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Edited by Martin Monk

32, Rainville Road, Hammersmith, London W6 9HA
Tel: 0207-385-5633. e-mail: **martin.monk@gtep.co.uk**

Contents

Editorial

Martin Monk

I have been helping Kate Buss with the editing for the past year. Now she has asked me to take over. I wish to thank Kate for more than four years of patience and skill in editing Education Forum. I think we all wish her well in the future. So this is the first issue of Education Forum for which I take sole responsibility

Tuesday 4th May is the deadline for copy for the next issue of Education Forum.
martin.monk@gtep.co.uk

Articles

Poems of science

John Cartwright

In this new series John Cartwright takes a poem each issue of Forum and examines its scientific content. With last year's BBC screening of an updated version of the Canterbury Tales there is more than one reason to start with Chaucer. Forthcoming issues will take readers up to the 20th century.

Geoffrey Chaucer (c1360-1400)

Geoffrey Chaucer led a double life as a poet and public servant and lived through some of the great events of his time: the Black Death, the Hundred Years War between England and France, and the Peasants' Revolt. He read fluently in Latin, French and Italian, was a competent astronomer and mathematician, and read widely in the sciences. His work for the State must have brought him into contact with virtually every sector of society and supplied rich material for his art. Not much is known about his private life. Around 1374 he married Philippa, possibly one of the Queen's ladies. Together they bore a son, the "little Lewis" for whom Chaucer wrote one of the earliest scientific textbooks in the English language, the *Treatise on the Astrolabe.*

His finest work is generally regarded as *The Canterbury Tales,* which he began about 1387. Here Chaucer paints an assembly of characters with all their virtues, faults and foibles laid bare. *The Canterbury Tales* provides a marvellous insight into the various layers of society, their customs and beliefs, in England in the late Middle Ages.

Chaucer’s Doctor of Physic

The medieval medical practitioner had three basic types of treatment: diet, surgery and medicine. Major surgery in the form of deep incisions and amputations was left to surgeons and barbers. Minor surgery, such as cautery (application of a hot instrument to the body) and bloodletting, and the prescription of healing substances, was the province of the physician. In the *General Prologue* to *The Canterbury Tales*, Chaucer provides in just 40 lines a marvellous description of his Doctor of Physic.

With us ther was a Doctor of Physik
In al this world ne was ther noon hym lik,
To speke of physik and of surgerye
For he was grounded in astronomye.
He kept his pacient a ful greet deel
In houres by his magyk natureel.
Wel koude he fortunen the ascendent
Of his ymages for his pacient.
He knew the cause of everich maladye,
Were it of hoot, or coold, or moyste, or drye,
And where they engendered, and of what humour.
He was a verray, parfit praktisour:
The cause yknowe, and of his harm the roote,
Anon he yaf the sike man his boote.
Ful redy hadde he his apothecaries
To sende hym drogges and his letuaries.
For ech of hem made oother for so wynne-
Hir frendshipe nas nat newe to bigynne.
We knew he the olde Esculapius,
And Deyscorides, and eek Rufus,
Olde Ypocras, Haly, and Galyen,
Setrapion, Razis and Avycen,
Averrois, Damascien, and Constantyn,
Bernard, and Gatesden, and Gilbertyn.
Of his diete mesurable was he,
For it was of no superfluitee,
But of greet norissyng and digestible.
His studie was but litel ion the Bible
In sangwyn and in pers he clad was al,
Lynded with taffeta and with sendal;
And yet he was but esy of dispence
He kepte that he wan in pestilence.

For gold in phisik is a cordial
Therefore he lovede gold in special.

(Canterbury Tales, General Prologue, l. 411-444)

The tone is wonderfully ironic and the content rich enough to paint a detailed picture of a mediaeval physician. The Physician is a "Doctour" which means he has won a degree from a university of medical school. The authorities studied by the doctor that Chaucer lists is impressive and includes classical figures, Moslem sources and his own countrymen. What is surprising to the modern mind is that the doctor is praised for his grounding in astronomy, not something that is part of modern medical training. Such knowledge however was essential for medieval physicians and was part of the whole doctrine that the human body was in some way a microcosm of the world at large, a view, which survived well into the 16th century.

The precise influence of the planets on health depended on their position in the zodiac. In addition, it was the configuration of the heavens at the moment of birth that determined a person's physical constitution, their "humour", and hence their predisposition towards certain aliments and diseases. Diagnosis and treatment were further complicated by the fact that it was important to know the position of the star signs and planets at the time of onset of the disease and at the time the physician visits to offer treatment. Knowledge of this timing had to be accurate to within an hour since the hours 'inequal' come under the varying influence of the seven planets. Furthermore, it was held that in each six hour period of each day one of the four humours was dominant: blood from midnight to 6 a.m.; choler from 6 a.m. to noon; melancholy from noon to 6 p.m.; and phlegm from 6 p.m. to midnight. On top of this, the strength of the humouric influence depended on the phase of the moon, being greatest when the moon was full. Each season of the year (and conveniently there are four) had affinities with each of the humours. Summer, for example, being a hot and dry season is associated with the element fire and the humour of choler. So for every individual although the disposition of their humours was partly determined at birth, as the celestial machinery grinds away overhead subtle and ever-changing influences are brought to bear on the body, each hour of the day, each day of the week and each season of the year. No wonder the medieval doctor needed a training in astronomy. This is the essence of Chaucer's remark that he kept "his pacient a ful greet deel/In houres by his magyk natureel". Here natural magic refers to the acceptable science of the day, i.e astrology, as opposed to black magic or necromancy.

