Historical Group

NEWSLETTER
and
SUMMARY OF PAPERS

No. 67 Winter 2015

Registered Charity No. 207890

COMMITTEE

http://www.chem.qmul.ac.uk/rschg/
http://www.rsc.org/membership/networking/interestgroups/historical/index.asp

RSC Historical Group Newsletter No. 67 Winter 2015

Contents

From the Editor

Welcome to the winter 2015 RSCHG Newsletter. If you have received the newsletter by post and wish to look at the electronic version it can be found at: http://www.rsc.org/historical or http://www.chem.qmul.ac.uk/rschg/

On behalf of the RSCHG Committee I would particularly like to welcome any new members to the group who are reading this newsletter for the first time. If you have any ideas for articles or would like to contribute, please do contact me. Also if you would like to receive a hard copy of future issues of the newsletter, please email our membership secretary, Bill Griffith via w.griffith@imperial.ac.uk

The spring RSCHG meeting on Sir John Cornforth will be held on Wednesday 18 March 2015 at the Royal Society of Chemistry, Burlington House, commencing at 1.30 pm. Full details on how to register for the meeting can be found in the flyer enclosed with the hard copy newsletter and also after this introduction.

This issue contains a wide variety of news items, articles, book reviews and reports, plus there is another mystery object to help identify. Readers' suggestions are also invited for any additions to the list of published histories of British Chemistry Departments that Bill Griffith has compiled. We also look at the activities of the Historical Division of the Gesellschaft Deutscher Chemiker, when William H. Brock provides a summary of the latest issue of their publication *Mitteilungen*. There are two short essays: the first is "Jeremy Bentham, Chemist Manqué" by Alwyn Davies. This is followed by an article written by Alan Dronsfield, Pete Ellis and John Pring, entitled "From Waterloo to Thiopentone: The Early Chemical History of Intravenous Anaesthesia".

This issue contains a broad selection of book reviews. The following titles are featured: Philip W. Anderson's *More and Different: Notes from a Thoughtful Curmudgeon*; Michael Freemantle's *The Chemists' War 1914–1918*; Kersten T. Hall's, *The Man in the Monkeynut Coat;* and Peter Reed's *Acid Rain and the Rise of the Environmental Chemist in Nineteenth-Century Britain*. The section ends with an essay review of Mary Jo Nye's *Michael Polanyi and His*

Generation: Origins of the Social Construction of Science, by Derry Jones. There are reports on the RSC Chemical Landmark Plaques unveiled at Johnson Matthey Plc, the University of Strathclyde, Saltend Chemicals Park, Hull and the University of Nottingham. A report also appears of the last RSCHG meeting: "Chemistry and World War One", held at Burlington House on 22 October 2014.

Finally I would like to thank everyone who has sent material for this newsletter, with particular thanks to the newsletter production team of Bill Griffith and Gerry Moss. If you would like to contribute items such as news, articles, book reviews and reports to the newsletter please do contact me. The guidelines for contributors can be found in the summer 2012 edition or online at: http://www.chem.qmul.ac.uk/rschg/Guidelines.html

The deadline for the summer 2015 issue will be Friday 12 June 2015. Please send your contributions to a.simmons@ucl.ac.uk as an attachment in Word. All contributions must be in electronic form.

Anna Simmons
University College London

Royal Society of Chemistry Historical Group News

The Life and Work of Sir John Cornforth CBE AC FRS

Wednesday 18 March 2015 at 1.30 pm

Royal Society of Chemistry, Burlington House, Piccadilly, London

This meeting, organised by the Historical Group of the Royal Society of Chemistry, celebrates the life and work of the gifted organic chemist Sir John ('Kappa') Cornforth CBE AC FRS (1917-2013), who was awarded the Nobel Prize for Chemistry in 1975. His research was characterized by a perceptive, innovative and elegant logic. Over sixty years it ranged from work on the structure of penicillin, the chemistry of oxazoles, steroid synthesis and biosynthesis, plant hormones, the stereochemistry of enzyme reactions, to models of enzyme action. His studies on the biosynthesis of steroids transformed biogenetic speculation into an experimentally established biosynthetic pathway in which the stereochemistry of each of the steps leading to cholesterol was clearly defined. The presentations at this meeting will highlight the influences on Sir John's life and his lasting legacy to organic chemistry. "[I] could hope for nothing better than to retain fresh curiosity and wonder at the chemistry of Nature", Sir John Cornforth, Nobel Prize Lecture, 1975.

Programme

13.30 Registration and tea or coffee

14.00 Welcome (Dr John Hudson, Chairman, Historical Group)

First Session – Chair: Professor Sir Alan Battersby FRS (University of Cambridge)

14.00 Introduction: Professor Sir Alan Battersby FRS

14.20 Professor Douglas Young FRSE (University of Sussex)

Early Days: 'Kappa' Cornforth – Australia, Oxford University and the Medical Research Council (NIMR)

14.55 Professor Tom Simpson FRSE FRS (University of Bristol)

The Popják-Cornforth (PopCorn) Collaboration on the Stereochemistry of Biosynthesis: NIMR and Milstead

15.30 Tea interval

Second Session – Chair: Professor Chris Willis (University of Bristol)

15.50 Professor Bernard Golding (Newcastle University)

Kappa's Application in Biosynthetic Studies of all the Isotopes of Nature's Simplest Element

16.25 Dr Tim Wallace (University of Manchester)

Models of Enzyme Action: Organic Synthesis at Sussex University

17.00 Concluding remarks: *Reminiscences of Kappa*

17.30 Close of meeting

There is no charge for this meeting, but prior registration is essential. Please register by emailing the Group's Secretary, Professor John Nicholson: [email: jwnicholson01@gmail.com]. If you do not have access to email please use the form enclosed with the hard copy version of the newsletter and send it to Professor John Nicholson, 52 Buckingham Road, Hampton, Middlesex, TW12 3JG. This is expected to be a popular meeting. If having registered, you are unable to attend, please notify Professor Nicholson.

Royal Society of Chemistry News

The Chemical Landmark Scheme is a Royal Society of Chemistry initiative recognising sites where the chemical sciences have made a significant contribution to health, wealth, or quality of life. The distinctive blue plaques are publicly visible, giving everyone an insight into chemistry's relevance to everyday lives.

Changes have been made to the application process for the Chemical Landmark Scheme. A maximum of four Chemical Landmark plaques are now awarded each year. To date, over fifty plaques have been awarded, including four international landmarks. Full details of the previous landmarks can be found using the RSC's Places of Chemistry App, which can be downloaded from the App Store or Google Play.

You can nominate a Chemical Landmark by completing the application form. Applications can be made at any time, and will be considered twice annually, at the end of April and October. Please visit

http://www.rsc.org/campaigning-outreach/connecting-with-chemistry/

Feedback from the Summer 2014 Newsletter

In the last Newsletter I asked for information about a pair of large sterling silver conical flasks and some unrecognised tubular objects in pure silver, which we had found in a safe in the UCL Chemistry Department.

Alan Dronsfield directed me to the Google Advanced Search where the words silver flask coupled with chemistry bring up a number of references to silver flasks. They have been used in reactions involving strong alkali, or HF or its precursor, which will attach glass. For example lubricating oils have been saponified with alcoholic KOH in silver flasks; "they have been in constant use for the last four or five years and are as good as new" [1]. Again, deuterium fluoride has been made by the reaction of benzoyl fluoride with D_2O in a silver flask [2].

I have not yet been able to find who might have used the flasks. They date from the time when Norman Collie was the Head of the Department; he had wide interests in chemistry himself and encouraged the staff of the department to follow their own interests, and there are a number of possible candidates.

The question over the pure silver tubular devices is a more difficult one and still hangs in the air. The prize for the most reasonable suggestion goes to Michael Jewess. He points out that silver has a high thermal conductivity and is not very expensive until it gets into the hands of silversmiths: perhaps some physical experiment was carried out on gases within the tube which could be immersed in a bath at the desired temperature or surrounded by a heater.

We continue to search.

References

P.H. Conradson, *J. Am. Chem. Soc.*, 1904, **26**, 672

Georg Bauer, *Handbook of Preparative Inorganic Chemistry* (New York, London: Academic Press, 1968), p. 128.

Alwyn Davies
University College London

Another Object to Identify

I have received a query from an RSC member, Dr Peter Barnes, asking if anyone could identify the object pictured. He writes: "These pictures were sent to me by an engineer friend, Stanley Graham. He added the following details: Material is bronze, probably highly leaded. Weight is 2lb 10oz, and diameter about 4 inches. It's very well made. The only marking is in the centre of the concave base 'I.C.I. Tested'".

Further details are that it has a release valve built into the top under the screw cap. When Mr Graham got it there was a small amount of what felt like a liquid in it, which released a gas when the valve was depressed. He was very careful with it and discharged the gas to atmosphere outside on a very windy day.

The best current guess is that it is probably a laboratory container for a very rare/dangerous/expensive chemical. The shape is of interest as it would have been a lot easier to make without that narrow neck. It was clearly very expensive to make and was made to a very high standard.

Any ideas about its identity would be appreciated. Please contact me at jwnicholson01@gmail.com and I will forward any replies to Peter Barnes.

John Nicholson
St Mary's University College

PUBLISHED HISTORIES OF CHEMISTRY DEPARTMENTS IN BRITAIN AND IRELAND

The committee of the RSCHG asked me to compile a database of published histories of British chemistry departments – as you see I've also covered Eire. This is my first attempt at compiling such a list. If any of you know of other items that should be included, please contact me directly, (w.griffith@ic.ac.uk), with details (full references as I've tried to give below, plus a doi number if you know of one). I'll then amend this list before it becomes a proper database.

Most of the histories have been taken from a series of papers which appeared in *the Journal of the Royal Institute of Chemistry* from 1953-1958. All those papers are entitled "Schools of Chemistry in Great Britain and Ireland" and numbered, followed by the name of the University or College – only the latter is given below. Thus, the *full* title for the Durham article is: "Schools of Chemistry in Great Britain and Ireland. XXII - The University of Durham". Since many of these articles date back over sixty years ago the titles in some cases are no longer appropriate but have been retained since these are historical documents. In some cases I've added a note about the present status of the institution.

Aberdeen: R.B. Strathdee, "The University of Aberdeen", *J. Roy. Inst. Chem.*, 1953, **77**, 220-231: doi.org/b5bwcv.

Aberystwyth: T. Campbell James and C.W. Davies, "The University College of Wales, Aberystwyth", *J. Roy. Inst. Chem.*, 1956, **80**, 568-574: doi.org/bzx5nk.
H.T. Ellis, *The University College of Wales, Aberystwyth 1872-1972*,
http://www.aber.ac.uk/en/development/alumni/osa/ucwaberystwyth.
John Hudson has a copy of *Coleg Prifysgol Cymru – The University College of Wales Aberystwyth. The Chemistry Department 1920-1972*. Various authors, with introduction by Mansel Davies. It was published by the Chemistry Department in 1973 as part of the departmental celebration of the centenary of the College (1972). In 2007 the college became part of Aberystwyth University.

Bangor: W.R. Angus, "University College of North Wales, Bangor", *J. Roy. Inst. Chem.*, 1954, **78**, 291-298: doi.org/cwgbfg. In 2009 the college became part of Bangor University.

Bedford College: E.E. Turner, "Bedford College, London", *J. Roy. Inst. Chem.*, 1955, **79**, 235-238: doi.org/b66489.
In 1985 the college amalgamated with Royal Holloway College, University of London.

Belfast: C.L. Wilson, "The Queen's University of Belfast", *J. Roy. Inst. Chem,*. 1957, **81**, 16-29: doi.org/dd4drf.

Birmingham: S.R. Carter and M. Stacey, "The University of Birmingham", *J. Roy. Inst. Chem.*, 1954, **78**, 405-414: doi.org/cqd8z9.

Bristol: W.E. Garner, "The University of Bristol", *J. Roy. Inst. Chem.*, 1954, **78**, 5-14: doi.org/cnsxc8.

Cambridge: W.S. Mills, "The University of Cambridge, Part 1", *J. Roy. Inst. Chem.*, 1953, **77**, 423-431: doi.org/fw38b3; W.S. Mills, "The University of Cambridge, Part 2", *J. Roy. Inst. Chem.*, 1953, **77**, 467-473: doi.org/b77hpt.

M. Archer and C. Haley (eds.), *The 1702 Chair of Chemistry at Cambridge: Transformation and Change* (Cambridge: Cambridge University Press, 2005).

Cardiff: N.M. Cullinane, "University College of South Wales and Monmouthshire, Cardiff", *J. Roy. Inst. Chem.*, 1955, **79**, 503-506: doi.org/b9v3qd.
In 1996 the college became part of the University of Wales, Cardiff, and in 1999 became known as Cardiff University.

Cork: J. Reilly, "University College, Cork", *J. Roy. Inst. Chem.*, 1954, **78**, 610-616: doi.org/c3mnws.

Dublin – Trinity College: T.S. Wheeler, "The Dublin Schools: (A). Trinity College", *J. Roy. Inst. Chem.*, 1953, **77**, 64-69: doi.org/fs7vmq.

Dublin – University College: T.S. Wheeler, "The Dublin Schools: (B). University College", *J. Roy. Inst. Chem.*, 1953, **77**, 113-121: doi.org/bkgwjd.

Durham: C.C. Clemo and N.S. Brown, "The University of Durham", *J. Roy. Inst. Chem.* 1956, **80**, 14-21: doi.org/dnc85h.

Edinburgh: E.L. Hirst and M. Ritchie, "The University of Edinburgh", *J. Roy. Inst. Chem.*, 1953, **77**, 505-511: doi.org/fv29vf.

Exeter: H.T.S. Britton, "Exeter University", *J. Roy. Inst. Chem.*, 1956, **80**, 617-623: doi.org/btsv64.

Glasgow: J.W. Cook, "The University of Glasgow", *J. Roy. Inst. Chem.*, 1953, **77**, 561-572: doi.org/djwmhb.

Glasgow Royal Technical College: J.A. Cranston, "The Royal Technical College, Glasgow", *J. Roy. Inst. Chem.*, 1954, **78**, 116-124: doi.org/bcqfxp.
In 1956 the college became the Royal College of Science and Technology, and in 1964 it became part of the University of Strathclyde.

Imperial College London (ICL): There are two internal histories, one by Eric Roberts covering the period 1845-1962, and another by Bernard Atkinson, 1962-1989. These are held in the ICL Archives as scripts (not digitised). Myself and Hannah Gay are writing a history of the department from 1845-2000, and we hope this will be published in 2016.

