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Historical Group

NEWSLETTER
and
SUMMARY OF PAPERS

Editor: Dr Anna Simmons

No. 83 Winter 2023

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COMMITTEE

https://rschg.qmul.ac.uk/
http://www.rsc.org/historical/

RSC Historical Group Newsletter No. 83 Winter 2023

Contents

From the Editor

Welcome to the winter 2023 RSC Historical Group Newsletter. This issue includes a selection of short articles, essay and book reviews and I am most grateful to everyone who has contributed. Alan Dronsfield and Pete Ellis discuss "Monitoring blood-glucose levels during a century of insulin therapy"; Michael Jewess takes us back to slide rules and mathematical tables in "Calculating Chemistry: How it Used to be Done, a Witness Account"; and there is a short biography of "A Chemist who was a Photomicrographer: Alton Ewart Clarence Smith (1887-1936)" by Edward Clarence-Smith, William Clarence-Smith and Peter J.T. Morris. There is an essay review of José G. Perillán, *Science between Myth and History: The Quest for Common Ground and Its Importance for Scientific Practic*e and a review of Stephen M. Cohen's graphic novel, *O Mg! How Chemistry Came to Be*. Readers will also find a tribute to the much-admired historian of science, Trevor Levere, a report of the group's meeting on Women in Chemistry held at Burlington House in October 2022 and summaries of its popular monthly online seminars.

The group's first meeting of 2023 will take place on Tuesday 14 March at Burlington House. It will be an open meeting where members give papers on particular interests or research in progress. The programme will be brought together in early 2023. Please keep an eye on the monthly e-alert sent by the RSC on behalf of the group for further details.

As ever, I am indebted to the newsletter production team of Gerry Moss and Bill Griffith for their assistance in bringing the final version together. If you would like to contribute items such as short articles, book reviews, news items and reports to subsequent issues please contact me. The deadline for the summer 2023 issue will be Friday 9 June 2023. Please send your contributions to a.simmons@ucl.ac.uk as an attachment in Word.

Group members should receive an email from the RSC informing them when the latest newsletter is available, but for the record the Newsletter appears twice each year – usually in January and July. It is often available online before official notification is sent out by the RSC, so please look out for the newsletter on both the RSC and Queen Mary Historical Group websites: http://www.rsc.org/historical or https://rschg.qmul.ac.uk.

Anna Simmons, UCL

ROYAL SOCIETY OF CHEMISTRY HISTORICAL GROUP NEWS

Letter from the New Chair

I am delighted to be taking over as Chair of the Historical Group from the beginning of 2023. The history of chemistry has long been an interest of mine, and I have been involved with the RSC Historical Group since 1981, when I first attended a symposium as a PhD student. I am not a proper historian of chemistry, though – I don't even have an O-level in history! But I can trace a glimmering of interest in chemical history back to my sixth form days, when I put a cover on one of my A-level books claiming it was a treatise on the philosopher's stone.

I became properly interested in the history of chemistry as an undergraduate at Kingston Polytechnic. I have been able to continue this interest ever since in one form or another, and over the years have managed to publish around fifteen papers on historical topics. My main interests are in chemistry and chemists between 1850 and about 1950.

My professional career was split between the scientific civil service and academia. On the way, I published over 200 papers and five books on my main chemical specialism, the chemistry of biomedical materials. However, I think a historical perspective made me a better chemist, and in my semi-retirement, I know I have more to learn about the history of chemistry.

I have been the committee of the Historical Group for several years, and for the last few years have been Secretary. Leading the Group as Chair will be a challenge that I am looking forward to. I hope to meet many of you at our future meetings, and I am sure that the Group can continue providing a varied and interesting programme on the history of our great subject.

John Nicholson

Secretary's Report for 2022

The Group held two one-day scientific meetings at Burlington House, London, in 2022, open to both members and non-members. Both of these were in-person, though the first of them, on the Life and Work of Sir Geoffrey Wilkinson held in March, included some on-line presentations from overseas. This was a particularly well attended meeting, and was organised in association with the Chemistry Department at Imperial College.

The second meeting, held in October, was on Women in Chemistry, and focused on how opportunities for women in chemistry have expanded since women were first allowed to take degrees in the latter part of the nineteenth century. The symposium covered various aspects of women's roles in chemistry, their contributions and the barriers they faced in becoming chemists. At this meeting, Sally Horrocks of the University of Leicester was presented with the Wheeler Award to celebrate her outstanding contributions to the history of chemistry. She delivered a fascinating lecture entitled *The 'Two Person Career' and the British Chemical Community in the Mid-twentieth Century* in which she showed the significance of the work done by women in supporting their husbands' careers in both private and public realms and in sustaining the chemical community in mid-twentieth century Britain.

Full reports of our meetings have been published in the *RSCHG Newsletter*, two issues of which appeared in 2022. This publication continues to be edited by Anna Simmons, and is something we are particularly proud of. Anna maintains a consistently high standard, and succeeds in attracting a wide range of articles, meeting reports and other news items. She deserves all our thanks.

