rivalry and other by the inspiration of Alexander von Humboldt. These travellers came across different cultures. Many soon realised that Western expansion would change these cultures forever. Some travellers sought out original cultural objects. They became engaged in a *salvage anthropology* whereby they *rescued* original artefacts from the rising tide of Westernisation. Objects that were unique were most highly sought, bought and shipped back to collectors in Germany.

Amongst the travellers, and in Germany itself, there were people interested in establishing a *science of culture*: rather than just dealing in, and collecting, objects as art. Scientific knowledge was to be achieved inductively through comparative work on the artefacts collected. One such aspiring scientist of culture was Adolf Bastian (1826-1905). He started out as a traveller/collector. He ended up as the director of the grand purpose built Museum für Völkerkunde on Köninggrätzer Strasse in Berlin. Museum curators like Bastian placed gifted collections of rich citizens alongside purchases of the museums themselves. The buildings that housed these collections were paid for out of local funds raised as a matter of local civic pride. The citizens, museums and curators of Hamburg, Berlin, Leipzig and Munich found themselves in rivalry. At the same time the citizenry, both those who paid for the museums and those who thronged the galleries, had their own purposes. Civic pride and entertainment were at the forefront. Such purposes clashed with those of the curators, who wanted to display collections for scientific study. Museums overflowed with gifts and acquisitions, placed cheek by jowl in ever increasing numbers of glass cases. The scientific enterprise evaporated as an unobtainable dream.

Those interested in the history of science, and/or modern museums that have a scientific theme, will find this book interesting. As they read, doubtless they will nod their heads in recognition of similar problems in today's society. Anyone who goes to the British Museum or even the Science Museum in London will pass through successive galleries demonstrating different equilibriums in multiple tensions placed on science museums by funders, governors, curators and public(s). Science teachers who use such museums for the education of their pupils will also recognise issues that shape the purpose and progress of their pupils' visits. So whilst the title of H Glenn Penny's book appears a tad recherché, the issues it raises are much more familiar.

"Ingenious Women: from tincture of saffron to flying machines" by Deborah Jaffe. Published by Sutton Publishing 2003. 210 pages including patents and chronology 1637-1914, notes, bibliography and index. £17-99. ISBN 0-7509-3030-6.
Reviewed by Martin Monk

I found this both a repetitive book and an interesting book, a frustrating book and an important book, having parochial content and huge implications, narrow in scope and widely researched, by turns irritating and enlightening.

The titles of the chapters give some indication of the coverage. These run: Innovators; Early Ladies; Appearances – bonnets, corsets and umbrellas; Domestic Challenges and Home Improvements; Amusements and Instruction – designs for children; For the Greater Benefit – philanthropy and reform; Transport, Travel and Technology; Queens of Science and Medicine; Exhibitions – London and America; Running the Company; Self-confident Expressionism.

There is little-to-no mention of ingenuity in the standard sciences of physics, chemistry, biology etc. There are occasional tours of business and industry, but these are few. The greater part of the ingenuity reported in the text was ingenuity in the home and concerned with domestic matters and fashion. Knowing that women have contributed to science, I felt short changed by the text. However, looking back over the past three hundred years or so, I know that science has been male dominated with the odd female scientist being the exception that proves the rule. Modern ideas of equality between the sexes are just that: modern. So the book successfully documents the areas where women have had most impact over the three hundred years that are surveyed. Here the text is true to its title and its subject matter. My modern sensibilities made me want ingenuity in science at every turn of the page. I never really got it.

In surveying where women have had most impact in terms of their ingenuity with the material and natural world, I was forced to confront my own prejudices on how the line between science and engineering, engineering and

ingenuity, ingenuity in the workplace and ingenuity in the home are drawn. The patents in the text, and in the appendix, testify to how women, in their traditional spheres of operation and influence, have shown engineering skills to match those of men. They may not have built bridges, railways, ships and planes, but they have changed peoples' lives with corsets, stoves, cleaning apparatus and aids to caring for others. None of the objects and procedures would have seen light of day without their efforts.

Resources

The Association of the British Pharmaceutical Industry (ABPI) has developed a set of web-pages that look at the history of our knowledge and attitudes to disease and medicine. It is targeted at KS3/4. The site can be found at:

http://www.abpischools.org.uk/resources04/history/index.asp

The resource marks out nine epochs. It has a set of biographical details on some of the more influential workers and also has a multiple choice items on pages and at the end. The 'time-line' graphics are very snazzy. Epochs covered are:

- Prehistoric medicine
- Ancient Egyptian Medicine
- Greeks and Romans
- Middle Ages
- Arabic medicines
- The Renaissance
- 18th and 19th centuries
- 20th Century
- 21st Century medicine

Mrs Sarah Jones, Head of Education at the Association (email: sjones@abpi.org.uk),
would be pleased to get feedback.

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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.

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Looking for the poetry of science? We asked Science Friday fans and SciArts producer Christie Taylor about their favorite poems with science themes. Hereâ€™s where they suggest you get started: â€œThe Story of Everythingâ€ by Kealoah (suggested by Christie Taylor and Tracy K. Smith).Â Explain and engage in scientific inquiry with this poem and investigation from The Poetry Friday Anthology for Science for Kids by Pomelo Books. Read More. How To Catch The Flu (Under The Lens). Science poems from famous poets and best science poems to feel good. Most beautiful science poems ever written. Read all poems for science. Best Science Poems: 1 / 100. next science poem Â». Sonnet- To Science - Poem by Edgar Allan Poe. Science! true daughter of Old Time thou art! Who alterest all things with thy peering eyes. Why preyest thou thus upon the poet's heart, Vulture, whose wings are dull realities?