King's College London (KCL): D.H. Hey, "King's College, London", *J. Roy. Inst. Chem.*, 1955, **79**, 305-315: doi.org/d5f7pf.
KCL is a self-governing College of the University of London.

Leeds: F. Challenger, "The Chemistry Department of the University of Leeds", *J. Roy. Inst. Chem.*, 1953, **77**, 161-171: doi.org/c9jg97.

Leicester: L. Hunter, "The University College of Leicester", *J. Roy. Inst. Chem.*, 1955, **79**, 14-18: doi.org/bczxs2.
The college is now part of the University of Leicester.

Liverpool: T.P. Hilditch, "The University of Liverpool", *J. Roy. Inst. Chem.*, 1957, **81**, 190-198: doi.org/fv49b4.

Manchester: G.N. Burkhardt, "The University of Manchester (Faculty of Science)", *J. Roy. Inst. Chem.*, 1954, **78**, 448-460: doi.org/fqw4kk.

North Staffordshire: H.D. Springall, "The University College of North Staffordshire", *J. Roy. Inst. Chem.*, 1956, **80**, 390-394: doi.org/cwnftc.

Oxford: H. Hartley, "The University of Oxford, Part 1", *J. Roy. Inst. Chem.*, 1955, **79**, 118-127: doi.org/fcd4sk; H. Hartley, "XVI: The University of Oxford, Part 2", *J. Roy. Inst. Chem.*, 1955, **79**, 176-184: doi.org/b85jnx.
R.J.P. Williams, A. Chapman and J.S. Rowlinson (eds.), *Chemistry at Oxford: A History from 1600 to 2005* (London: Royal Society of Chemistry, 2009).
Sir Harold Hartley, *Studies in the History of Chemistry* (Oxford: Oxford University Press, 1971), Chapter 10, "The contribution of the College Laboratories to the Oxford School of Chemistry", (reprinted from *Chemistry in Britain*, November 1965).
The link: www.chem.ox.ac.uk/history gives links to online versions of detailed histories of the Physical and Theoretical Chemistry Laboratory and of the Dyson Perrins Laboratory. Both were originally produced as hard copy books, but are now only available in electronic format. These are:
R.F. Barrow and C.J. Danby, *The History of the Physical and Theoretical Chemistry Laboratory*, (Oxford, 1991). This originally covered 1941-1991 and was subsequently updated to 2001 by Sir John Rowlinson.
J.H. Jones, R. Curtis, C. Leith and J. Nall, *The Dyson Perrins Laboratory and Oxford Organic Chemistry 1916-2004*, (Oxford, 2008), ISBN 978-0-9512569-4-7.

Queen Mary University London (QMUL): K.W. Sykes, "The Chemistry Department at Queen Mary College", *Chem. & Ind.*, 1961, 542-544.
W.J. Hickinbottom, "Queen Mary College", *J. Roy. Inst. Chem.*, 1956, **80**, 457-465: doi.org/cp39f6.

For other books on QMW in general, see G. Goodwin, *Queen Mary College* (London, 1939); G.P. Moss and M.V. Saville, *From Palace to College* (London, 1985) and R. Valentine, *The Making of Queen Mary, University of London* (London, 2012).
As Queen Mary University London, QMUL is a self-governing College of the University of London.

Reading: H. Bassett, “The University of Reading”, *J. Roy. Inst. Chem.*, 1955, **79**, 359-362: doi.org/dp8d9r.

Sheffield: R.D. Haworth and T.S. Stevens, “The University of Sheffield”, *J. Roy. Inst. Chem.*, 1956, **80**, 269-274: doi.org/fbvmmj.

Southampton: N.K. Adam and K.R. Webb, “The University of Southampton”, *J. Roy. Inst. Chem.*, 1956, **80**, 133-140: doi.org/fsqmvw.

Swansea: E.E. Ayling, “University College, Swansea”, *J. Roy. Inst. Chem.*, 1955, **79**, 623-628: doi.org/b7rnbx.
The college is now part of the University of Swansea.

St. Andrews: J. Read, “The United College of St. Salvator and St. Leonard, in the University of St. Andrews”, *J. Roy. Inst. Chem.*, 1953, **77**, 8-18: doi.org/bqgrsj.
Elements of Genius – The Legacy of Chemistry in St. Andrews. A booklet (18 pages) to accompany an exhibition to mark the bicentenary of the department was published by the University of St. Andrews in 2011. The college is now part of the University of St. Andrews.

UMIST: J.K. Wood, “The Manchester College of Science and Technology”, *J. Roy. Inst. Chem.*, 1958, **82**, 755-762: doi.org/bmbkn8.
In 2004 the college merged with the University of Manchester.

University College London (UCL): A. Davies and P. Garratt, *UCL Chemistry Department 1828– 1974* (St Albans: Science Reviews (2000) Ltd., 2013).
UCL is a self-governing College of the University of London.

Bill Griffith
Imperial College London

SOCIETY NEWS

News from the Historical Division of the German Chemical Society

Mitteilungen. Herausgegeben von der Fachgruppe “Geschichte der Chemie” in der Gesellschaft Deutscher Chemiker. Nr 23, Pp 205, illust. (Frankfurt, 2013). ISNN: 0934-8506.

The Historical Division of the Gesellschaft Deutscher Chemiker (GDCh) was formed in 1973, some 18 years before Stephen Mason organized the RSC’s Historical Group. Unlike our British group the Fachgruppe only meets annually to hear its members read papers in an agreeable German city. It was not until 1988 that selected papers read at these meetings were published as *Mitteilungen* under the able editorship of Christoph Meinel who now holds the chair of History of Science at the University of Regensburg. Meinel has given much encouragement to German chemists to undertake historical investigations and is also currently the Chairman of the Fachgruppe. The present issue is the twenty-third annual selection of recent papers under his editorship. As with previous issues, the reader is presented with about a dozen articles in German accompanied by English abstracts. Highlights of the articles in the present issue, all of which are impeccably referenced, are: the archaeology of fossilised polymers; the purported presence of the alchemist Basil Valentine at Walkenried Abbey; a valuable account of Ferdinand Runge’s popularizations of chemistry using visual aids; Carl Fresenius’ methods for analyzing spa waters; useful information on Kekulé’s close friendship with Reinhold Hoffmann; Marcellin Berthelot’s pioneering studies of polymers in 1863; Johann Döbereiner’s work on platinum catalysis; the rival claims of Friedrich Giesel and Andre-Louis Debierne to have discovered actinium in 1902; an account of the former East German Chemical Society (1953-88); and reminiscences of the chemistry department at the University of Jena during the German reunification period. The annual concludes with six pages of news items for the membership. Membership of the Fachgruppe includes a copy of the *Mitteilungen* and costs 10 euros (address at www.gdch.de/geschichte); non-members can purchase the collection for 20 euros.

W.H. Brock
University of Leicester

News from the Society for the History of Alchemy and Chemistry

2015 Morris Award: Call for Nominations

The Society for the History of Alchemy and Chemistry solicits nominations for the 2015 John and Martha Morris Award for Outstanding Achievement in the History of Modern Chemistry or the History of the Chemical Industry. This award honours the memory of John and Martha Morris, the late parents of Peter Morris, the former editor of *Ambix*, who has contributed the endowment for this award. The recipient chosen to receive the Morris Award will be expected to deliver a lecture at a meeting of SHAC, where the awardee will be presented with an appropriate framed photograph, picture or document and the sum of £300. The award is international in scope, and nominations are invited from anywhere in the world. The first Morris Award was given to Professor Raymond Stokes (University of Glasgow) for his path-breaking work on the German chemical industry. The second award was given to Professor Mary Jo Nye (Oregon

State University) for her work on physical chemistry and the boundary between physics and chemistry in the twentieth century.

A complete nomination consists of

• a complete curriculum vitae for the nominee, including biographical data, educational background, awards, honours, list of publications, and other service to the profession;

• a letter of nomination summarising the nominee's achievements in the field of history of modern chemistry and/or the history of the chemical industry and citing unique contributions that merit this award; and

• two or more seconding letters.

Only complete nominations will be considered for the award and the nomination documents must be submitted in electronic form. All nomination materials should be submitted by e-mail to Peter Morris at peter.morris@sciencemuseum.ac.uk and a separate email which indicates that the material has been submitted should be sent to the same address (a precaution in case of incomplete transmission of documents) for arrival no later than 1 May 2015.

SHORT ESSAYS

Jeremy Bentham, chemist *manqué*

We know Jeremy Bentham as a social and educational reformer, whose followers were responsible for founding University College London, and whose body was preserved and put on display to serve as an example to future generations of students. He was also in fact a chemist *manqué*, and if his teaching at Oxford had included science, history might have turned out very differently.

In 1760, at the age of twelve, Jeremy Bentham went from Westminster School to Queen's College, Oxford, graduating BA in 1763. He deplored the fact that he was taught no chemistry there. His correspondence with his brother Samuel shows that, later, he was reading chemistry texts including Priestley's *Observations in Different Kinds of Air* and probably followed a course in chemistry given by his friend George Forsyth. He trained as a lawyer, but is said to have spent his time performing chemical experiments rather than reading law books. In 1774 he wrote to Priestley describing some experiments which he had carried out on gases. In his reply, Priestley said "If you were to go to work in good earnest you would do something considerable" [1].

In 1779, Torbern Bergmann published in Swedish the text of a lecture course which he gave at the University of Uppsala on the applications of chemistry to medicine and industry. A German edition was translated by Franz Xaver Schwediauer into what Bentham called *Lingua Franca*, which was halting English interspersed with French and Latin when Schwediauer's English was inadequate to cope. Bentham translated Schwediauer's version into idiomatic English and the book was published under the title of *Essay on the Usefulness of Chemistry* in 1783.

Bentham wrote a great deal, but little got as far as publication. He drafted a preface to Bergmann's book but never finished it. However his notes for it are in the Bentham manuscripts in the UCL Library [2], and W.R. Smeaton, of the Department of History and Philosophy of Science, quotes it in a paper in *Annals of Science* [3], which forms the basis for this paper.

Bentham deplores his ignorance of the physical world and castigates his Oxford professors "who deem it if not more useful at least more ornamental to know what the antients have dreamt than what the moderns have observed" and is scathing about what they had taught him:

Air. I learned nothing of the air I breathed in: except that the mischief it was apt to do was owing to the spitefulness of a god who when he was in an ill humour used to get a parcel of overgrown school boys to blow it in people's faces.

Sea. I knew not what the sea contained; but in recompense I knew that Neptune governed it and that Venus was generated out of the foam of it.

Human body. I knew nothing of anatomy, though in order to know it I wanted nothing but eyes if any body would have shewn it me. I knew nothing of the manner in which man is made, but I knew perfectly how he used to be made, sometimes by a man's setting fire to a statue (Prometheus), sometimes by 3 Gods making water or something else into a cow's hide (Trion)

Medicine. I know nothing of the manner in which man is preserved from the several calamities by which his health may be affected but I was made to read a great deal of the circumstances that have ever attended his destruction.

Earth. I knew nothing of the earth I trod upon: except that it was set on fire once by an unlucky boy whom the sun, who in those days kept his carriage, sent to take an airing upon the coach box.

Water. I knew nothing about the water I drank: except that we used to be created sometimes by Gods pouring it out of a porridge pot, sometimes by a Goddess when she had a fit of the vapours.

Natural Philosophy. I had heard that there was a science called Natural Philosophy; but was told that it was abstruse and difficult, and in the mean time was crammed with Logic obscurely explained from an obscure text, with Greek Testament drummed in at both ears, and with Geography learnt by hunting out the names of places *coram urbis* upon a map, and above all with Greek and Latin better taught before at Westminster.

Chemistry. I had heard that there was another science called Chemistry but was discouraged from all thought of it by a universal frown, as a science useless if not pernicious, and which considering what it was and by whom taught could be fit only to make a man an atheist or an apothecary.

He says that he was ignorant of science when he graduated but "this complaint would not long subsist if but half the time were given there to the study of chemistry that is consumed for example in the study of the Greek Testament".

In his later comments on the *Declaration of the Rights of Man and of Citizen* (1789) which was put forward during the French Revolution, he compares chemistry favourably with the legislation.

Chemistry has commonly been reckoned, and not altogether without reason, among the most abstruse branches of science. In chemistry, we see how high they have soared above the sublimest knowledge of past times; in legislation, how deep they have sunk below the profoundest ignorance …..Comparatively speaking, a select few applied themselves to the cultivation of chemistry …the science is acknowledged to be an abstruse and difficult one, and to require a long course of study on the part of those who have had the previous advantage of a liberal education; whilst the cultivation of it, in such manner as to make improvements in it, requires that a man should make it the great business of his life; and those who have made these improvements have thus applied themselves.

In chemistry there is no room for passion to step in and to confound the understanding - to lead men into error, and to shut their eyes against knowledge: in legislation, the circumstances are opposite, and vastly different.

This, then, was the background in which UCL was founded in 1826, largely by Bentham's disciples, as an institution which would accept anyone who was academically qualified, irrespective of religion, social status, or nationality, and which would teach those subjects which Bentham so sorely missed at Oxford. When the college opened for teaching started in 1828, it included a Chemistry Department, the first in England [4].

One can speculate how history might have been changed if only Oxford had taught Bentham chemistry. He might have followed a chemical career and we might now be teaching Bentham's chemistry, but if he had not instead become a social and educational reformer there might be no UCL in which to teach.

It is chemically appropriate that when the time came for his body to be mummified, his head was dehydrated in a vacuum desiccator over sulphuric acid. Although the experiment was chemically successful the result was aesthetically unattractive as shown in the before and after pictures below, and the head on the autoicon was replaced by a wax model.

References

1. T.L.S. Sprigg (ed.), *The Correspondence of Jeremy Bentham* (London, 1968), vol. i, 265.
2. A database containing a detailed catalogue of the Bentham papers, held in the University College London Library can be found at:
   www.benthampapers.ucl.ac.uk
3. Bertel Linder and W.A. Smeaton, "Schwediauer, Bentham and Beddoes: Translators of Bergman and Scheele", *Annals of Science*, 1968, 24, 259-273. Most of the quotations in this article are taken from Smeaton's paper.
4. A. Davies and P. Garratt, *UCL Chemistry Department 1828–1974* (St Albans: Science Reviews (2000) Ltd., 2013).