In addition to our one-day meetings, we continued our highly successful online lecture series on the third Tuesday of the month (August excepted), and these covered a wide range of topics on the history of chemistry. They were well attended, audiences typically being up to around seventy participants, with people taking part from all over the UK and beyond. Lastly, we held two committee meetings during the year, both of which were virtual and this is likely to be our pattern for the foreseeable future.

John Nicholson

ROYAL SOCIETY OF CHEMISTRY HISTORICAL GROUP MEETINGS AND ONLINE LECTURES

Pot Pourri Meeting 14 March 2023

Royal Society of Chemistry, Burlington House, London

The group's first meeting of 2023, on Tuesday 14 March at Burlington House, will be an open meeting where members give papers on particular interests or research in progress. The programme will be brought together in early 2023. If you are interested in giving a paper at the meeting please contact the meeting organizer, Peter Morris, on doctor@peterjtmorris.plus.com . Keep an eye on the monthly e-alert sent by the RSC on behalf of the Historical Group for further details. There will be no charge for the meeting but registration in advance will be needed. Details will be available on:

https://www.rsc.org/events/member-network/interest-groups/historical-chemistry-group

Online Lectures

These are continuing on the third Tuesday of each month at 2 pm. Future topics include Isaac Newton and the apothecary, astrochemistry, putting chemistry back into the history of chemistry, and Henry Enfield Roscoe. You do not need to already have the free version of Zoom to be able to take part as Zoom will connect you to the platform remotely. Webcams or microphones are not necessary as the audience will be asked to turn off their video and mute themselves to avoid any possible complications. Questions for the speaker should be posted via the chat function on Zoom during the meeting.

Online Lecture Series on the History of Chemistry

These lectures took a break over the festive season but will resume with the science writer Philip Ball talking about the controversial iatrochemist Paracelsus on 24 January 2023. They will continue on the fourth Tuesday of each month.

RSC YouTube Channel

The recordings of a number of previous online lectures can be found at the Historical Group's playlist on the RSC YouTube Channel: https://www.youtube.com/playlist?list=PLLnAFJxOjzZu7N0f5-nVtHcLNxU2tKmpC

TRIBUTE

Trevor Harvey Levere (1944-2022)

The highly accomplished and much admired historian of science, Trevor Levere, has died in Toronto at the age of seventy-eight. He published his first paper in *Ambix,* the Journal of the Society for the History of Alchemy and Chemistry, entitled "Affinity or Structure: An Early Problem in Organic

Chemistry" in 1970. Trevor was born in North London during the Second World War. He first went to a private preparatory school, enduring a brutal headmaster, and then proceeded to the academically highly-regarded St Paul's School, where he thrived. He went on to the University of Oxford in 1962 to read chemistry at New College. After three years he chose history of chemistry as his Part II research option, working on the eighteenth-century Dutch natural philosopher, Martinus van Marum. His research then took a different direction when he studied for a DPhil under the supervision of A. C. Crombie, work which in 1971 appeared as *Affinity and Matter: Elements of Chemical Philosophy 1800-1865*. In Oxford he had come into contact with Gerard L'Estrange Turner, a curator at the Museum of the History of Science, who was also fascinated by van Marum. Levere's essay on the introduction of Lavoisier's work to the Netherlands was published in the first volume of the van Marum series, and then, publishing jointly with Turner, the whole of volume four was devoted to Teyler's Museum in Haarlem (van Marum being its first director). Levere was fascinated by instruments and by the scientists who created them: he edited and contributed to a book on Instruments and Experimentation in the History of Chemistry in 2000 which resulted from a meeting at the Dibner Institute at MIT, and on the Enlightenment of Thomas Beddoes in 2017. The eighteenth century kept pulling him back: the Coffee House Philosophical Society in London, active from 1780 to 1787 was composed of chemists, industrialists and instrument makers. It met fortnightly and kept a minute book. Editing this with Turner, it emerged as *Discussing Chemistry and Steam* in 2002.

But back to the realities of life: having completed his doctorate, Trevor Levere needed a job. He found a temporary one in 1968 at the University of Toronto as a lecturer in the newly created Institute for the History and Philosophy of Science and Technology. Though he couldn't have known it at the time, this is where he would spend the whole of his career. He was appointed Assistant Professor one year after he first joined and he made his way inexorably up the promotion ladder: Associate Professor (1974), Professor (1981) and prestigious University Professor (2006). He retired as University Professor Emeritus in 2007. Toronto was his home but on occasions he worked outside Canada: he was Visiting Fellow at the Centre National de Recherche Scientifique in Paris in 1981, a Visiting Fellow at Clare Hall, Cambridge in 1983 and a Dibner Institute Fellow at MIT in 1995. His research, books and papers took on a number of directions. As examples, he published on Samuel Taylor Coleridge and Science in 1981 and edited essays on Galileo in 1990. He became keenly interested in the development of science in Canada. As early as 1974 he published *A Curious Field-Book: Science and Society in Canadian History*, then on Science and the Canadian Arctic in 1993, the Royal Society of Canada in 1998 (he had become a Fellow in 1980), and his final book, *The Arctic Journal of Captain Henry Wemyss Feilden,* published in 2017.