The lines "Wel koude he fortunen the ascendent/Of his ymages for his pacient" are amongst the most difficult in the passage. The most probable interpretation is that to "fortunen" the images refers to the practice of placing engraved images of favourable zodiacal signs on appropriate positions on the body of the patient. This procedure stemmed form the belief that all objects fashioned by man bear the imprint of the constellation reigning at the time of manufacture and retain this celestial energy with them until they are destroyed. In a typical clinical encounter the physician might produce a small disc of gold, manufactured, for example, as the sun was entering Aries and so engraved with the sign of the ram, and place this on a patient's head to cure a fever.

So far, Chaucer's physician seems to know his stuff: he has studied sound authorities, ancient and modern, knows his astrology and understands humour theory. Chaucer also tells us he is well connected and organised: his apothecaries are on hand to send him drugs and letuaries

(medical powders mixed with honey or syrup). Moreover, his relationship to the apothecary is tried and tested: “Hir friendshipe was nat newe to bigynne”. The learned physician also looks after himself with nourishing food and avoidance of excess (“superfluitee”). But then with a few careful phrases Chaucer destroys what illusion we may have about the integrity of the learned doctor. We find, for example, that there was none to match him for *speaking* of physic and surgery. Perhaps the physician is a little too fond of his own voice or is all bombast and no substance. Chaucer’s readers would also understand that his long-standing arrangement with apothecaries is designed to ensure that they both share the exorbitant profits charged for drugs containing cheap or useless ingredients. In a curious line Chaucer tells us that he little studied the bible. We could read this as the fact that the pious physician is too busy with good works for such reading. More likely, we are to note that he is a godless man. Indeed medieval theologians eyed physicians, with their study of pagan and heathen authors, with some suspicion. The physician is wealthy and fashionable; even for a pilgrimage he is clad in clothes of red (sangwyn) and blue (pers or Persian blue) lined with expensive thin silk. He is not overgenerous with his wealth however: he is “esy of dispence” , in other words reluctant to part with money he has gained from disease (pestilence). Now gold was supposed to be a useful remedy, in its drinkable form it was called aurum potabile, but in reality it simply bumped up the price of medicine for no medical benfit. Unsurprisingly, this physician especially loved gold.

John Cartwright: j.cartwright@chester.ac.uk

Deadening uniformity or liberated pluralism: can we learn from the past?

Martin Monk

Can we learn from the past? Can we learn from the past to create a better future? Can we learn from the past to create a better future without making the mistakes of the past? In this brief article I want to show you that we can. Furthermore I want to turn to the history of science to do this. But I need to make use of some history that is not immediately associated with science as a preamble. That piece of history is the Reformation.

The Reformation in England (roughly the 1530s to 1660s) is marked out by historians as a period of great change. Change was more violent and fast moving than at other times. Successive Tudor and Stuart monarchs presided over, and contributed to, a lot of unhappiness about religious belief. In making the first break with a Rome centred orthodoxy the opportunity arose for a whole range of different perspectives: the dissenters dissented from each other. Following the initial schism and oscillations, Elizabeth I struggled to unite her people in a single church. Under Charles I the fragility of that unity was exposed with a civil war. Over the following decades the tight grip required by a single faith was gradually relaxed and we are heirs to the more tolerant pluralism that emerged in 1689 with the Act of Toleration.

In the UK. our acquiescence to a single Science in the National Curriculum grew from the best possible motives. Generally, through the 1970s and into the 80s, the belief that all youngsters in a modern democracy should be given equal opportunity wherever possible grew in currency. The old divide of boys doing physics and girls doing biology was unacceptable. The old divide of grammar school GCE and secondary modern CSE examination was unacceptable. However, in making equity our goal we sacrificed one of the most important principles in education: youngsters need to feel they are making progress at something that interests them. By focussing single mindedly on one principle, necessarily compromises others. Because we science teachers wanted everyone to be given the same chance, that very aim guaranteed some youngsters would be switched-off science by the very programme of study they shared in common. Luckily for us, our pupils have not resorted to civil war. What they have done is vote with their feet. Science is being deserted for more attractive subjects: refugees are on the curriculum road.

Now comes my lesson. Having come through nearly twenty years of a single science education within the National Curriculum, we are at the dawn of our own relaxation of the need for a single faith. The programme of study for 14-to-16 year olds is to be opened up. Instead of a single view on what constitutes a suitable science education for our youngsters, we are to have two. The recommendation is for a core and two different options. These will not be like the single and double science currently existing. For single science is essentially double science with bits missing. No, in the near future, one option is to be more vocationally orientated and one more academic. The same science treated in different ways. The lesson I draw from the Reformation is that where a single schism is introduced, pluralism can follow. So whilst you may be rejoicing in the opportunity the core plus two options create, I am already looking for multiple alternatives.