The images in this article are courtesy of UCL Public and Cultural Engagement/UCL Creative Media Services.

A.G. Davies
University College London

From Waterloo to Thiopentone: The Early Chemical History of Intravenous Anaesthesia

2015 sees the bicentenary of Wellington's famous victory at Waterloo. Less well-remembered are the many soldiers injured in that battle who endured their amputations without the benefit of any form of anaesthesia. There's a memorial to Wellington, complete with horse, in London's St Paul's Cathedral and of course we know that the architect of this most magnificent building was the scientist and polymath, Christopher Wren. Curiously, Wren held the key to effective intravenous anaesthesia about 150 years before that fateful battle. As a Fellow of All Souls' College, Oxford, in 1659 he injected an aqueous extract from opium into the vein of a dog, using a quill attached to a bladder as a makeshift hypodermic syringe (today's device was only invented in 1853). The dog was stupefied, but not killed. Sadly, the experimenters found this a curiosity rather than a breakthrough that could open the doors to painless modern surgery. Over a century before this, Paracelsus had used ether to render fowls insensible but also took his work no further. Perhaps we should not be surprised at this - no-one at the time envisaged surgery as being anything other than extremely painful. When in 1800 this view was challenged by Humphry Davy's suggestion that the insensibility induced by nitrous oxide could allow pain-free surgery, the idea was not followed up. Surgical interventions and pain remained inseparable until the mid-1840s, when ether, chloroform and nitrous oxide were used to induce oblivion. These agents were relatively safe and within a matter of months became widely adopted. Around 1900 the risk of death from ether anaesthesia was 1 in 15,000 and with chloroform, 1 in 3,000. Both agents (alongside nitrous oxide used mainly for teeth extractions) were the mainstays of inhalation anaesthesia until the mid-1950s. However, as well as the occasional fatality, they had other drawbacks. In the early days of anaesthesia, induction was sometimes a battle between the anaesthetist and the patient, the latter terrified of the feeling of suffocation induced by the mask. Moreover, on regaining consciousness, vomiting and breathing difficulties were common. Feelings of anxiety/terror could be partially remedied by the use of a potent pre-operative hypnotic drug such as the barbiturate *Nembutal*, but vomiting and breathing difficulties remained a problem until the introduction of fluorinated volatile agents (typically halothane) [1] in the mid-1950s. Anaesthetic agents were clearly absorbed into the blood via the lungs and then carried to their site of action in the brain. Early research focussed on trying to avoid the irritant effects of these gases and vapours on the lungs by delivering the anaesthetic to the brain by injecting it into the blood – i.e. intravenously. This, it was hoped, would also avoid the feelings of suffocation and instead the patiently would simply drift off into sleep.

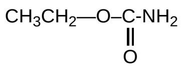
Although the soluble opium extracts used by Wren and others were reinvestigated in 1902 and sporadically over the next thirty years, the major problem with their use was that a dose strong enough to prevent pain could also stop the patient breathing, or cause such shallow breathing that the person's life was in danger. It was clear that anaesthetists would have to look beyond poppy extracts for their intravenous agents.

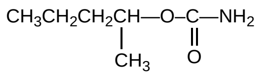
Chloral hydrate

The first reasonably successful intravenous agent was chloral hydrate. Justus von Liebig had been exploring the reaction between chlorine and ethanol as early as 1822 and in 1831 reported the isolation of chloral, $CCl_3.CHO$, an oily pungent-smelling liquid that combines with water to form chloral hydrate, $CCl_3.CH.(OH)_2$, a water-soluble crystalline solid. This was first used as an hypnotic in 1869 (orally and rectally) [2]. Three years later Cyprien Oré, a surgeon working in Bordeaux, used it intravenously to anaesthetise fifty-one patients without a single fatality. However, other practitioners were not so lucky and it soon became clear that, like the morphine extracted from opium, the effective dose was close to the lethal dose. It was an irritant to the veins, causing phlebitis in some cases. Charles Adams, an American pioneer of pre-World War Two intravenous anaesthesia, writes of the use of chloral hydrate: "….(it) actually constitutes the birth of IV anaesthesia. Broadly speaking, chloral hydrate was a failure and was certainly both a dangerous and doubtful means of producing anaesthesia. However this also applies to many other agents which have been used subsequently. The IV use of this agent marked the advent of a new method which made the medical world conscious of new possibilities" [3].

Hedonal and ether

Towards the end of the nineteenth century derivatives of carbamic acid were being investigated for their medical potential. Urethane (ethyl carbamate) and especially its amyl analogue, marketed as *Hedonal*, were particularly good at inducing drowsiness to relieve insomnia as alternatives to chloral hydrate and so it was logical to try them out as possible intravenous agents.


Urethane (ethyl carbamate)


Hedonal

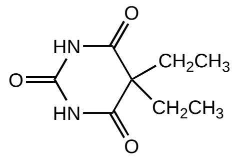
Success (with Hedonal) was reported by Nicholas Krawkow and Sergei Fedoroff in 1909 [4]. A little later it was found to be an effective adjunct to the volatile agents, significantly reducing the amount needed for full anaesthesia. Although not free from risk, it was safer than chloral hydrate. It was only sparingly soluble in water so a typical anaesthetic dose had to be dissolved in a litre of saline. The solution would be run into a vein through a cannula, causing the patient to slide into unconsciousness between two and thirteen minutes later. It was reported to be a pleasant experience. It had the bonus of being a muscle relaxant, which made operations on the abdomen easier. Recovery took between six and twelve hours and the patient might remain drowsy for a further twenty-four hours. 'Excitement' (as agitated delirium was euphemistically termed) was a feature of the recovery process and this required careful nursing. How safe was

Hedonal? The volume of saline necessary to get it into the patient could be a problem, because this could overload the circulation with fluid, causing heart failure or accumulation of fluid in the lungs. On the other hand it could be a life-saver in those patients whose survival might be compromised by excessive blood loss. Generally its use was reserved for those individuals who were judged unlikely to survive anaesthesia with ether or chloroform. Despite its perceived safety, some 10% of these high-risk patients died either during or soon after the operation.

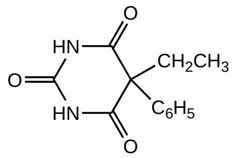
More or less in parallel with the research on Hedonal, investigations began into the use of intravenous ether. Like Hedonal, its low solubility in saline could be a problem. Using a typical 5% solution an adult would require between 350 and 2,500 cm^3, infiltrated by gravity feed into a vein. The solution would be run in until the patient was sufficiently unconscious to withstand the knife. The flow would then be stopped until reflex movements showed that the patient was on the verge of consciousness, when titration would be resumed. Intravenous anaesthesia with ether was relatively safe. Recovery was swift and usually unaccompanied by vomiting. Until World War Two it was arguably the safest IV agent available [3].

The barbiturates

The earliest derivative of barbituric acid to have a useful pharmacological effect was the diethyl analogue. This was synthesised in 1903 and marketed as *Barbital*, a sleeping draught. Phenylethyl barbituric acid was patented in 1912, christened *Luminal*, and again used as a soporific (and, incidentally, as the first really effective treatment for epilepsy).

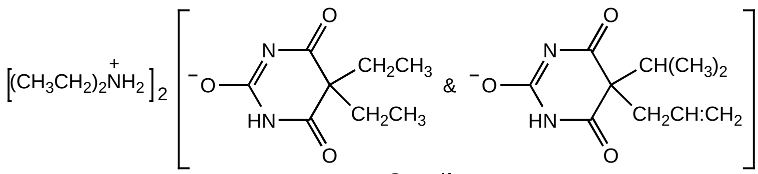


Barbital (diethylbarbituric acid)



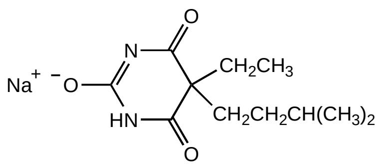
Luminal, also known as phenobarbitone

Their dramatic effects spurred three decades of research for derivatives that would act as effective IV anaesthetics. In particular, agents were sought that were safe, gave rise to swift inductions, were predictable in their actions and would give rise to swift and uneventful recoveries. Although most parent barbiturates were only slightly soluble in saline, they could be rendered soluble by exploiting their acidic behaviour and simply converting them into an appropriate salt. Thus *Somnifene* was a mixture of diethylbarbituric acid and allylisopropyl barbituric acid, rendered soluble by combination with diethylamine.



Somnifene

It was introduced into anaesthetic practice in 1921, after establishing it could dull the pain associated with childbirth. Its most significant drawback was that in order to conduct an ‘average’ operation, the patient would be rendered insensible for three to four hours followed by a recovery time of twenty-four to thirty-six hours, during which periods of agitation might occur. Patients had to be carefully nursed during this period to avoid risk of injury. Really, it had no advantages over the other agents in use at the time. Slightly better was the sodium salt of isoamylethyl barbituric acid (sodium amytal).



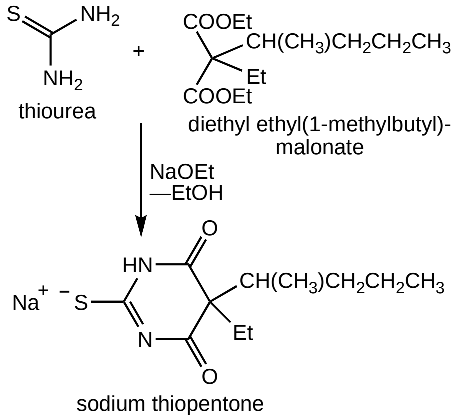
Sodium amytal

This was synthesised in 1921 and first used, like so many agents in this class, to treat insomnia. It was used intravenously in 1928/9 to relax patients suffering from the convulsive effects of tetanus and almost immediately afterwards both as a pre-operative soporific and as a ‘stand-alone’ IV anaesthetic agent. When used as the latter, it had two main disadvantages: firstly some 16% of the recoveries, described at taking ‘several hours’, were associated with various degrees of patient excitement. Secondly, although an injection of 1.2-2.0g would give the surgeon some fifteen minutes of operating time; for longer, more complicated procedures the amount had to be increased to 3.0g, dangerously close to the lethal dose range of 3.0 – 6.4g.

Sodium thiopentone

Much drug research takes the form of exploring variations on a lead molecule. Thus having established the potential usefulness of Barbital and Luminol, it was reasonable to see if improved products would result from the replacement of one of the oxygen atoms by its Group VI vertical neighbour, sulphur. Replacing urea by thiourea in the synthesis was an easy method of substitution (Scheme 1) [5]. Emil Fischer prepared the first of this class in 1903, but as the result of an experiment on an unfortunate dog, it was accepted that the introduction of a sulphur atom into the structure imparted a toxic character. In the early 1930s the chemists Donalee Tabern and Ernest Volwiler, working for Abbott Laboratories in the USA challenged this view. Again they found that these sulphur-containing barbiturates acted both as hypnotics and sedatives, but when injected, they had a powerful *and transitory* anaesthetic effect. Used appropriately, patients would regain consciousness in a matter of minutes, rather than hours and the sequelae of pneumonia and pulmonary congestion lessened. Some 200 compounds were synthesised for evaluation, and research on animals revealed that the sodium derivative of ethyl (1-methylbutyl) thiobarbituric acid (known variously as *Thiopentone*, Sodium Thiopentone and *Pentothal*) was the best candidate for human studies.

Scheme 1 Synthesis of sodium thiopentone



Medical staff, especially in America, were enthusiastic and looked forward to the day when the craft of the anaesthetist would no longer be required. A nurse would administer a single injection, the patient would slide into relaxed unconsciousness for a predictable period, after which s/he would awaken, clear-headed and only needing a little morphine to dull any post-operative pain. The fact that unconsciousness could be induced by injection of approximately 1/3 the lethal dose gave sodium thiopentone an attractive safety margin. In good hands in was an excellent IV agent and it was for long referred to as the ‘gold standard’ against which subsequent anaesthetics were compared. In less expert hands though, its use was fraught with danger. It is difficult to kill a spontaneously breathing patient with ether by inhalation. If he or she shows signs of over-dosage, then removing the mask will restore equilibrium. But in the case of an IV overdose, once the anaesthetic has been run into a vein, there is little that can be done but hope, wait and give general support. In the aftermath of the World War Two attack on Pearl Harbor, many victims (often in a state of extreme shock) were operated on as surgical emergencies using sodium thiopentone as anaesthetic. A few never woke up, possibly as a result of mal-administration of the anaesthetic. However, the legend that more casualties fell victims to sodium thiopentone than were killed by Japanese bombs is to misrepresent the truth, and underestimate the expertise of the surgeons and anaesthetists of the period [6].

It is in the nature of medical advances that the initial enthusiasm for a new advance (here, that intravenous barbiturates would allow safe anaesthesia to be administered by non-specialist doctors or nurses) is soon replaced by a fierce reaction, threatening to abandon the approach entirely, only to be followed by a more careful appraisal of its place. Indeed, the intravenous method of anaesthesia was a major advance that moved the technique from reliance on chloroform and ether, with their complications and risks, to the modern era. If only Paracelsus or Wren had had the vision to appreciate the significance of their findings, or others had listened to Humphry Davy, then the suffering of the injured at Waterloo might have been significantly eased.

Table 1: Intravenous agents of brief popularity

Substance	Formula	Comments
Paraldehyde	$(CH_3CHO)_3$	Used from 1913, most effectively in combination with IV ether. Best used for operations of < 20 min duration. Recovery time swift (30 min) Displaced by the short-acting barbiturates
Magnesium sulphate	$Mg\ SO_4.7H_2O$	Used briefly in 1916 on only three cases; two without incident, the third calamitously. It acts also as a muscle relaxant, though its advantage here is outweighed by the risk associated with its use
Ethanol	CH_3CH_2OH	Used from 1926, though seems to have been abandoned by 1931. Typically 2-3cm^3/kg body mass used. High risk of thrombosis. An unsafe agent
Tribromethanol	CBr_3CH_2OH	Largely used rectally from 1926, but occasionally intravenously from 1929. Good for short operations (< 10 min), with consciousness being regained some 3-7 min later. Mainly used to induce unconsciousness before etherisation

21st Century Anaesthesia Practice

The advantages of intravenous anaesthesia described in this article are even more obvious in modern anaesthesia. Many anaesthetists now favour the technique of TIVA – total intra-venous anaesthesia. There are three phases to the anaesthetic 'recipe' – induction, maintenance, and reversal (or sleep, more sleep and wake-up!) The aims are to produce sleep, control pain, relax muscles as necessary and support the patient's breathing and circulation.

Initially, the patient breathes 100% oxygen from a facemask while the anaesthetist injects a combination of drugs. The key anaesthetic agent is now 2,6-diisopropylphenol (*Propofol*). This acts quickly and allows faster recovery than Thiopentone. A single injection produces unconsciousness in 30-40 seconds. Pain is controlled by intravenous remifentanil, a synthetic opioid analgesic. Other drugs assist sleep, help amnesia, reduce secretions and help maintain the heart rate. A muscle relaxant drug is then injected and a tube is inserted through the patient's mouth into their windpipe, to allow the anaesthetist to safely control the patient's breathing and to give them oxygen-enriched air. Anaesthesia is then maintained with an infusion of remifentanil/propofol. Small doses of ephedrine may be required to maintain blood pressure, and further doses of muscle relaxant if the operation is prolonged.

Recovery from anaesthesia is much like approaching traffic lights at red – just as you'd decelerate as the stop line approaches (rather than suddenly clapping the brakes on!) so too the infusion rate is reduced as the end of the operation approaches. The effect of longer-acting muscle relaxants can be reversed with a specific antidote. Once the remifentanil/propofol infusion is stopped, the patient wakes within minutes and will often carry on a sensible conversation on the way to the recovery ward, yet remember nothing about it when questioned afterwards!

This rapid recovery is because once the infusion is stopped, remifentanil is metabolised by non-specific blood and tissue esterases within 5-10 minutes and the propofol in the blood and the brain is rapidly redistributed into, and metabolised by, other tissues of the body. (If it is no longer in the brain tissue, it no longer has an anaesthetic effect). Once these two drugs are removed from the brain, there is nothing maintaining anaesthesia and the patient wakes up promptly. This rapid recovery means that instead of having to stay in hospital overnight after surgery to recover from the anaesthetic, patients can go home the same day after minor surgery.

Epidural and spinal anaesthesia (which numb the lower part of the body) are important in major joint surgery, such as hip and knee replacements. These allow lower doses of other anaesthetics to be used, particularly for people with heart or lung disease. However, there is still a place for using volatile agents for anaesthesia, particularly with newer agents, typically fluorinated ethers, that do not have the drawbacks of nitrous oxide. TIVA, despite its long gestation since Christopher Wren's experiments, is clearly established* as a cornerstone of modern anaesthetic practice.

Acknowledgements

The text by R. Charles Adams contains much detailed information about the agents discussed in this article [3] The authors are very grateful to Dr Frank Bennetts of the History of Anaesthesia Society for many helpful comments and for stimulating our interest in this aspect of anaesthesia [7].

References

1. A.T. Dronsfield, M. Hill and J. Pring, *Educ. Chem*., 2002, 39.131.
2. A.T. Dronsfield, T.M. Brown and P.M. Ellis, *Educ. Chem*., 2001, 38, 56.
3. R.C. Adams, *Intravenous Anaesthesia (1st Edn)*, (New York: Paul B. Hoebner, Inc., 1944).
4. C.M. Ball and R.N. Westhorpe, *Anaesthesia and Intensive Care*, 2001, 29, 3.
5. G.M. Dyson and P. May, *May's Chemistry of Synthetic Drugs (5th Edn)*, (London: Longmans, 1959).
6. For a rebuttal, see F.E. Bennetts, *Br. J. Anaesth.*, 1995, **75**, 366.
7. F.E. Bennetts, *Proc. Hist. Anaesth. Soc*., 2000, 28, 51.

*One of us (JP) formerly used TIVA for about 95% of his patients.

Alan Dronsfield, Pete Ellis and John Pring

BOOK REVIEWS

Philip W. Anderson, *More and Different: Notes from a Thoughtful Curmudgeon*, (Singapore: World Scientific Publishing, 2011). Pp. ix + 412. ISBN 978-981-4350-13-6. £25 (paperback).

As his preface concedes, Anderson knows that publishers don't expect review collections to sell. Reviews may be too dated for useful recommendation or criticism of a new book (biographies here of Crick, Feynman and Gell-Mann are from the 1990s, and 1980 for Landau) but, as Anderson rightly claims, his reviews usually contain some original thoughts. This assembly of over sixty essays is divided into ten groups, which range from Personal and Historical, via Science Politics (mainly Star Wars), to Futurology ('a mug's game') and Complexity Physics; each is usually preceded by a page of introduction. The title arises from Anderson's slogan *More is Different* in a 1972 *Science* article; this opposed the deterministic Laplace approach with a view that simple laws and mechanisms yield new consequences when applied to large assemblages. Broken symmetry, the concept that simplicity of laws is not manifest in their consequences, is a continuing philosophical theme, with a tribute to Nambu Sensei. The final section, headed Popularization Attempts, including Pauling's Resonating Valence Bond Theory and the scope of theoretical condensed matter physics, supports Anderson's admission, despite his wide scientific interests, about limited ability for explanations to a lay public. He writes that, although he had envisaged devoting more time to writing in later years, physics proved too strong.

Philip Anderson (born 1923) was brought up in an academic family in Urbana before taking a wartime degree aged nineteen at Harvard. His time in the US Navy as a Chief Specialist (X) at the Office of Naval Research ended after World War II and was followed by a PhD with Van Vleck in the early NMR days. Having married in 1948, he nearly took an academic post in Washington State, but, with no offers from General Electric or Brookhaven, was glad to join Bell Technical Laboratories (BTL) in 1949 on ferroelectricity under Shockley ('brilliant but arrogant and overconfident'); he stayed for thirty-five years. The Nobel Prize for Physics, on the quantum theory of condensed matter, came in 1977. There was a valuable spell in 1953 to 1954 with Ryogo Kubo in Tokyo and a visiting chair until 1975 followed the years 1961-1962 spent at the Cavendish Laboratory, Cambridge; in formal retirement, research continued at Princeton.

Early historical sections of the book include lengthy articles based on chapters of an unfinished 1960s history of superconductivity, but also embrace twentieth century physics. Naturally, the people and culture of BTL figure prominently. Anderson uses initials without immediate explanation; I don't think BCS is anywhere explained as the 1957 *Phys Rev* paper of the quietly brilliant Bardeen, the inspired dilettante Cooper and the affluent self-critical Schrieffer (who later suffered a tragic decline). Despite the justified reputation for Nobel Prizes (electron diffraction, Johnson noise, etc) from speculative research, Anderson contends that pre-war Bell required the research of such first-rate scientists as Townes and Shockley to be associated with company activities, i.e. communication systems. During the war, Jim Fisk's group under Shockley developed the British invention of the magnetron microwave generator and silicon crystal detector underlying the Allies superiority in radar. Only in the 1950s did the BTL management style relax to become less hierarchical and paternalistic. Physical electronics broadened to include ferroelectricity, while a theorists' sub-department was set up in 1955. Over the next thirty years came the transistor, maser, laser, LED, fibre optics, MRI, the Josephson effect, etc, although the company rarely exploited them.

After the wartime triumph of physics, Anderson regrets that Big Science was dominant in the proliferation of national laboratories until the end of the Cold War and the decline of the Strategic Defense Initiative (SDI). His case against SDI is that a defensive system costs ten times as much as an offensive one. As BTL declined and Small Science vastly expanded in the 1980s, he bemoans the decline in quality, excessive specialization, and emphasis on grants and papers from the 1990s. A 1985 lecture argued that condensed matter physics was transforming the technology of everyday life while in another article reproduced from 2000 he notes that the theorist must be creative and exercise taste and judgement. For the twenty-first century, an essay predicts a shift from the reductionist study of detail to the emerging field (1995) of understanding of complexity, the overall title of the penultimate batch of papers. Also envisaged are the merging of physics, technology and biology/medicine and the wider employment of physics-trained people as in economophysics. A 1995 review is included of *Frontiers of Complexity* (Ballantine, 1995) by Peter Coveney and Roger Highfield. There are several references to the Santa Fe Institute founded in the 1980s by some extremely eminent scientists to respond to the observation that most scientific revolutions are outside or between established disciplines.

More and Different has no illustrations but art work by the author's daughter Susan Anderson introduces each chapter. A good contents list, albeit with some enigmatic titles, is no excuse for the lack of an index; more contemporary comment and greater clarity of contribution dates would have been welcome. For the physicist or chemist interested in recent scientific history, almost every article has some appeal, whether portraits of Nobel Prize-winners by one who knew them or Anderson's reflections (written in the 1970s) on different species of futurologists. More typically, a reader may be interested in one or two of the sections, such as the people involved in the generation of superconductivity theories (Frohlich's contribution to the earlier theory is acknowledged), views on the philosophy of science (labelled Tactics and Strategy), reductionism and complexity, or even the Star Wars debates. Curmudgeon or not, Anderson's Notes are well worth reading, but not at one sitting.

Derry W. Jones
University of Bradford
D.Jones217@btinternet.com

Michael Freemantle, *The Chemists' War 1914–1918* (Cambridge: Royal Society of Chemistry, 2014). Pp. 342. ISBN 978-1-84973-989-4. £19.99 (RSC members receive a 35% discount).

This book follows Michael Freemantle's *Gas! Gas! Quick Boys! How Chemistry Changed the First World War*, published in 2012, and looks at both the role of chemistry and the many chemists who played such a crucial part in The Great War. The title of the book is taken from the term 'the chemists' war', first used in 1917 by Richard Pilcher, registrar and secretary of the Institute of Chemistry of Great Britain and Ireland. It has a broad canvas that covers not just the expected topics of armaments and chemical warfare gases, but also developments in medical techniques for the war casualties, the birth of cancer chemotherapy and the importance of nitrogen-fixation for fertilizers and food production.

At the core, the book considers in detail how particular chemicals (including metals and alloys) were developed and harnessed for the war effort. Chapters deal with the heavy demand for sulphuric and nitric acids for producing explosives, the need to find large quantities of glycerine, the production and deployment of warfare gases of increasing debilitation from chlorine, phosgene and mustard gas, and the search for ways of producing acetone that was required in increasing quantities for the production of the propellant, cordite. One unexpected chapter is on ‘Whaling for War’ and shows the importance of whale blubber in fighting trench foot that inflicted so many troops confined to the appalling conditions in the trenches.

The role of chemists is brought out by considering the work of not just the famous chemists but also less well-known chemists who nevertheless played a vital part in their own way in the war effort. The work of Fritz Haber, Carl Bosch, Chaim Weizmann, Emil Fischer, Cyril Norman Hinshelwood and William Jackson Pope, among many others is treated in some detail. Lesser-known chemists include Edward Harrison who designed a respirator known as the British ‘large box respirator’ or ‘Harrison Tower’ that must have saved very many lives, and May Leslie who, having trained with Marie Curie in Paris before the war, played a major role in the manufacture of explosives in Litherland and North Wales.

Many visitors to Burlington House have probably walked past the two war memorials as Michael Freemantle had before writing this book; the memorials are for the Royal Institute of Chemistry and the Chemical Society. Freemantle has researched several of the names inscribed on these memorials and included them in a poignant chapter that highlights not just the sacrifice but also the tragic lost young lives, in this case chemists and those associated with the two societies.

The book could have been improved in two ways: the many interesting photographs are unfortunately poorly reproduced; the general reader would have benefited from some simple flow-charts to summarize the source of chemicals and their production pathways.

With the centenary of the outbreak of The Great War in 2014, this book should be read by all those with an interest in chemistry, not just those with a detailed knowledge of chemistry but also the general reader who wants to understand the part chemistry played in a war that became known as the chemists’ war.

Peter Reed
Independent Historian

Kersten T. Hall, *The Man in the Monkeynut Coat* (Oxford: Oxford University Press, 2014). Pp. ix + 243. ISBN 978-0-19-870459-1. £18.99 (hardback).

This book is subtitled ‘William Astbury and the Forgotten Road to the Double-Helix’. Astbury (1898-1961) was a physicist and molecular biologist, a Cambridge graduate who worked with Sir William Bragg, at University College in 1921 and then, from 1923, at the Royal Institution. In 1928 he became a lecturer in the textile physics laboratory at the University of Leeds, becoming Professor there in 1945 of the new Department of Biomolecular Structure. His name lives on at Leeds in the Astbury Centre for Structural Molecular Biology, set up in 1999. He is principally remembered as a pioneer in X-ray studies on wool fibres, keratin, and globular proteins, but he also worked on aspects of nucleic acids, particular on their X-ray diffraction, and his contributions to this are the main concern of this volume.

I find the book to be in some ways wayward, needing a lot more reader attention to follow the rather jerky flow of the narrative than ought to be necessary. It tells its story in a rather circumlocutory way: the main title is daft, redeemed only by the subtitle, and some of the chapter headings in the book are equally unhelpful. The first chapter starts rather ahead of itself with a summary of Crick and Watson’s work on DNA and points out that Astbury too, in 1951 at Leeds, took photographs of DNA comparable in quality and detail with the famous ‘photo 51’ of 1952 by Rosalind Franklin, which led Crick and Watson to their famous *Nature* paper on the double-helical structure of DNA in 1953. Unfortunately and to a large extent inexplicably, Astbury never published his 1951 photographs; had he done so, it is claimed, Pauling might have realised the true structure of DNA before Crick and Watson. So, this is partly a ‘What if…..?’ book. It is not until chapter 11 that the main title is explained. Astbury had suggested that artificial fibres could be made from denatured proteins, and in 1942-1944 ICI Nobel developed and manufactured such a fibre, called Ardil, based on groundnuts (i.e. monkey nuts or peanuts). Questions arose as to the credit for its invention – Astbury’s or ICI’s? – but a compromise was reached.

The book is well-priced for a hardback. The print is rather small and the monochrome photographs are not of high quality, but it is extremely well-referenced and the author has clearly done much research, particularly on Astbury’s voluminous correspondence. The index is mediocre (‘monkeynut coat’ does not appear in it at all). This is a serviceable if waywardly-arranged account of Astbury’s life and work.

Bill Griffith
Imperial College London

Peter Reed, *Acid Rain and the Rise of the Environmental Chemist in Nineteenth-Century Britain: The Life and Work of Robert Angus Smith* (Farnham: Ashgate, 2014). Pp. xv + 209. ISBN: 978-1-4094-5775-6. £70 (hardback).