The future is not the past. There is a feature of the past we must dispense with. The binary divide of academic and vocational is unsuitable for the modern world. The modern economy is not one in which a clear division between academic and vocational appears. Instead we have a proliferation of sectors and activities where flexibility is the key to survival. We cannot go back to the future. Early twenty-first century youngsters are not to be so easily shoe-horned into such simple categories. Modern youngsters are interested in themselves, music and culture, fashion and design, the past and their futures, helping others and having a good time. Some, but not all, are also interested in the natural world, what it consists of and how it works, how we explain it and how we can use our ideas to make things happen at will. If we are to learn from history and not repeat its mistakes, we need a pluralism of options, beyond the core for 14-to-16 year olds, that builds on the multiple interests and talents of our youngsters. These options need to allow our youngsters to be successful in learning science on their own terms.

What might these alternative multiple options be like? Well, if we are to learn from the past, they have to come closer to addressing the plural interests of our youngsters than before and yet still cover biology, chemistry and physics. I can immediately offer several different alternatives. A first is to approach biology, chemistry and physics through the history of science itself. This would involve studying scientific themes like our views on reproduction, or our views on the nature of the universe, and spending time looking at how those ideas have changed and why. A second is to look at the way the materials produced through technological advance have shaped the range of opportunities for different cultural alternatives. This would involve studying the production of materials and how they are put to use. The materials could be both biological as well as non-living. I might call this the anthropological/sociological option. A third is to look at the science behind the contemporary technical world. One component might involve studying topics such as the science behind communications – music and art – the biological and physical. I might call this the technological option. Obviously others can think of different alternatives to mine. What should be common to our efforts are the principles of pluralism and the interests of our students.

Have I gone back to the future in recommending something that looks suspiciously like the old CSE mode 3s? Well I think not. Firstly, these options would be limited in number. Even though I was able to offer three alternatives above, there will not be a large number of alternatives. Secondly, and similarly, when there were CSE mode 3s there were many examination boards, now there are only three. Thirdly, each of the alternatives above contains elements of biology, chemistry and physics where CSEs didn't necessarily do so. Fourthly, and again similarly, the alternatives will have to pay attention to Science in the National Curriculum and the core to the 14-to-16 programme of study.

To conclude, I want to return to the first of my options, the historical one, and declare a vested interest. The British Society for the History of Science has an Education Committee that is charged with promoting the history of science. We now see an opportunity to press forward with our mission. We are seeking fellow travellers who have an interest in the history of science. Our aim is to design a suitable programme of study for 14-to-16 year olds that would enable youngsters to learn their science with an historical perspective. If you think you might be a fellow traveller, we would be delighted to hear from you. You can contact us through:

Martin Monk: martin.monk@gtep.co.uk

This article also appears in the next issue of *Education in Science* published by the Association for Science Education.

A Tale of Two Teachers?

Peter Fowler

Introduction

Issue 41 of Education Forum carried an article I wrote on the contrast between the way the National Curriculum opens up opportunities for teachers both to teach the History of Science (HoS) and use the HoS to teach science, and the way exam questions set by the Edexcel examination board limit that opportunity. In conversation about the article, Andrew Hunt, of the Nuffield Foundation, remarked there were two types of teacher: those that use HoS in their teaching, and those that do not: hence *A tale of two teachers*.

Teacher A

Teacher A is a good, conscientious teacher. He actually exists and I know him well. He wants his pupils to achieve their best and learn as much science as possible in his lessons and when they do science homework. However, he realises that even though he has high aims, he has to compromise because of pressures outside of his control.

Teacher A sees the National Curriculum as having too much content to allow pupils to learn in the best way for them: the over-riding method of instruction has to be *transmission*, the transfer of knowledge and understanding (K&U) from the teacher to the pupil. Teacher A realizes that the emphasis is on the science K&U rather than the pupil. However, to make this transfer as efficient as possible, Teacher A has to plan lessons quite thoroughly, starting with aims and objectives, with an eye on the assessment of learning outcomes. Teacher A has also to think about the fact that there is a KS3 strategy, where he is *encouraged* to use starter activities and plenary sessions at the end of lessons to improve the efficient transmission of K&U. There are also whole-school policies on literacy, numeracy, ICT, thinking skills and citizenship, elements of which teacher A is also *encouraged* to introduce into his lessons. Then the list is made yet longer because he should not forget the all-important practical investigations and the skills required to achieve high marks in the national Key Stage tests.

Each lesson has to cover multiple objectives. To fit all this in, science lessons are highly structured. Teacher A regrets that it is probably the repeated familiar structure of science lessons that remains long after much of the fleeting unfamiliar content has been forgotten. For pupils past and present the structure of science lessons becomes synonymous with Science. Pragmatically, teacher A also knows that good marks and grades are not the same thing as a good understanding of science ideas, particularly when applied to real life contexts.

Teacher A knows that HoS is not assessed directly at KS3 and hardly at KS4 – it only appears occasionally as a question context. How can he fit HoS in when he looks at all the other things that have to be added into his lessons: HoS is at the bottom of teacher A's list of priorities. It is a bolt-on that drops-off. In fact teaching HoS is often seen by teacher A as incompatible and irrelevant to the teaching that he has to undertake. This is Andrew Hunt's teacher who does not teach the history of science.

Teacher B

I happen to know Teacher B as well as teacher A. Teacher B considers the balance in science education purveyed in the documentation of the National Curriculum to be wrong. Teacher B knows, in common with teacher A, there is too much content. For teacher B, although

education is about content, it is also about learner-centred skills, and context. One does need to pay attention to the skills and abilities learners need to acquire. But neither K&U nor skills are of any value unless they occur within a context that makes sense of them. That context is provided through science as a social activity.