The first half of the nineteenth century saw a major transformation in the UK’s chemical industry with the adoption of new synthetic processes and dramatic increases in the level of production to meet the demands of mass industrialization. However these developments had a significant environmental impact as, despite advances in chemical technology, process control remained limited. Many chemical works were clustered together and located close to residential areas, which increased the impact of pollution from waste products on both the environment and the people living there. Alkali works, which produced soda using the Leblanc process, were a particular cause for complaint for local residents. However it was only when wealthy landowners voiced their protests about the impact of pollution on property values that the House of Lords intervened and appointed a Select Committee on Injury from Noxious Vapours in 1862. This resulted in the 1863 Alkali Act, legislation which aimed, with later revisions, to control pollution from chemical works and which also created a new regulatory body, the Alkali Inspectorate.

When Robert Angus Smith (1817-1884) was appointed as the first Inspector (later Chief Inspector) under the Terms of the Act in 1864, he faced the challenge of organizing a team of sub-inspectors and drawing up regulations for inspecting alkali works in order to enforce the regulations of the 1863 Act. His use of chemical analysis, and the adoption of a 'best possible means' approach for preventing the release of pollutants into the atmosphere, whilst also working in a cooperative manner with the manufacturers, were all fundamental to the improvements brought about by the Act. Given the importance of Smith's role, the Alkali Inspectorate and an assessment of Smith's administrative and structural legacy within it form a central focus of the book.

However, as the author clearly shows, Smith's work must be considered in the wider context of the emergence of the 'civil scientist' in nineteenth-century Britain and the changing political landscape of the time. The significance of the growing chemical community and particularly the influence of Thomas Graham, Justus von Liebig and Lyon Playfair on Smith's career are also clearly demonstrated. Manchester, which became Smith's base from 1843, also plays a central role in the book, with the author providing a vivid picture of its air and sanitation problems in the 1840s. Smith remained in Manchester until his death in 1884 and built up a reputation as an outstanding analytical and consulting chemist. Smith worked extensively on air quality, and although much of his research concentrated on the presence of organic matter and carbon dioxide, his concern over the quantity of sulphuric acid in air and its damaging effect on the environment resulted in a paper published in the *Quarterly Journal of the Chemical Society* in 1859 which included the first use of the phrase 'acid rain'. Smith studied many of the factors that influenced air and water quality, and not only contributed to the continuing dialogue in scientific circles on these subjects, but also helped the emerging field of sanitary science to retain a high profile amongst those influential in directing government policy.

The discussion of Smith's upbringing in a strict Calvinist family and his later indecision as to whether to pursue a career in chemistry or to enter the Church, provide further insights into his personality. Smith was also a man with diverse interests, who accumulated a considerable library of 3,946 books, including texts on meteorology, theology, classics and Celtic history, as well as many different aspects of chemistry, during his lifetime. This collection was presented intact to Owens College, Manchester after his death in 1884 and still forms part of the University of Manchester Library today.

This book ably succeeds in providing an in-depth analysis of Robert Angus Smith's crucial role in developing the regulation of air pollution in Britain, and underlines his contribution as one of the first scientists to apply scientific knowledge to the field of sanitary science. It will be of interest to all historians of nineteenth-century science, technology and industry and particularly appeals not only to those studying the professionalization of chemistry and the role of science in government, but also to environmental historians and chemists working as 'civil scientists' today. Its broader appeal to those interested in environmental concerns is highlighted anecdotally by the number of people who on enquiring about the book I was reading, eagerly wanted to find out more about the man who first used the phrase 'acid rain'. There aren't many books on nineteenth-century chemistry that I read which provoke such an enthusiastic response!

Anna Simmons
University College London

ESSAY BOOK REVIEW

Polanyi: Physical Chemist and Science Philosopher

Mary Jo Nye, *Michael Polanyi and His Generation: Origins of the Social Construction of Science* (Chicago: University of Chicago Press, 2013). Pp. 405. ISBN-13: 978-0-226-10317-4. £21.00 (paperback).

Michael Polanyi (1891-1976) was a distinguished physical chemist (FRS 1944) who didn't quite win the Nobel Prize (though his son, John C Polanyi did). From 1948 he gained wider celebrity, perhaps more in the USA (where there is a Polanyi Society) than in the UK, as a social scientist and philosopher. His friend and earlier student the Nobel Prize winner Eugene Wigner (1902-1995) put Polanyi on the same level as von Laue, Nernst and Pauli. Referring to Polanyi's career change, Isaiah Berlin is said to have quipped 'a great scientist giving up the Nobel to write mediocre works of philosophy' but Polanyi was convinced that it would be more valuable to turn to philosophy than to continue in science. As her subtitle indicates, Nye's book is directed at how the personal element in scientific findings originated. In pursuit of this, she chronicles Polanyi's scientific researches which were predominantly at the world centre of physics in Berlin in the 1920s and at what was said to be a first-class centre of chemistry in Manchester in the 1930s and early 1940s. Nevertheless Polanyi complained about the historic benches and lack of facilities, even though he had managed to bring several technicians (who trained local ones) and students from Germany. Approval was given for a new Manchester Physical Chemistry building in 1937 but it was not built until well after the Second World War!

Mary Jo Nye, Professor Emerita of History at Oregon State University, USA, has spent several periods at the Max Planck Institute for the History of Science in Berlin and at the Royal Society in London and made relevant visits to Budapest and elsewhere. She is also particularly knowledgeable about Manchester in the late 1930s and early 1940s, having published an authoritative but enjoyable biography of Nobel physicist P.M.S. Blackett, holder of the Manchester Physics Chair. Blackett was Polanyi's contemporary and friend, though they didn't always agree. Each of them made creative contributions in several distinct peacetime scientific fields. Aside from her other publications, Nye has written substantial contributions on aspects of Polanyi's life and achievements, including a short biography, but has taken a special interest in the move towards social history and the sociology of science. The eight chapters, plus introduction and epilogue, in *Michael Polanyi and His Generation* are organized in themes but the first half is largely chronological, dealing with Polanyi's scientific life in Hungary, Germany, especially Berlin, Manchester and Oxford, with visits to the USA. She argues that, though the social concept of science may have emerged in the 1960s, it originated in the 1930s at a time of political extremes.

In addition to the Royal Society memoir [1], there has been an excellent biography [2], assembled over many years, encompassing 150 interviews, by W.T. Scott, an American physicist and philosopher, and M.X. Moleski, a professor of religion who met many of Polanyi's friends. Scott, the senior author, got to know his subject during the last seventeen years of his life but became ill and died in 1999. Moleski, named as co-author in 1997, revised and edited the book which appeared in 2005. Istvan Hargittai was impressed by Polanyi when he met him in 1969. Although this led to one of his candid conversational written portraits, Hargittai did not include him in his book as one of *The Martians of Science;* these were the five brilliant Hungarian physicists of Jewish extraction who worked in Germany but whose greatest achievements were in the USA, some in the Manhattan Project. Michael (or 'Misi') Polanyi was born in Budapest on 11 March 1891 (until 1890 the family lived in Vienna) into an affluent railway engineer's assimilated Jewish family. His mother held weekly artistic salons and the family had English and French tutors, a German governess, and Hungarian servants, plus horses and a groom. However, following flood damage to railway construction in 1900, Michael's father was declared bankrupt; he died in 1905. Michael was already at the *Mintagimnazium* or model high school (which had been attended by two of the Martians, von Karman and Teller), from where he studied medicine from 1908 at Budapest University, graduating in 1913; the medical course apparently gave full measure to physical chemistry and theoretical physics. He had a year as a full-time student in physical chemistry at the Karlsruhe Technische Hochschule until his wartime service was required as a medical doctor in the Austro-Hungarian army. Lengthy recuperation from illnesses enabled him to complete several papers in thermodynamics and physical chemistry. Political changes in Hungary after the war gave poor prospects for Jewish leftish scientists, even with his surname change from Pollacsek and baptism as a Catholic, so Polanyi went first to Karlsruhe. In 1920 he took up Haber's invitation to the new Kaiser Wilhelm Gesellschaft Institute of Fibre Chemistry in Berlin-Dahlem. Several of the Titans also emigrated to Germany around the same time to escape persecution.

The Director, R.O. Herzog, assigned Polanyi the task of interpreting the X-ray diagram, observed with its groups of four symmetrical spots by Herzog and Jancke, of a bundle of ramie fibres. He soon achieved this, without previous X-ray or fibre experience, and so had what Herzog poetically described as 'cooked a piece of meat' i.e. had proved his capacity as a craftsman [3]. In 1921, he married Magda Elizabeth Kemeny who was completing her chemical engineering degree at Karlsruhe, and they had two children. At the Haber colloquium in early 1921, Polanyi reported that the cellulose diffraction pattern could be interpreted either as hexobiose anhydrides (favoured by Herzog and Kurt Hess) or was a long-chain molecule of linked hexoses (advocated by Hermann Staudinger). Polanyi admits that he then lacked the chemical sense to eliminate the first alternative. It was left to Mark to follow cellulose up years later; it was only in the 1950s that the author re-examined the 1937 Meyer and Misch structure which was based on the Meyer and Mark structure of 1928. Polanyi continued to be a consultant to Izzo, the Budapest lamp company. Having cooked his meat, Polanyi was soon able to engage Brill, von Gomperz (who sailed with him), Mark, Schmid (a skiing companion) and Weissenberg as assistants and later Wigner. The rotating- crystal X-ray technique was established and also the relation between hyperbolae (on a plane film) or horizontal layer lines and the repeat distance. Polanyi commended Mark (whose later career on high polymers was in New York) for his manipulative skill and Weissenberg for his mathematical ability. Weissenberg, who had in Berlin developed the moving film X-ray goniometer bearing his name, also much later devised a rheogoniometer for textile testing at the Shirley Textile Research Institute in Manchester, following enforced departure from Germany. Years afterwards, Polanyi recalled the Wednesday afternoon colloquia of Berlin University in the early 1920s as 'the most glorious intellectual memory of my life'. Nobel Prize-winners Einstein, Haber, von Laue, Nernst, and Planck would often be present while, as Nye notes, the novel architecture and new arts in post-war Berlin provided additional intellectual stimulation. James G. Crowther, the left-leaning science correspondent of the *Manchester Guardian*, who visited Polanyi, was almost equally impressed, regarding it as an idealized research community with no teaching commitment.

The emphasis of Polanyi's group shifted to the strength and plastic flow of solids through stretching of zinc and then crystals and microcrystalline wires. Although he transferred in 1923 to independent membership of the Institute of Physical Chemistry and Electrochemistry in Berlin, Polanyi continued to publish through the 1920s on the solid state, especially with Bogdandy, Sachs and Schmid on plasticity and annealing of metal crystals and the deformation of ductile materials. Experiments with Ewald on cold working of a rock salt prism in 1924 led to early notions of dislocation or *Versetzung*. Among several references to Polanyi in his *The Crystalline State*, W.L. Bragg credits him as the pioneer in single-crystal deformation and the theory of metal crystals. Elsewhere, Polanyi was disappointed at lack of appreciation for his X-ray studies, not just by organic chemists uninterested in the value of diffraction for molecular structure, but also by the elite physicists more concerned with atomic and quantum phenomena. Polanyi's interest turned to the strength of solids, a field in which few physicists wanted to be engaged; material science was barely recognized in the 1920s and early 1930s. However, Polanyi interacted with Wigner and Fritz London on applying quantum mechanics to atoms and molecules and collaborated with Eyring, a visiting fellow in 1929-30; Eyring also visited him in Manchester in 1937. The collaboration led to the transition state (or activated complex) theory in which the potential energy surface for a chemical reaction has a saddle between two valleys, as with $H + H_2$. They also developed an explanation for adsorption (or dispersion) forces.

Despite the persecution as Hitler's National Socialist regime came to power in the early 1930s, Polanyi was reluctant to leave Germany. There were academic offers from several countries but, in 1933, he accepted the second Manchester invitation to a Physical Chemistry chair. He followed the suggestion of renting a large house in Didsbury, Manchester, with five bedrooms, plus a guest room and two for servants, assisted by three maids and an *au pair*. According to accounts of W.L. Bragg's time in Physics, and that of his successor Blackett in 1938, a grand house was evidently par for a Manchester professor, engaged in a vigorous social-intellectual life, in the 1930s. Polanyi joined with history professor Lewis Namier (of Russian Polish Jewish extraction) in helping refugees to settle. Polanyi's scientific co-workers often gained distinction elsewhere. With different experimental projects and collaborators in separate rooms, Polanyi was said to make daily rounds for chats with people such as Cecil Bawn (later Professor at Liverpool), Alwyn G. Evans (brother to Meredith G. Evans), who lectured to Manchester students in the 1940s, and Ernest Warhurst. The latter was a student then but took over in 1946 from Polanyi's General Chemistry lectures. Students, of course, barely realized that Polanyi had been a pioneer in the X-ray techniques and equipartition of energy levels on which he lectured – the author still has some cyclostyled sheets that he released after each lecture – or that he was now devoting so much attention to social sciences. Hydrogen activation was studied in porphyrins and heamoglobin by visitor Melvin Calvin and Donald D. Eley, later Professor at Nottingham and Exeter The velocity of the vapour phase reaction of organic halides with sodium atoms was called harpooning by Polanyi and Richard Ogg; the electron is the harpoon. This was taken up by Meredith Evans (later Professor at Leeds and Manchester), G.N. Burkhardt, who lectured on organic chemistry (referring to stewpot reactions) to first-year Manchester students in 1945, and the experienced inorganic chemist Fred Fairbrother. Polanyi rarely put his name on the publications of these co-workers. As an indication of concurrent or merging interests, adjacent 1935 articles from his list were on 'adsorption and catalysis' and 'USSR economics'. Although his elder brother Karl (who lived in Vienna from 1919 to 1933, when he emigrated to London) was an economic historian as well as a linguist, this does not seem to have been a persuasive influence although they had long-standing arguments.

Even before World War II began, and again when he was naturalized in September 1939, Polanyi tried unsuccessfully to take on war work. [Desmond Bernal (who had taken up Polanyi's X-ray methods in the 1920s) and Blackett each separately was fully occupied throughout the war with diverse aspects of operational research and advice.] This rejection may have encouraged Polanyi to concentrate even more on economics and politics, which had had half his attention for some years. Early in 1941, at a gathering of the Society for Freedom in Science (of which he became a co-vice-president) he met the Oxbridge biologists John Baker and Arthur Tansley. Polanyi recalled this as the last turning point of his life when he started to be a philosopher. There was a fear that planning of science needed in war might lead to excessive restrictions on post-war science. Polanyi strongly opposed, as illustrated by his radio talks on the decline of freedom, the absence of criticism of Soviet science by both Bernal and Crowther. Bernal had written his *Social Function of Science* in 1939 while Crowther was author of *Soviet Science* in 1942 and *Social Relations of Science* in 1941. Surprisingly, perhaps, Crowther was regarded in 1946-7 as sufficiently mainstream to write and edit with physicist Richard Waddington the official HMSO record of *Science at War*. Polanyi had made several visits to the USSR (followed by discussion dinners in Berlin with economists and Nobel scientists) while based in Germany and went again in 1935. Together with Burkhardt and F.S. Springall (not Spring), who ran the Manchester organic teaching lab before leaving for a chair at the new Keele University, Polanyi did a small amount of work for ICI before the war and this continued. He also got ICI support for E.T. Butler (whose Chemical Thermodynamics book was the text for the Second Year Physical Chemistry lectures in 1946-7) to work on isobutylene polymers. In a broader project, Polanyi, Fairbrother and A.G. Evans tried from 1942 to improve for ICI the irreproducible isobutene polymerization process and were assisted from 1944 by H.A. Skinner, lecturer in Advanced Physical Chemistry at Manchester in the 1940s, and Peter Plesch, Hungarian son of the Polanyis' doctor in Berlin; Plesch later ran a teaching laboratory at Manchester and took a chair at Keele. Realizing with Polanyi the co-catalytic effect of atmospheric moisture, Plesch achieved a successful polymerization. Despite the ICI collaboration, Polanyi insisted that pure research, regarded by Bernal as indulgent snobbery, be kept separate from applied science.

Although still teaching chemistry in the mid-1940s, Polanyi accepted a transfer of his chair to social sciences in 1948, as his interest now centred on economic, philosophic and political thought. The appointment appeared to provide freedom of leave; much of 1949 was spent at an inn in Wales writing lectures for another university! In retrospect, his friend M.G. Evans felt that, on arrival in Manchester, he had too much adhered to the German model of concentrating on his physical chemistry rather than taking a broader interest in the Chemistry Department. In 1946 Polanyi gave the Riddell Lectures on *Science, Faith and Society* in which he highlighted originality, profundity and intrinsic interest, suggesting that the ideal objectivity of observations could be over-estimated or misleading. He very nearly went to Chicago in 1951-1952 but complications over the visa prevented this. In 1959, he retired to Merton College, Oxford, and received limited acceptability there. But, as a world scholar, he was now able to make many visits to the USA, emphasizing the importance of personal commitment, but revealing a mind groping for a relation between scientific knowledge and religious knowledge and faith.

Nye's later chapters assess the influence of Polanyi on other historians and philosophers of science. She argues that the social construction of science, what she calls the social epistemology of science, began with natural scientists Bernal and Polanyi. Polanyi contended that science thrives because it involves personal creativity and belief. In *Personal Knowledge*, based on the Gifford Lectures of 1951-1952, he again presented the idea of tacit or silent non-subjective knowledge, requiring apprenticeship and practice to know-how; more formal articulated knowledge requires unarticulated knowledge as well. In the next generation, Kuhn (born in 1923; he was at the Telecommunications Research Establishment, Malvern in 1944-1945 before going to Harvard) and Polanyi countered Popper. In the 1960s generation, Nye says, the history and philosophy of science was transformed from the study of scientific knowledge to that of scientific belief. A nominal Roman Catholic, who married a Catholic, Polanyi and his wife sent their children to Anglican and Quaker schools. He opposed Zionism and occasionally attended Protestant services in Manchester. He spoke at an Student Christian Movement conference in 1940 and one of his later chairs was in a Religion Department at Duke. Briefly, intelligent design thought his outlook favoured them but that support was rapidly withdrawn. The attitude to religion is perhaps neatly summarized by the biologist Joseph H. Woodger who said that Polanyi was haunted by the inescapability of belief and doubt.

Michael Polanyi and his Generation is a beautifully written memoir with a purpose. It describes how polymath Polanyi made major contributions to X-ray analysis, solid state science, sodium flame reactions and transition state theory before emerging as an acclaimed philosopher of science. There are eighty pages of notes and references, photographs of most of the principle characters, and a thirteen page index. The extensive sections on the physical chemistry are clear enough but there may be challenges in the later chapters for those of us less involved in the philosophy of science.

References

1. R.A. Hodgkin and Eugene I. Wigner, "Michael Polanyi 1891-1976", *Biographical Memoirs of the Royal Society*, 1977, 23, 421.
2. W. Tausig Scott and Martin X. Moleski, SJ, *Michael Polanyi, Scientist and Philosopher*, (Oxford: OUP, 2005).
3. Michael Polanyi, "My Time with X-rays and Crystals", in *Fifty Years of X-ray Diffraction*, ed. P.P. Ewald (Utrecht: Oosthoek and I U Cr, 1962) 629
4. H. Meyer and L. Misch, *Helv. Chim. Acta.*, 20, 1937, 232

Derry W Jones
University of Bradford

RSC CHEMICAL LANDMARK SCHEME

RSC Chemical Landmark Plaque at Johnson Matthey Plc

On Friday 20 June 2014 an RSC Landmark plaque was unveiled at the Johnson Matthey Plc Emission Control Laboratories at Royston, Herts, and I attended on behalf of the Group.

The site has some 1100 workers, and an unusual and pleasant feature of the day was that almost all of these attended, in four 'shifts'. The gathering involving the RSC presentation started at 11.00 am with an introduction and brief history of the car catalyst facility at the site, given by Dr Chris Morgan, the Technology Director of Johnson Matthey at Royston. A platinum-rhodium catalyst for the reduction of vehicle hydrocarbons had been developed in the Royston laboratories in 1969, and the passing of state legislation in California requiring that new vehicles should have exhaust converters stimulated the firm to set up a plant for commercial catalyst production at Royston in 1974.

The Johnson Matthey National Chemical Landmark Plaque
[Image by Bill Griffith]

Later refinements led to a 'three-way' catalyst which oxidised CO and hydrocarbons but also reduced nitrogen oxide (NO_x) emissions to nitrogen, so that modern convertors are both oxidative and reductive. The latest catalyst made at Royston involved palladium-rhodium sintered on to alumina honeycombs, often with a base-metal catalytic component. Johnson Matthey is now the world's largest producer of catalytic converters, satisfying a third of the world's requirements. For this the firm has ten technology and fourteen manufacturing plants worldwide.

David Phillips then briefly introduced the aims of the RSC, now very much a global organisation, and spoke of the Landmark scheme which was started in 2001; there are now 49 such plaques. He and David Prest, the managing director of Johnson Matthey Royston, unveiled the plaque, and after lunch guests were taken on an extensive tour of the development and testing facilities for exhaust catalysts at the site. Later in the afternoon the Queen's Award for Enterprise in Sustainable Development for 2014 was presented to the firm.

Bill Griffith

RSC Chemical Landmark Plaque honouring Thomas Graham at the University of Strathclyde

On 2 July 2014 an RSC Chemical Landmark plaque to Thomas Graham was unveiled at the University of Strathclyde. Of all the individuals, locations and events that have been commemorated by RSC Landmarks, this is the one which is of most direct relevance to the RSC itself. Not least among Graham's achievements was his role in the formation in 1841 of the Chemical Society, the earliest forerunner of the various organisations which united to form the RSC in 1980. But he is also remembered for his studies on diffusion and dialysis, his work at Anderson's University (as it was then), and his subsequent role as master of the Mint.

The event took place appropriately enough in the Thomas Graham Building at the University of Strathclyde. Attendees were welcomed by Professor Duncan Graham, Acting Head of Department of Pure and Applied Sciences at Strathclyde. There followed a presentation on the work and life of Thomas Graham by Professor Colin Suckling. Nobel Laureate Professor Roald Hoffmann then gave a lecture entitled "All the Ways to Have a Bond". Finally Robert Parker spoke about the RSC Chemical Landmark scheme, and invited Roald Hoffmann to unveil the plaque. These formalities were followed by a reception for the attendees, amongst whom were a number of students following chemistry courses at Strathclyde. The plaque is now mounted on the exterior wall of the building by the main entrance.

Roald Hoffman, Professor Duncan Graham and Robert Parker with the new plaque at the University of Strathclyde
[Image supplied by the RSC.]

The event took place appropriately enough in the Thomas Graham Building at the University of Strathclyde. Attendees were welcomed by Professor Duncan Graham, Acting Head of Department of Pure and Applied Sciences at Strathclyde. There followed a presentation on the work and life of Thomas Graham by Professor Colin Suckling. Nobel Laureate Professor Roald Hoffmann then gave a lecture entitled "All the Ways to Have a Bond". Finally Robert Parker spoke about the RSC Chemical Landmark scheme, and invited Roald Hoffmann to unveil the plaque. These formalities were followed by a reception for the attendees, amongst whom were a number of students following chemistry courses at Strathclyde. The plaque is now mounted on the exterior wall of the building by the main entrance.

The wording on the plaque reads:

Thomas Graham
(1805-1869)
Born in Glasgow and Professor of Chemistry at
Anderson's University (now University of Strathclyde)

from 1830-1837. His famous contributions to
Science were Graham's Law of Diffusion and his
pioneering work on dialysis. He founded the
Chemical Society of London in 1841, and
became Master of the Mint. He is
commemorated by this building and
by a statue in George Square.
2 July 2014

John Hudson

RSC Chemical Landmark Plaque awarded to Saltend Chemicals Park, Hull

The plaque was presented on 23 September 2014 by Professor Dave Garner, former President of the RSC, to mark one hundred years of chemical-related activity on the Hull site.

Saltend is a hamlet, just outside Hull, on the north bank of the Humber. It is dominated by a chemical works which hosts a number of industries, most of which have a connection with BP. Noteworthy on the 370 acre site is the BP production of acetic acid (presently 600,000 tonnes per year, the largest plant in Europe) and acetic anhydride (150,000 tonnes per year). Also part of the complex is *Vivergo Fuels*, a joint operation between BP, British Sugar and Dupont, which produces 330,000 tonnes per year of bioethanol from sugars mainly derived from wheat. Our host for the day was the *Hull Research and Technology Centre*, part of BP, which concentrates on catalyst discovery and development, and the testing of new processes, such as novel methods to dehydrate ethanol to ethene, at pilot plant level. Staff members at the Centre were responsible for initiating the Landmark Award and overseeing the day's activities at the local level.

Chemical activity at Saltend started in 1914 with the construction of a jetty to facilitate the importation of petroleum products, notably benzene. In 1922 an American, Herbert Green, frustrated by the prohibition laws in his home country, began to import molasses with a view to converting them into ethanol and built a distillery on site. The Distillers Company, long associated with the whisky trade, wished to diversify into the preparation and exploitation of industrial alcohol, and so bought a controlling interest in Green's firm in 1925. Acetic acid production started in 1930 with aqueous ethanol being trickled over beech wood shavings doped with a suitable culture to facilitate the aerial oxidation. The company was later renamed *British Industrial Solvents* and the product range diversified further as outlets were found for ethanol-derived plastic monomers such as vinyl acetate. By 1962, the manufacture of chemicals from molasses had become uneconomic and instead the company switched production to an oil-based feedstock, naphtha, which was oxidized directly to acetic acid and other chemicals. In 1967 the Distillers Company sold its chemicals and plastics business to BP because the division did not have the scale of its major competitors in the USA. In the 1980s and 1990s the research centre developed new processes for the manufacture of acetic anhydride (A5 process), acetic acid (Cativa^{TM}), ethyl acetate (Avada^{TM}) and vinyl acetate (LEAP^{TM}), all of which were successfully commercialized at Saltend.

Looking to the future, the BP chemists and engineers at Saltend have recently developed two new petrochemical production technologies. SaaBre™ is a new route for the production of acetic acid from syngas and Hummingbird® directly converts ethanol to ethylene through dehydration. SaaBre's breakthrough is a process for the conversion of synthesis gas (carbon monoxide and hydrogen derived from hydrocarbons such as natural gas) directly to acetic acid in a proprietary, integrated three-step process that avoids the need to purify carbon monoxide (CO) or purchase methanol. Hummingbird® is a newly developed proprietary process by which ethanol is dehydrated to produce ethylene, a fundamental building block for the plastics and other petrochemical industries. The new technology is lower cost and simpler compared to existing ethanol to ethylene technologies. BP is actively exploring options for commercialising both technologies. SaaBre™ is planned for deployment in future acetic acid investments whilst Hummingbird® is a licensing opportunity for BP.

The plaque was presented to Scott Roberts, head of the BP Saltend research department, who said "…the exciting thing about Saltend is its marriage between the small-scale lab work carried out by my team and the vast industrial processes going on outside. It's really the only place I know in BP that contains capability spanning from an initial idea, exploring the fundamental chemistry and taking the process all the way through to large-scale manufacturing operations".

The text on the plaque reads:

Saltend Chemicals Park
In recognition of 100 years of innovation in
supplying the UK with transportation fuels
and important base chemicals. Saltend has
uniquely combined in one location the research,
development and commercialisation of
numerous new processes for the
manufacture of organic acids,
alcohols and their
derivatives
23 September 2014

Group photograph of Saltend Chemicals Park staff and RSC representatives (Professor Dave Garner is fourth from the right).
[Images supplied by the RSC]

The Saltend Chemicals Park National Chemical Landmark Plaque

The Historical Group was represented by Alan Dronsfield

Alan Dronsfield

Dan Eley: A Celebration of 100 Years of Life and Science

The presentation of an RSC Chemical Landmark plaque to celebrate the one hundredth birthday of Daniel Douglas Eley, FRSC, OBE, FRS, took place during a half-day symposium held in the School of Chemistry at The University of Nottingham on Wednesday 29 October 2014. There were six speakers and about 300 people attended the event, including many of Dan's former students.

The first part of the programme was chaired by Peter Sarre (Professor of Chemistry and Molecular Physics). After a welcome to the symposium by Saul Tendler (Pro-Vice-Chancellor for Research and Professor of Biophysical Chemistry), Professor Katharine Reid, the current Head of Physical and Theoretical Chemistry, gave the first presentation entitled “Dan Eley: A Perspective”.