Teacher B believes that a narrow focus on the content, as understood by most teachers' reading of the National Curriculum in England & Wales, actually denies pupils and students access to their own heritage and culture because it divorces content from context, both historical and current. Teacher B is convinced the HoS provides good opportunities for learning and understanding science because it looks at contexts within which science ideas developed and were understood in the past.

Teacher B looks beyond the pupils' time in school to their lives outside of school and when they grow and become adult. By stepping back from the content and taking into account context and the learner, a different approach to school science is possible. Teacher B calls this the *science-as-culture* approach. He contrasts it with the science *rationalistic* approach to science education. The backbone of Teacher B's science-as-culture approach is the HoS.

Working with modular courses, teacher B takes the module content and reworks it so that it to a theme more compatible either to HoS or a more contemporary issue. Because he is working on his own (his colleagues are less interested) Teacher B sees the whole of his professional practice as a large educational experiment (or research) to investigate different ways of teaching and learning science. Teacher B is obviously one of Andrew Hunt's people who does use the HoS in his science teaching

Comparing Teacher A and Teacher B
I want to look at two related issues to locate these two teachers, these are (i) degree of pragmatism and (ii) field of view.

Teacher A is the more pragmatic. Teacher A recognizes that there are competing forces acting on the choice of material. The most pressing is that youngsters in his classes do well in the examinations. Because the examinations make only occasional, contextual, reference to anything in the history of science, the history of science can be ignored. Teacher A, therefore spends a great deal of classroom time on the successful results of past studies of natural phenomena and very little classroom time on the cultural practices of studying natural phenomena. Teacher B is less pragmatic. For teacher B the reason for studying science is to understand how scientists understand the natural world about us. So the history of science is of the essence, even if it is not in the examination.

Being more or less pragmatic leads to different locations on the second issue of field of view. Teacher A focuses on a narrow view of the pupils' immediate needs: to train them to pass the examinations. The bigger picture of science as a culture is therefore out of focus. Teacher B's view of science as culture has a wider field of view. It focuses on the pupils' wider needs to be educated to understand and play a role in their society.

Both teachers are looking at different, but complementary, facets of teaching and learning. And these two facets are as important as each other. All teachers know, from experience, that the idealism of the aims and objectives that may appear in lesson plans, schemes of work, course specifications, and national curricula have often to be tempered and compromised with the realities of the classroom. But at the same time aims and objectives (and underlying educational directions, theories and traditions) enable teachers to produce lesson aims and objectives in the first place. The big picture cannot exist without the small picture and vice versa.

Professionalism?
Teachers A and B are one and the same person. They are caricatures of different sides of myself. Andrew's stark dichotomy left out those, like myself, who live a Jekyl and Hyde life every time they set foot in the science laboratory at school.

It is evident from my experience as a teacher that the pragmatic concerns of the classroom are considerable, complex and frustrating and can take over the thinking of individual teachers and thus forcing the big educational picture to fade and disappear. It has and does happen to me, particularly when the same thing is happening to everyone around me. It is perhaps only by being a member of the BSHS that I have been able to (sometimes) snap out of the pragmatic way of thinking and think more about the meaning of HoS in education. I believe that this is what professionalism is meant to be about - **not** focusing on only one facet of education.

Over the last few years I have connected both the big and small pictures. In particular I have had occasion to reconcile the two in taking HoS into my science teaching. This has been one aspect of my personal professional development. Other teachers can travel the same path. I think that there are four steps that teachers need to identify and understand.

The first step is for science teachers to get past the inadequacies, limits, frustrations, etc. of the conventional view of science education at the present time in England & Wales (i.e. the pragmatic, small picture). Secondly, teachers need help with finding an alternative to the conventional view. Thirdly, teachers need to see how they and their pupils can benefit from an adoption of parts of the new view, creating a customized synthesis. As a fourth step, trialling new ways of working in the classroom needs to be seen as an evolutionary process that is part of the action research. Such action research was Donald Schön's (1987) way of defining the reflective practitioner. The four steps must be carried out within the framework of the teacher's own teaching for it to have long-lasting effects. This is the lesson that comes from the work of Joyce and Showers (1988) meta-analysis of effective in-service training.

Andrew Hunt's observation divided the world into those that do and those that don't. My personal experience, and testimony here, is of Andrew's two teachers inhabiting the same body: mine. Transcending such schizophrenia is a possibility if one sees action research as being part of professional development.

References

Joyce, B. and Showers, B. (1988) *Student Achievement Through Staff Development.* New York: Longman.

Schön, D.A. (1987) *Educating the Reflective Practitioner*. London: Jossey-Bass.

Peter Fowler: petfow@hotmail.com

News items

THE TYRANNY OF TREATMENT
Samuel Johnson, his friends and Georgian medicine.
An exhibition at Dr. Johnson's House
17, Gough Square, London EC4A 3DE

By looking at the lives of Dr. Johnson and five of his closest friends, this exhibition explores how a range of medical conditions was regarded during the eighteenth century. The displays include descriptions of the often extraordinary treatments used for blindness, depression, venereal disease, breast cancer and various childhood ailments.