Dan graduated with first class honours in Chemistry at the University of Manchester in 1934 before starting postgraduate work on catalytic processes supervised by Michael Polyani, the Hungarian-born polymath. He obtained an MSc in 1935 and a PhD in 1937 before leaving for Cambridge to join the Colloid Science Laboratory of Eric Rideal (later Sir Eric Rideal) where he obtained a second PhD in 1940. It was during this period that measurements of ortho-para hydrogen equilibration catalysed by a tungsten surface were made. This led to the publication of the famous Eley-Rideal mechanism in which a gas-phase molecule collides with a surface-adsorbed molecule. Subsequent elevation to textbook status of the mechanism means that citations of the original papers are no longer considered necessary.

Before leaving Manchester, Dan also become interested in the statistical thermodynamics of aqueous solutions. With M.G. Evans (who later succeeded Polanyi to the chair of physical chemistry) he published a highly cited paper on ions in water. This was followed in 1939 by two papers on the solubility of gases authored by Dan alone which continue to be cited to this day.

In 1945 he was appointed to a Lectureship in Colloid Science at the University of Bristol and promoted to a Readership in Biophysical Chemistry in 1951. It was here that his research interests broadened still further to include the electrical properties of organic and biological materials, and in particular their semi-conductivity. Following a seminal note to *Nature* in 1948 in which Dan reported that phthalocyanine and copper phthalocyanine exhibited semi-conductivity, he began a long-running study of semi-conductivity in organic substances that produced a series of papers eventually running to eighteen parts.

In 1954 Dan was appointed to the newly created Chair of Physical Chemistry at Nottingham, joining a Department which up to that time had only a single Chair, the Jesse Boot Professor of Organic Chemistry. Research and teaching took place in cramped conditions in the Trent Building and in some prefabricated huts which had been erected after the war. Dan quickly built up a vigorous physical chemistry group supported by funding from the DSIR, government departments and industry, including a grant of £10,000 from ICI to support colloid science.

Construction of a new building, designed by Basil Spence, to accommodate the Chemistry Department commenced in 1958. Staff moved in during 1960, although the building was not completed until 1961. There was now space for 300 students and 70 postgraduate students. A new Chair of Inorganic Chemistry in 1960 completed the professoriate and during the next decade all three incumbents were elected Fellows of the Royal Society.

Throughout the 1960s and 1970s physical chemistry research under Dan’s leadership included work on zeolites, photochemistry, photocatalysis, X-ray crystallography, magnetic properties of materials, and infrared spectroscopy in addition to the well-established programmes in heterogeneous catalysis, electrical properties of organic materials and colloids and interfaces. Dan also played a full part in the teaching of undergraduates and was renowned for his lectures to first year students on wave mechanics.

Following his retirement in 1980, Dan continued to collaborate with former colleagues and research students with whom he co-authored around another twenty-five papers, the final one appearing in 1994.

Professor Martyn Poliakoff (left) with Professor Dan Eley and the RSC Chemical Landmark Plaque at the University of Nottingham.
[Image supplied by the RSC.]

Unfortunately Professor Sir John Meurig Thomas (University of Cambridge) who was scheduled to present a talk entitled “Three Demonstrations: Three Experiments” was unable to attend the meeting because of illness. However Professor Martyn Poliakoff (Research Professor of Chemistry) stood in for him, using the material provided by

Professor Thomas. The lecture which focused on the design and application of solid catalysts was illustrated by video clips from Professor Thomas's 1987 Royal Institution Christmas Lectures "Crystals and Lasers".

Professor Peter Norton (Western University, London, Ontario) then presented a talk entitled "Memories and Connections: Nottingham and Back Again". Peter Norton, who was in the first cohort of students to move into the new Chemistry Building in 1960, described his time as a PhD student and as an ICI Fellow in Dan's laboratory. These years were enjoyable and critical for his own later career in Canada during which he interacted with a number of distinguished physical chemists who all held Dan in high esteem. For the one hundredth birthday celebration, he had contacted Professor Gerhard Ertl (Nobel Prize in Chemistry, 2007), Professor John Polanyi (Nobel Prize in Chemistry, 1986 and the son of Michael Polanyi) and Sir David King (University of Cambridge, former Government Chief Scientific Advisor), all of whom responded with warm, complimentary messages and greetings for Dan.

At the close of the first session Professor Martyn Poliakoff, Vice-President and Foreign Secretary of the Royal Society presented Dan with a certificate to mark the fiftieth anniversary of his election to the Society.

Professor Dave Garner (Past President of the RSC, Professor Emeritus, School of Chemistry) then spoke about the activities of the RSC and especially of the criteria for the award of Chemical Landmarks. He drew attention to the list of other illustrious chemists honoured in this way whose company Dan was now joining before calling for the formal unveiling of the plaque which reads:

Daniel Douglas Eley
OBE FRS
To mark the 100th birthday of Daniel Eley, pioneering
physical chemist. His research, much of it conducted
in Nottingham, bridges chemistry, physics and
biology. It includes the Eley-Rideal mechanism of
gas-surface reactions, organic semiconductors,
discovery of the conductivity of DNA,
ortho/para hydrogen conversion and
understanding of the structure of
aqueous solutions.
1 October 2014

Finally, the one hundred candles on a birthday cake were lit by technician Neil Barnes who worked with Dan from 1977 to 1980.

After tea the second part of the programme chaired by Dr Elena Bichoutskaia (Associate Professor in Computational and Theoretical Chemistry, University of Nottingham), opened with a talk by Professor John Simons (Dr Lee's Professor of Chemistry Emeritus, University of Oxford) entitled "A Few Problems Dan didn't Address – but probably would have, given another 100 years". John Simons who succeeded Dan as Professor of Physical Chemistry at Nottingham introduced his talk by referring to Dan's work in the biophysical area before going on to describe his own recent research using molecular-beam experiments to study molecular interactions between sugars and peptides.

Professor Ronald Pethig (Honorary Professorial Fellow and former Professor of Bioelectronics, University of Edinburgh) then spoke on "Towards Molecular Electronics and a Submolecular Biology". Ron Pethig described how as a PhD student in Electrical Engineering at the University of Southampton, he was inspired on reading a paper by Szent-Györgyi proposing the existence of conduction bands in biological systems. As a result he joined Dan's research group as an ICI Fellow where he obtained a second PhD working on dielectric properties of biomacromolecular systems. Reviewing Dan's pioneering contributions to molecular electronics, he highlighted his studies of conductivity in DNA. Recent investigations have vindicated this early work by demonstrating that conductivity in DNA molecular wires approaches almost metal-like behaviour at high frequencies raising the prospect of exciting applications in nanotechnology such as DNA sequencing.

Dr Maria del Carmen Giménez-López (Royal Society Dorothy Hodgkin Research Fellow, School of Chemistry) gave a talk entitled "Multifunctional Hybrid Metal-Carbon Nanostructures for Spintronic and Energy Related Applications". Dr Giménez-López gave an account of her work developing methods for confining complex molecular structures within nanotubes to form novel types of hybrid nanomaterials with potential for applications in next-generation electronic devices. The meeting was brought to a conclusion by Professor Jonathan Hirst (Head of the School of Chemistry) with a talk entitled "Chemistry@Nottingham: The Next Century" in which he set out the prospects for the School under the headings: People, Science and Infrastructure.

The Historical Group was represented by Mike Hey and Alan Dronsfield.

Mike Hey

Meeting Reports

Chemistry & World War One

This full-day meeting was organized as the Historical Group's contribution to the RSC events marking the outbreak of World War One. It was held on 22 October 2014 at Burlington House and attracted an audience of fifty-two. Unfortunately, the planned live stream to the Catalyst Science Discovery Centre at Widnes (Cheshire) had to be abandoned, although it is hoped to stage such ventures in the future. The meeting comprised seven speakers and the topics covered included not just British perspectives but also German and French. As part of the meeting, Dr Tony Travis (The Hebrew University of Jerusalem) was presented with the Wheeler Award for his outstanding contribution to the history of chemistry, and a fuller-version of his talk will be produced separately. The meeting was rounded-off with some concluding remarks from Professor Alan Dronsfield (past Chairman of the Historical Group) that drew on his own family's connection with World War One. The Historical Group is grateful for a grant from the RSC towards the costs of this meeting.

Peter Reed

The Chemists' War: 1914–1918

Michael Freemantle, Author of The Chemists' War: 1914 –1918

Britain declared war on Germany on 4 August 1914. Between then and the Armistice on 11 November 1918 an estimated 15 million people died as a result of the war. The toll included not only battlefield fatalities but also military and civilian deaths resulting from starvation, disease and other causes.

This industrial-scale slaughter could not have occurred without the industrial-scale production of a vast variety of chemicals. They included high explosives such as trinitrotoluene (TNT) for shells, cordite and other propellants for firing the shells, and chemical warfare agents like chlorine, phosgene and mustard gas. In one battle alone, the Battle of the Somme (1 July-18 November 1916), the British and Germany armies fired a total of 30 million shells at an average of almost 150 per minute.

Paradoxically, chemicals were used not just to kill, maim, and destroy, they were also used to protect and help care for troops. For example, steel was used not only to manufacture guns but also to make protective helmets for the infantry and armour for tanks and battleships. Chlorine was employed as a lethal chemical warfare agent throughout the war and at the same time as a purifying agent for the drinking water supplied to the armed forces. Nitroglycerine was used as an explosive and also as a drug for heart disease. Anaesthetics such as chloroform and ether, two relatively simple chemicals, and painkillers such as morphine, a chemical that occurs naturally in the opium poppy, were used extensively in the war.

The chemistry of the war therefore proved to be a double-edged sword. It was used not only as a destructive instrument of war but also for protection, for preventing the spread of disease, and for healing sick and wounded soldiers.

The Great Munition Feat': Reflections on Kenneth B. Quinan, the Making of Gretna, and the Imperial Chemical War Effort

Professor Roy MacLeod, University of Sydney

Since the beginning of 2014, historians have revisited long-standing debates about the *causes* of the Great War and its *conduct*. Much less attention, however, has been given to the *management* of the war – and in particular, to what George Dewar famously called *The Great Munition Feat* (1921). For nearly four years, in each of the belligerent powers, the war prompted the mobilization and management of public and private industry in ways both unprecedented and unforeseen. Nowhere was this effort more conspicuous than in the chemical industry, and in the manufacture of explosives and chemical weapons. A war of factories was fought by engineers and men of business, who blended science with tradition, producing outcomes that had implications far wider than their contemporaries understood, or even we have so far unpacked.

This paper stepped back, to ask not only how chemistry changed the War, and how the War changed chemistry – important questions in themselves - but also how the need to do brought about dramatic and permanent change in industrial management. The focus was on Britain's much heralded but little studied Ministry of Munitions, and the role of Lord Moulton, Kenneth Quinan and a small army of imperial chemists and chemical engineers who transformed the green fields of Gretna and many other sites. Their efforts turned textbook principles into industrial processes, and raw materials into *materiel*, in the vast quantities that the war famously consumed. Perhaps, in their very success, the chemical industry helped prolong and magnify a war it had been summoned to finish. Alongside memories of achievement, such questions remained. But, for the moment, the war was over. The guns fell silent, and, for the time being, chemists and engineers returned to the preoccupations of peace.

Nitrogen, Novel High Pressure Chemistry and the German War Effort

Dr Tony Travis, The Hebrew University of Jerusalem

The almost four-year stalemate that followed the Battle of the Marne in September 1914 made heavy demands on producers of nitrogen compounds employed in the manufacture of explosives. At that time both the Allies and the Central Powers were reliant on imported Chilean nitrate (Chile nitrate, sodium nitrate) for production of the nitric acid required to nitrate organic chemicals such as toluene which was converted into the explosive TNT. For the Central

Powers the availability of the vital nitrate ceased following the Battle of the Falkland Islands on 8 December 1914, when the British Royal Navy gained a major victory over the Imperial German Navy. Germany then quickly turned to industrial processes for capturing atmospheric nitrogen that had been developed from around 1905: the electrothermal production of calcium cyanamide, based on the work of Adolf Frank and Nikodem Caro (the Frank-Caro process); and the synthesis of ammonia from its elements by the high-pressure method invented in 1909 by physical chemist Fritz Haber, with the aid of his British assistant Robert Le Rossignol, and adapted to industrial production by Carl Bosch of BASF, at Ludwigshafen. Manufacture of ammonia, at nearby Oppau, commenced in September 1913. There were also the high-voltage electric arc processes for nitric oxide, first developed by Birkeland and Eyde in Norway. The cyanamide and Haber-Bosch processes were of critical importance to Germany. This stimulated technical improvement and massive expansion of all the synthetic nitrogen processes, as well as major developments in the production of concentrated nitric acid by catalytic oxidation of ammonia (mainly the Ostwald process). The Haber-Bosch process came to the forefront from 1916-1917 mainly as a result of the Hindenburg programme of state-led industrialization and the opening of the Leuna works at Merseberg in 1917. The astounding technical brilliance of the process could not be matched by the Allied nations. Synthetic ammonia inaugurated a new era in industrial chemistry, based on the application of high pressures and catalysts, and including the growth of a key sector: nitrogen products as fertilizers.

The British Chemical Industry and World War One: The United Alkali Company

Peter Reed, Independent Researcher

When on 4 August 1914 Britain entered the First World War the country was unprepared for conflict and was forced to mobilize quickly. It is estimated that British forces fired 250 million shells and produced about 25,000 tons of 'battle gases' during the course of the war, which it has become known as the 'Chemists' War'. Production of chemicals for the war effort was directed by the Ministry of Munitions and its Trench Warfare Department (with the Treasury overseeing financial costs).

Huge demands were placed on the chemical industry with the United Alkali Company as one of the largest companies within the heavy-chemical sector (principally producing alkali, sulphuric acid and bleaching powder) contracted to manufacture a wide range of chemicals for the war effort while maintaining wherever possible its production of chemicals for homeland use. Much of this work centred on its Central Laboratory that had been established in 1890 to move the company away from its dependence on the obsolete Leblanc process, though by 1914 the Company was still largely dependent on this process.

UAC's wartime work relied on the Central Laboratory (under the leadership of Julius Raschen) working closely with the Engineer's Department (established in 1905) to focus on R&D requirements: innovation in process pathways, plant installation and operation, and meeting production targets, all as quickly as possible. This work involved transferring from the lead chamber process to the contact process, the manufacture of new explosives (picric acid and ammonium perchlorate) and the manufacture of a number of warfare gases (including chloropicrin, phosgene, mustard gas and arsenical agents).

The wartime period proved successful for UAC and for the Central Laboratory. This was largely because the company did not have to assess the commercial market for the chemicals it produced since this was determined by the Ministry of Munitions as it responded to the changing battlefield demands.

The French Chemical Industry and World War One

Erik Langlinay, Ecole de Hautes Etudes en Sciences Sociales, Paris

By October 1914 France had already lost a quarter of its chemical capacity and many works in the north-east of the country were occupied by the Germans. The country suffered further disorganization when men were sent in their masses to the front. The industry was unable to cope with the shortage of dyestuffs and high explosives previously imported from Germany. London played an important role in transforming the peace-time French chemical industry into a wartime industry. Since October 1914 the French army had bought considerable amounts of benzol, necessary to produce phenol and explosives, from British industry. Further approaches were made to America, and the first contract with Du Pont de Nemours for guncotton was signed in autumn 1914.

It was only in October 1915 that the Minister of Armament decided to launch a vast industrial policy and built around twenty new explosives, sulphuric and nitric acid and benzol factories; these were mainly in the Rhone Valley, south of Lyon, the more remote city of Toulouse and the harbours of Marseille and Bordeaux. Albert Thomas, Under-Secretary in charge of ammunition adopted a mixed policy of state and private control; very few products were requisitioned but some works were state-owned while others were privately owned (such as Saint-Gobain and Kuhlmann). A huge effort was demanded of the workforce, with factories working twenty-four hours a day. Men, women, foreigners (Chinese and Vietnamese) were widely employed, though often working in very poor conditions. Albert Thomas, for the security of France, continued the mass importations from the UK and the US: eighty percent of the benzol was British in December 1916, fifty percent of the alcohol and fifty percent of toluol was American for instance.

The industrial programme was almost ready by the end of 1916 when the Germans launched their submarine attacks against allied navies. Imports of nitrate were severely reduced in March 1917, with only three months of reserve remaining which meant the whole explosives industry could have collapsed. The allied decision was to reduce the import of these nitrates and replace them with US-made explosives: the latter jumped to twenty or thirty percent of the total production in 1918. At the same time a synthetic nitric acid programme was launched that was still under construction in November 1918. France's chemical production made huge progress during the war in almost every field; explosives advanced from 9 tons per day in October 1914 to about 750 tons at its peak in March 1917. The contribution of the Americans and British, together with the colonial workforce, to this success was huge and victory would not have been possible without it.

Chemistry, Patents and the Transformation of the European Pharmaceutical Industry in World War One

Dr Viviane Quirke, Oxford Brookes University

Histories of chemistry in World War One have tended to focus on the chemicals 'that kill', i.e. those involved in the manufacture of shells, bombs, and war gases, while histories of medicine have tended to concentrate on heroic surgery, the identification of new diseases, or the development of medical specialisms, such as orthopaedics and psychiatry. This paper focused on the chemicals used to treat the wounds, shock and trauma caused by war, as well as diseases that are common in wartime, in particular venereal diseases. The paper argued that, although not as many new drugs were developed in World War One as in World War Two, their manufacture and use in the First World War helped to transform the European pharmaceutical industry, contributing to the diffusion of chemical knowledge and practice, of a particular way of 'knowing and doing'.

Before the First World War a number of chemical drugs were already in use, including plant alkaloids such as quinine, morphine, and digitalin; synthetic drugs (e.g. barbiturates, aspirin and other analgesics and antipyretics); and anaesthetics (chloroform and ether). In addition, the arsenical drugs Salvarsan and Neosalvarsan, which had been developed by Paul Ehrlich and marketed by Hoechst AG in 1910 and 1912 respectively, were used for the treatment of syphilis before – and most importantly – during the conflict. Not only did these drugs mark the birth of modern chemotherapy, they also helped to transform the European pharmaceutical industry.

Indeed, before World War One, many of the chemical drugs listed above had been manufactured in Germany, and by the 1900s the Big Three (Bayer, BASF, Hoechst) dominated chemical-pharmaceutical patents. This led to a number of 'patent wars' which preceded the Great War, prompting the introduction of new Patent Acts in 1907 in Britain and Switzerland. Meanwhile France, which did not allow the patenting of drugs or processes, pursued a strategy of emulation and imitation that would endure until after World War Two.

The abrogation of German patent rights during World War One, by further enabling the transfer of chemical knowledge and knowhow, stimulated chemical-pharmaceutical innovation and boosted the growth of science-based firms in countries at war with Germany. This was achieved thanks to collaboration between private companies and public research institutions, under the coordination of government bodies such as Britain's Medical Research Committee, or the Royal Society's Chemical (later Drugs) Subcommittee, thus paving the way for the scientific-military-industrial complexes of World War Two and the Cold War.

From Bunsen to POWs in Britain: Dr K.E. Markel, a Chemist in the Great War

Colin Chapman, Chairman, RSC Bristol & District Section

On the declaration of war on 4 August 1914, the British Government immediately ordered male civilians of military age with Germanic origins then living in Britain to be arrested, questioned, and if deemed a potential spy or saboteur to be interned for the remainder of the conflict, irrespective of their circumstances. In the event some 23,000 Germans and Austrians were detained, mostly on the Isle of Man, until 1919. After the sinking in May 1915 of the *Lusitania* with the loss of some 1,200 lives, the internment policy was more strongly enforced.

Among the Germans living and working in Britain in 1914 were chemists who had migrated from continental Europe during the nineteenth and early twentieth centuries to take up employment in industries embracing the chemical sciences. Some had been swiftly promoted, others had even founded their own companies. A few German owners had been sufficiently astute to give their firms British names to disguise their true origins; nevertheless from 5 August 1914, many such men were considered guilty as possible traitors until proved innocent, hence few avoided arrest and interrogation. Some German chemists had taken out British Citizenship long before the outbreak of hostilities, but unless they could demonstrate they were "working for the national good", this carried little weight. Among those who were not interned was Karl Markel who had been invited to England by Ludwig Mond, a former fellow student of Robert Bunsen, to tutor his sons, Robert and Alfred. Markel subsequently worked for Brunner and Mond before becoming Technical Director of Warrington soap manufacturer Crosfield. On his retirement in 1911 he moved to London, and in 1915 set up a Prisoner of War Relief Agency using his own and others' wealth to provide elements of comfort to men held captive because of their origins. This lecture described some of Markel's outstanding philanthropic work for German internees and, later, combatant prisoners of the First World War in Britain.

MEMBERS' PUBLICATIONS

If you would like to contribute anything to this section please send details of your publications to the editor. Anything from the title details to a fuller summary is most welcome.

Derry Jones writes: the publications below may be of interest to members. They are chiefly book reviews or essay reviews in rather more physics-based journals and newsletters.

Derry W. Jones, review of Morton A. Meyers, *Prize Fight: The Race and Rivalry to be the First in Science*, published in *Contemp. Phys.*, 2013, **54** [1] 67-68. Discusses MRI (Lauterbur, Mansfield and Damadian) and other cases.

Derry W. Jones, review of Peter Mansfield's, *The Long Road to Stockholm*, published in *Contemp. Phys.*, 2013, **54** [4] 219-220. Autobiography about NMR and the emergence of MRI.

Derry W. Jones, "Crystallographic Centenary Celebration: The Emergence of X-ray Analysis", *Contemp. Phys.*, 2013, **54** [6] 267-270. Essay review of A. Authier's *Early Days of X-ray Crystallography.* Review includes comparisons with P.P. Ewald's large, edited but multi-authored volume of fifty years earlier; the book includes some quite early history of crystallography.

Derry W. Jones, "Wrinch: Mathematics, Models and Molecular Biology", *BCA Cryst. News*, 2013, No 125, 21-22. Book review of M. Senechal's *I Died for Beauty: Dorothy Wrinch and the Culture of Science.* Senechal knew Bernal, Crowfoot/Hodgkin and Russell, and spent sabbatical spells with crystallographers Perdok (Groningen) and Belov (Moscow) and had a long battle with Pauling.

Derry W. Jones, review of Gérard Liger-Belair, *Uncorked: the Science of Champagne*, published in *Contemp. Phys.*, 2014, **55** [2] 138-139. Review of a book by a physics professor at the University of Reims which focuses on bubble formation and bubble science.

Derry W. Jones, review of Eric Scerri, *A Tale of Seven Elements*, published in *Contemp. Phys.*, 2014, **55** [3] 257-258.

Derry W. Jones, "The Genesis of the Bohr Atom", *Contemp. Phys.*, 2014, **55** [3] 222-225. Essay Review of Finn Aaserud and J.L. Heilbron, *Love, Literature and the Bohr Atom: Niels Bohr's 1913 Trilogy Revisited*. Deals mainly with Bohr's time at Manchester and implies his wife was an active inspiration and editor.

FORTHCOMING LECTURES

UCL Lunch Hour Lectures

UCL runs a series of free lunchtime lectures showcasing new research and recent academic publications, which are open to the public. The spring term

programme can be found at:

http://events.ucl.ac.uk/calendar/tab:lunch_hour_lectures/

Lectures can also be watched online on the UCL Lunch Hour Lectures YouTube channel:
http://www.youtube.com/user/UCLLHL

Recent lectures have included Dr Simon Werrett exploring the changing relationship between science and art in the sixteenth to nineteenth centuries by looking at interactions between pyro-technicians and scientists. Fireworks, used to celebrate grand occasions of state, inspired a variety of ideas about the natural world, while scientific advances in physics and chemistry helped to create surprising new pyrotechnic effects.

CALLS FOR PAPERS

Chemical Biography in the 21st Century

10th International Conference on the History of Chemistry (10th ICHC)

University of Aveiro, Portugal, 9-12 September 2015

Conference website: http://10ichc-2015.web.ua.pt/

This interdisciplinary conference welcomes participants from a range of academic disciplines including history of science and technology, science and technology studies (STS), economic and business history, and the history of material culture and museum studies. We also warmly welcome participants from chemistry and related disciplines with an interest in the history of their discipline.

Biographies - whether in the form of books or articles - have always been an important genre in the history of chemistry. General histories of chemistry have often taken a biographical approach, most notably the four volume work of J.R. Partington. Many chemists, especially in the German-speaking world, have written autobiographies which along with the formal obituaries produced by national academies of science have formed an important source of information for historians of chemistry. More recently the American Chemical Society published the "Profiles, Pathways and Dreams" series which extended the autobiographical form up to the end of the twentieth century. For several decades in the latter half of the twentieth century, professional historians of chemistry avoided the biographical approach as being inherently too hagiographical and 'Whiggish'. However following the pioneering work of scholars in the history of physics the biography has been taken up anew as a framework for analysing thematic problems and social-cultural questions. This conference will critically examine this conceptual "turn" in the historiography of chemistry and explore ways in which the biographical approach can be fruitfully employed by historians of chemistry.

The conference will embrace all aspects of the history of alchemy and chemistry including the history of materials and the history of biochemistry. Papers which simply present the biography of a chemist will not be accepted, as there must be a line of argument or a historical problematic. Papers might address:

1. Autobiographies as a source for historians of chemistry
2. Biography and discipline building
3. Biographies and nationalism
4. The making and unmaking of chemical heroes
5. Myths and misrepresentation
6. Iconography as a mode of self-representation in the visual arts, sculpture and photography
7. The historiography of the biographical mode
8. Collective biographies including biographical dictionaries and the "biographies" of research groups

Proposals for papers on other topics can be submitted, but preference will be given to papers reflecting the conference theme. Proposals can be made for sessions, standard papers (20 minutes), short papers (10 minutes) and posters. Proposals (abstracts) should be uploaded using Easychair on the website http://10ichc-2015.web.ua.pt/ and be a minimum of 150 words and a maximum of 300 words. The session proposals should also contain the abstracts of the proposed papers. The deadline for all proposals is midnight (Universal Time/GMT) on 31 March 2015. Further details of the conference, including local arrangements and accommodation, will be found on the website. Please address any queries to the chair of the programme committee, Peter Morris, at peter.morris@sciencemuseum.ac.uk.

FORTHCOMING MEETINGS AND CONFERENCES

Transformation of Chemistry from the 1920s to the 1960s

An International Workshop on the History of Chemistry

2-4 March 2015, Tokyo Institute of Technology

This three day workshop consists of keynote lectures by Jeffrey Johnson, Mary Jo Nye and Ernst Homburg and twenty-six contributions from the participants in eight sessions. For more information on the workshop and a full programme see: http://kagakushi.org/iwhc2015/

The deadline for registration is 31 January 2015

From Hooke to Helioseismology: The UK's contribution to seismology – past, present and future

9-10 April 2015, College Court, University of Leicester

A meeting sponsored by the British Geophysical Association, the Royal Astronomical Society, the History of Physics Group of the Institute of Physics and Shell Global Solutions International BV.

Participants are encouraged to submit posters on any aspect of seismology, particularly on the UK's historical contribution to the science.

Registration and further information can be found at:

http://shop.le.ac.uk/browse/extra_info.asp?compid=1&modid=2&deptid=1&catid=75&prodid=180#http://shop.le.ac.uk/browse/extra_info.asp?compid=1&modid=2&deptid=1&catid=75&prodid=180

Early Bird Registration closes on 31 January 2015.

Registration closes on 20 March 2015.

Living in a Toxic World (1800-2000): Experts, Activism, Industry and Regulation

8th European Spring School on History of Science and Popularization

Maó (Menorca), 14-16 May 2015

The School is structured around four key-note lectures and a research workshop and focuses on issues regarding the regulation and risk management of toxics from the perspective of different actors (industry, government, experts, activists, stakeholders, patients, etc.) during the last two centuries (1800-2000). The keynote lectures will be delivered by four outstanding scholars covering four particular toxics (fumes, pesticides, lead, and mercury) from the beginning of nineteenth century to the end of the twentieth century. The workshop “Living in a Toxic World” is organized in three thematic sessions and one poster session. Participants will present papers on many other toxicants (polymers, aluminum, asbestos, arsenical pigments, etc.) as well as studies on food additives, regulation of drugs and environmental toxicology. Participants will deal with issues related to regulation, standardization, risk management, experts, law, public health, activism, controversies and so on. The School sessions and discussions will be conducted in English.

For a full programme and details see:
http://blogs.iec.cat/schct/activitats-2/escola-de-primavera/8th-european-spring-school/

Deadline for registration with discount: 31 March 2015:

Deadline for registration: 8 May 2015

For more information please contact the organizers: José Ramón Bertomeu Sánchez bertomeu@uv.es and Ximo Guillem-Llobat ximo.guillem@uv.es