Open Monday to Saturday, 11 am to 5 pm.
£4 adults, £3 concessions, £1 children
Entrance to the exhibition included with ticket for the museum.
For other details: curator@drjohnsonhouse.org

ENIGMA OUTREACH
Secret codes can be a fantastic way of generating excitement about mathematics and history. Code breaking develops skills in data handling, problem solving and logical thinking. You can book a code-breaking workshop with a genuine Enigma machine in your school with a Bletchley Park guide via:
- Kay Jamieson , tel: 01908-631129
e-mail: kjamieson@bletchleypark.org.uk
- Claire Ellis, Web page: www.simonsingh.net/Enigma_Schools_project.html

Information on Bletchley Park, which is open to the public, can be found at:
www.bletchleypark.org.uk

MUSEUM OF THE ROYAL PHARMACEUTICAL SOCIETY
The Royal Pharmaceutical Society has had a museum collection since 1842. The 45,000 items collected since then cover all aspects of British pharmacy history, from traditional dispensing equipment to 'Lambeth defltware' drug storage jars, and from proprietary medicines to medical caricatures. The museum provides:

- An historical research service based on the information, archives, photographs and objects held by the museum;
- Research of pharmacists career histories and the history of premises;
- Reproduction of images from a photographic archive;
- The loan of two traveling cases;
- Sales of books, postcards, greetings cards and other merchandise directly from the museum and by mail order.

For more information see the website at: www.rpsgb.org.uk

e-mail: museum@rpsgb.org.uk
Telephone: 0207-572-2210

HISTORY OF SCIENCE SOCIETY DISCOUNT

The History of Science Society (USA) is once again pleased to extend a special offer to members of the British Society for the History of Science to join the HSS at a 50% discount. This unique opportunity for members of sister societies to enjoy the benefits of HSS membership. It is prompted in honor of the joint BSHS, CSHPS and HSS meeting to be held August 5th to 7th 2004 in Halifax, Nova Scotia.

Details are to be found at: http://www.journals.uchicago.edu/Isis/order1.html

EINSTEIN YEAR

The Institute of Physics is putting on a range of events in 2005 to celebrate the centenary of Einstein's *annus mirabilis*. What's in store for 2005 includes:

- A specially commissioned production by the Rambert Dance Company.
- Up to three mass participation experiments.
- A pantomime for youngsters based on the "Uncle Albert" books.
- A touring exhibition.
- A poster campaign on buses supported by a web-site.
- A Europe-wide outdoor exhibition of awe-inspiring physics based photographs.
- A collaboration with the Premier League to produce an interactive web-based activity on the physics of football.
- The equipping of up to five lorries with experimental physics apparatus to tour the UK.
- A national party to celebrate Einstein's birthday on 14th March.

If you would like more information:
visit the web site at: networks.iop.org/archives/einstein2005.html
or contact: Caitlin.Watson@iop.org

EDUCATION COMMITTEE VACANCIES

The Education Committee of the BSHS is in the process of reviewing its tasks and responsibilities. We are looking for BSHS members to join us to help with the following:

1. Representation at the ASE annual meeting
2. Production of *Education Forum*
3. Presence at BSHS annual conference
4. Presence at ASE regional meetings
5. Development of teaching materials and resources
6. Representation to Examination Boards
7. Maintenance of Web site for teachers
8. Linkage between secondary and higher education

9. Linkage with Science museums

If you would like to join us, Peter Fowler would be pleased to hear from you.

Contact: petfow@hotmail.com

Forthcoming events

BSHS CONFERENCE, 2004
The 2004 conference is scheduled to take place at the Everton Campus, Liverpool Hope University, June 25th – 27th, 2004.

The Education Section is planning to build on the 2003 experience and incorporate more activities for local teachers in the area. We would also like to create more opportunity for a dialogue between BSHS members – yourselves – and those interested in incorporating history into their science teaching.

If you have ideas for activities/ events please contact: petfow@hotmail.com

HISTORY OF SCIENCE SOCIETY CONFERENCE, 2004
The 2004 conference is scheduled to take place in Halifax, Novia Scotia, August 5th – 7th, 2004. It is a joint meeting of the CSHPS, HSS and BSHS.

Details can be found at: http://www.hssonline.org/3Societies/index.html

Reviews

"Great Physicists: the life and times of leading physicists from Galileo to Hawking." by William H. Cropper.
Published by Oxford University Press (2001). 500 pages. £24.99. ISBN 0-19-513748-5.
Reviewed by Patrick Gavin.

This book, by the Professor Emeritus of Chemistry at St Lawrence University, is a pleasure to read and the author is well served by his publishers. As the subtitle indicates, the book is much more than thirty brief biographies. Each physicist is treated sensitively and sympathetically as a person and located in an academic environment so as to bring out the influences which acted on him and the influences which he in turn passed on to others. The book reads like a labour of love: it is the distillation of many years of study of the fine details of the great moments in the progress of Physics and of deep reflection on issues in the History of Science. Great Physicists also serves as an excellent reference book for ideas and facts : there is a detailed Index, a generous Glossary, a Chronology from 1564 (the birth of Galileo) to 2000 (the tau neutrino), and a sensibly brief Invitation to More Reading for each Chapter, giving just the most recent, or most important , references.

In Cropper's Pantheon there are thirty Great Physicists, but we are introduced to many more, so that for instance, in writing about Rutherford we meet J.J. Thomson, Soddy, Chadwick, Geiger, Marsden, Moseley and others and their individual contributions are carefully explained. The author does not shy away from quoting the appropriate Mathematics, for as he says : "Mathematical equations express the language of Physics". But the equations discussed are for the most part well within the range of a final year student at school , and the author is always at pains to stress the physical reality behind the equations, for example, Maxwell's equations for electromagnetic radiation, so that the general reader need not be deterred. Cropper makes due acknowledgement to the books by the late Abraham Pais, the subject matter of which often overlaps with Great Physicists.

If we consider the country of origin of the thirty Great Physicists then the tally runs : Germany (including Austria) 11, Great Britain 8, the USA 4, France and Italy 2, Denmark ,Poland and India 1 .There are two women, Madame Curie and Lise Meitner. There are no Russians, but Mendeleev, Landau and Kapitza get passing references. The book is divided into nine sections, Mechanics , Thermodynamics, Electromagnetism etc, but the rigidity which this might suggest is offset by the author's diligent cross-referencing to linking themes in the History of Scienc, eg the interplay of theory and experiment.

Each section is introduced by an Historical Synopsis which sets the scene. Modern Science begins, or at least took a great leap forward, with Galileo and the emphais on experiment, observation and mathematical formulae. Perhaps some reference might have been made to Greek and Medieval Science. Cropper carefully follows Galileo's reasoning in arriving at the equation for free fall.

In 1642, on the 8 th of January, Galileo died and Newton was born, on Christmas Day; on the 8 th of January 1942 Stephen Hawking was born. Such trivial, but memorable, details and anecdotes enliven the book. Newton's Laws of Motion, Gravitation, the Calculus and the Optics are discussed, and also his complex personality and interests in Alchemy and Biblical

Studies. The present reviewer once counted ten topics on the A-level Physics Syllabus which were first introduced by Newton. In the penultimate Chapter on Chandrasekhar, Cropper mentions that before he died Chandra worked thoroughly through the Principia and was continually astounded by Newton's genius. Newton takes first place in the Pantheon.

A Physicist might ponder the different styles of working. Faraday and Feynman have left us visual models; Maxwell tended to work by analogy; Schrodinger and Dirac wanted beautiful equations; Einstein wanted more than statistics in Quantum Mechanics. Bohr was always talking; Dirac hardly said a word.. Fermi was eminent in both theory and experiment, and was a distinguished teacher. Robert Mayer jumped from an observation of the colour of blood to the First Law of Thermodynamics.

All the Physicists in our Pantheon were driven by a seemingly overpowering urge to understand the workings of the physical universe. Arthur Koestler used the expression "The Sleepwalkers" and the poet Alfred Noyes "The Torchbearers" When trying to describe this collective, sequential urge. Professor Cropper has given us a lucid and thought provoking survey.

"Mercator: the man who mapped the planet." by Nicholas Crane.
Published by Pheonix Paperback (2002). 397 pages including notes, bibliography, colour plates and index. £8.99. ISBN 0-75381-692-X.
Reviewed by Martin Monk.

I found this is a good read. Nicholas Crane has combined elements of the familiar and strange into a tale that has heroes and villains, tension and tenderness, feast and famine, a race against time, and events that changed the course of history. No mean feat.

Mercator was born Gerard Kremer on the 15th of March 1512 in Rupelmonde, a small town on the western bank of the Schelde, a little way up-stream from Antwerp. He died eighty two years, thirty seven weeks and six hours later on the 2nd of December 1594 in Duisberg on the eastern bank of the lower Rhine. His health had deteriorated with a series of strokes. The first being when he was seventy eight. His great project, a complete and up-to-date atlas was finished by his sons and grandsons. It was still incomplete on his death. Only when the atlas was re-published in 1606 did Mercator enjoy posthumous widespread fame. Prior to that he was known as a good, reliable and painstaking cartographer amongst a small band of map and globe makers whose clients were the warring aristocrats of the Holy Roman Empire that included the emperor Charles V himself.

Nicholas Crane provides a fairly strong sense of cause and influence in explaining why Mercator became the cartographer he died. Mercator was the last child of seven born into a poor family that was relying on an uncle in religious orders to help support them. When Mercator was born, the family had only recently moved to Rupelmonde from Gangelt, due east, two thirds of the way to Cologne. Schooled at 's-Hertogenbosch to the north where the Maas turns west to meet the north sea Gerard Kremers Latinised his name to Gerard Mercator in 1530 before moving to Louvain to further his studies. Nicholas's point is that moving back and forth across the flat watery landscape of the low countries provided Gerard Kremers/Mercator with just the right experiences to take an interest in where places where located and how one got from one to the other. But he wasn't the only one travelling. Nicholas Crane suggests that what added to this common experience was the extraordinary meeting with his mathematics tutor and life long friend Gemma Frisius (1508-1555) who taught him how to triangulate between points.

The low point of Mercator's life must have been his imprisonment in the castle at Rupelmonde between February and September in1544. He had been named. He had been named by the clerics at Louvain. Many of those named died at the stake or were buried alive. They were dangerous times. Here is a story to set alongside that of Galileo's embroilment with the inquisition. Hollywood should buy the film rights now.

Scientifically, the high points of his life passed without notice or with grumbling irritation by others. In 1541 he added rhumb lines to a globe he was making. (Rhumb lines are the path travelled by a ship travelling on a constant compass bearing.) In 1569 his rumination over navigation and the problems of compass bearings came to fruition with his publishing, "A new and more complete representation of the globe properly adapted for navigation." This map was unlike any ever published before. A distortion was deliberately introduced so the lines of longitude and latitude created a rectilinear grid – ever since known as the Mercator projection. With this projection, the rhumb lines appeared as straight lines. For the first time ever, ships' captains could chart their progress across the map, using compass bearings, as

though the spherical globe were as flat as the land of the low countries. Navigation never looked back. The map was not too popular at first. Globe makers, who printed conjoined segmented gores to glue onto their globes were most puzzled. Especially as they knew Mercator was a successful globe maker himself.

Mercator's second break with tradition was to design his grand project of an atlas with pages whereby there was continuation across the margins of the pages. In this way a user could follow a path from one page to another without getting lost. All around the margins of pages the same towns, villages, rivers and hills allowed the navigator to follow on. This is so common nowadays as to be standard to all books of maps. It was Mercator who did it first.

How can one use this book in teaching science? Well Earth science has a shifting relationship with physics as curriculum reforms ebb and flow. What I take away as science is the problem of representing the world. It is the representational aspect that I think is both fascinating and important. This is particularly the case as the Mercator projection is just that - a projection - and therefore not caught up in a realist view, as with the gores to be glued onto a globe. The Mercator projection has an instrumentality in that it can be used to navigate. In this sense it provides a science. This is science as having the power to predict – to predict where on Earth one would arrive, if one set sail from here on a particular compass bearing. With the current school curriculum in England and Wales this will not turn up in science. It will turn up in physical geography.

“The Lunar Men: the friends who made the future.” by Jenny Uglow.
Published by Faber and Faber, 2002. 588 pages including chronology, reference sources and footnotes, list of illustrations and index. RRP £9.99. ISBN 0-571-21610-2.
Reviewed by Martin Monk.

I found this a frustrating book to read. Obviously any read is interactional and my usual strategy of snatching time to read when travelling didn’t pay off. At the same time, I do think there is a problem with the narrative of the text. If you read in snatches then you need a strong story-line to provide continuity. Jenny Uglow’s text is not that strong in a story line. The reason for this is that the story is that of the Lunar Society. And societies are multifarious in their membership, operation and function. There was so much going on in the opening chapters, as Jenny set the scene, that I became irritated by the fact that every time I picked up the book afresh, what I then read about had little to no relationship with what I remembered from my earlier reading. I was actually ready to give up.

In her choice of topic, the Lunar Men, Jenny appears set to counter the ‘great man’ (singular) picture of the history of science. For here we are introduced to friends, who, being in the plural, are obviously going to be more than one great man. At the same time this is not a history of the Lunar Society per se. We are not treated to a chronology of meetings, events and outcomes. We are treated to interwoven biographies. The effect of relating these biographies is not one of a single narrative strand but rather patterned strands that make up the length of a knitted scarf. The scarf of the Lunar Society comprises the interwoven yarn(s) of the biographies: they cross, intersect, hold each other in place and even allow for unravelling. It would have to be an extremely skilled author to be able to make this hold together. In places, for me, the text produced the effect of tangle rather than knitting. Is this because that is how life is in principle?

The sub-title is that of “the friends who made the future”. These friends are major and minor. The dominating trio in the story line are Matthew Boulton and Erasmus Darwin and Josiah Wedgwood. The minor friends include Joseph Priestly, James Watt, William Withering, James Keir, William Murdoch, Richard Edgeworth and Thomas Day as well as Joseph Wright, the painter . Then there are more distant friends, associates and influences in Benjamin Franklin, Thomas Bentley, James Brindley, Joseph Banks, Joseph Black, Francis Egerton 3rd Duke of Bridgewater, Sir William Hamilton (husband of Emma, of Nelson fame), George Stubbs, the painter etc. etc. These, of course are all white males who for the most part were comfortably off. The brothers, sons and grandsons are minor characters in Jenny’s pagent. Only one woman enters the text as having anything to contribute that is of the same standing as these men and that is Anna Seward. In the text, Jenny has her living in close proximity to Darwin at Lichfield, and therefore interacting with Darwin, on numerous occasions. For the most part, the mothers, wives, sisters and daughters remain that. Perhaps this catalogue of participants gives you some idea of why the knitting together of biographies can occasionally become a frustrating tangle.

The trio of Boulton, Wedgwood and Darwin carry the burden of the great man view of history. Doubtlessly, history would have been different had they not lived or taken part in these activities. The circle of the Lunar Society friends carries the burden of reminding us that these great men could not have made their intellectual contributions alone. The sisters, cousins and aunts (not to mention their servants) remind us that the great men and their friends would otherwise have been starving, cold and naked without the familiar support

machine. Events, like the riots in Birmingham that resulted in Priestly's house being trashed and his flight to London, and ultimately North America, remind us that wider political and economic events provide not just a context, but also are also an integral element in the intellectual progress the great men made.

How can one use this in teaching science? Well there are bits of text that could be abstracted for use when covering particular topics. This will mean looking for biographical detail on the great men via the index. So Withering, Watt, Priestly, Black and Banks are the ones that I see as being of immediate interest to secondary teachers. But it would be a cutting-and-pasting job. This leaves out our trio of Boulton, Wedgwood and Darwin as being also-rans: something of a reversal to their priority in the text. One could possibly take momentous events, like the Birmingham riots, to illustrate the social context of science. References to Joseph Wright and George Stubbs, the artists, really require illustrations and a visit to art-galleries. This will need preparation visits to set it up as a worthwhile activity.

So here is a puzzle. On the one hand, Jenny Uglow's text conveys the nature of the emergence, support, growth, transference and decline of scientific activity in the lives of real people. But at the same time, in order to get one's own head around this, particularly as a learner and not as an aficionado, one needs to follow one strand to make sense of the booming buzzing confusion. Jenny has managed to get her head around the knitted lives of this group of friends. I am still struggling to distinguish the scarf from the knitting.

“Gods in the Sky – Astronomy from the ancients to the Renaissance”
by Allan Chapman. TV : Channel 4, 3 one-hour programmes,
first shown in August 2003, and repeated in January. 2004.
Associated book (2002), pp342. ISBN 0 7522 6164 9
Reviewed by Patrick Gavin.

Dr Chapman’s book is a clearly written account of the development of Astronomy from its origins in Mesopotamia and Egypt up to 1650. The Astronomy is discussed in the context of the religious and cultural settings. The author makes clear his own belief that the development of modern science was assisted by religious monotheism, which gives a definite source for the rationality and intelligeability of the Universe.

This theme has also been discussed independently by S.Jaki in ‘Science and Creation’ (1974). Dr Chapman traces the development of arithmetic and geometry in Mesopotamia and the accumulation of astronomical data and its interpretation. The Babylonians introduced the 360-degree circle and used the sexagesimal system of reckoning. Throughout practical aspects and instrumental details are emphasised. Roger Bacon’s experiments on the rainbow at Oxford c.1250 illustrate the point that experimental science was being conducted in the Middle Ages. There is a final Chapter on ‘Astronomy , Religion and Culture from 1650’.

The style of the television programmes is markedly different from the straightforward account in the book: here we are entertained as well as being informed and taken along at a brisk pace by a production displaying considerable verve and panache and imagination. The apparently vague myths of Egypt are shown to be tied to astronomical observations, with practical applications such as predicting the annual flooding of the Nile. Delightful use of marionettes gives a vivid rendering, a walk-on appearance of Patrick Moore as the Sun God Ra provides a humorous touch. The irrepressible Dr Chapman, with bowtie and waistcoat, cycles past the pyramids. From time to time the programmes revert to the Library of the Royal Astronomical Society where Dr Chapman, reclining comfortably in an armchair, expatiates on the themes. In dealing with Greek Astronomy I thought that the account of Eratosthenes’ calculation of the Earth’s radius could have been made clearer, given that it is a superb example of a very significant result coming from a simple observation, and it is quite intelligible to GCSE candidates. Altogether a very stimulating production by Channel 4 and much to be welcomed by those concerned with the History of Science.

Resources

THE WRIGHT BROTHERS AND FLIGHT
The anniversary event was the flight by Wilbur at Kill Devil Hills, Kitty Hawk North Carolina, on December the 17th 1903. Wilbur flew the bi-plane designed and built with his brother Orville, a distance of 40m in 12s.

It is not too late to access web-sites for history information.
Try: www.wam.umd.edu/~stwright/WrBr/tale-plane.html

For paper planes access:
www.workman.com/fliersclub/downlaod.html
www.geocities.com/peterkunzmann/instructions.html

For general articles, try Physics Education Volume 38, Number 6, November 2003.

DARWIN AND DESIGN: Does Evolution have a purpose? By Michael Ruse
Published by Harvard University Press £19-95. ISBN 0-674001023-X.

150 years after Darwin, why do people still speak about natural selection in terms of intelligent design? The intricacies of the eye, they say, must be the work of God. The same can be said for the hand. How important is Darwin these days? It was once thought that Darwinism would eliminate less scientific thoughts, but this does not seem to be true. Within science there are still fierce debates over issues of design and purpose versus Darwinism. Michael Ruse, a well known authority on Darwinism, uses both philosophy and history to provide a definitive overview of the debate, its history and who the proponents are on both sides.

HOW TO WIN THE NOBEL PRIZE: an unexpected life in science. By J. Micheal Bishop. Harvard University Press. £18-95. ISBN 0-674-00880-4.

In 1989 Michael Bishop and Harold Varmus were awarded the Nobel Prize for their discovery that normal genes under certain conditions can cause cancer. In this book, Bishop tells us how he and Varmus made their momentous discovery. More than the lively account of the making of a brilliant scientist, How to Win the Nobel Prize is also a broader narrative combining two major and intertwined strands of medical history: the long and ongoing struggles to control infectious diseases and attack the causes of cancer.

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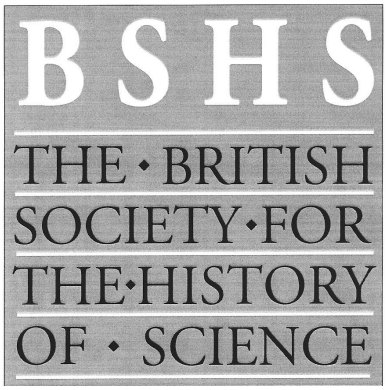

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