Trevor Levere was an excellent teacher and influential scholar. That was more than proven when in 2017 during the course of the HSS meeting in Toronto, several of his former students and others (I was one of the 'outsiders') presented him with a Festschrift at a splendid party in his former Institute: *The Romance of Science* edited by Jed Buchwald and Larry Stewart. Trevor was fun to be with. I remember when with little persuasion he joined a party of truants from the Berkeley IUHPS 1985 meeting. Together with Gerard Turner, Peter Spargo and me, we absented ourselves from the conference for twenty-four hours to go camping in Yosemite National Park. Trevor's career added a great deal to history of chemistry and related subjects. Though fundamentally a modest man, he offered warmth and intellectual stimulation to all those students and colleagues who were lucky enough to come into contact with him.

Robert G.W. Anderson

MEMBERS' PUBLICATIONS

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

D.M. Behrman and E.J. Behrman, *From My Life* (Springer, 2022).

This is the first English translation of Emil Fischer's autobiography "Aus Meinem Lieben". Published in the Springer Biographies Series it narrates Fischer's life and scientific path, enabling wider access to his life story.

https://link.springer.com/book/10.1007/978-3-031-05156-2

Peter E. Childs, "The Iodine Industry in Glasgow and Scotland", *Bulletin History of Chemistry*, vol. **47**, Number 2 (2022), 198-214.

For most of the nineteenth century and well into the twentieth century, Glasgow was the UK centre for the iodine industry, together with other nearby Scottish lowland towns. Iodine was obtained from seaweed, a renewable resource, which was harvested on the coasts of Scotland and

Ireland. It was burnt to produce kelp (the vitreous ash from burnt seaweed), and much of it was shipped into the Clyde, first for Glasgow's soap and glass works and later for the production of potash (manure) and iodine. In the middle to late 1800s Glasgow produced ninety percent of the UK's iodine and a substantial proportion of the world's supply. The death-knell of the industry was the first importation of iodine from Chilean caliche in 1874, and this supply of iodine grew and eventually dominated world supply, as it was more abundant and easier and cheaper to produce. The Chilean nitrate industry could produce up to 5,100 tons of iodine a year as a by-product of nitrate production at a time when world demand was only 500 tons. The production of iodine from kelp limped on, thanks to an international iodine cartel to regulate prices until 1931 when the last iodine factory in Glasgow closed.

The latest articles by Peter E. Childs in the *Pioneers in Science Education* series feature Peter Fensham and Rosalind Driver. Articles continue to be added to: https://www.cheminaction.com/copy-of-issue-111-120

Anna Simmons and William H. Brock, "Robert Warington and Heinrich Will: Friendship and Co-operation in Chemistry in Nineteenth Century Britain and Germany", *Ambix*, vol. **69**, issue 4, November 2022, 374-398. https://doi.org/10.1080/00026980.2022.2133807

This Open Access paper discusses fourteen letters that Heinrich Will (1812–1890), Justus Liebig's (1803–1873) successor at the University of Giessen, sent to Robert Warington (1807–1867), the chemical operator at Apothecaries' Hall in London, between 1842 and 1854. The correspondence illuminates a range of topics related to the development of the British chemical community in mid-Victorian Britain – its organisations, networks, and commercial opportunities, as well as offering insights into the importance of family, friendship, and collegiality in sustaining scientific careers. Studying such an exchange of material and textual knowledge helps to further understand how science was organised and ideas disseminated in a key period for institutional development in chemistry.

PUBLICATIONS OF INTEREST

The following journal issues have been published since the summer 2022 *Newsletter* was completed.

Ambix, The Journal of the Society for the History of Alchemy and Chemistry, vol. 69, issue 3, August 2022

Elena Serrano, Joris Mercelis and Annette Lykknes, " 'I am not a Lady, I am a Scientist': Chemistry, Women, and Gender in the Enlightenment and the Era of Professional Science".

Francesca Antonelli, "Becoming Visible. Marie-Anne Paulze-Lavoisier and the Campaign for the 'New Chemistry' (1770s-1790s)".

Elena Serrano, "Patriotic Women: Chemistry and Gender in the Eighteenth-Century Spanish World".

Annette Lykknes, "Enabling Circumstances: Women Chemical Engineers at the Norwegian Institute of Technology, 1910–1943".

Joris Mercelis, "'Men Don't Like to Work Under a Woman': Female Chemists in the Photographic Manufacturing Industry, *ca*. 1918–1950".

Ambix, The Journal of the Society for the History of Alchemy and Chemistry, vol. 69, issue 4, November 2022

Ute Frietsch, "Robert Fludd's Visual and Artisanal Episteme: A Case Study of Fludd's Interaction with his Engraver, His Printer-Publisher, and His *Amanuenses*".

Anna Simmons and William H. Brock, "Robert Warington and Heinrich Will: Friendship and Co-operation in Chemistry in Nineteenth Century Britain and Germany".

Sarah N. Hijmans, "The Tantalum Metals (1801-1866): Nineteenth-Century Analytical Chemistry and the Identification of Chemical Elements".

Essay Review

Helge Kragh, "Biographical Histories of Chemistry".

Bulletin for the History of Chemistry, vol. 47, number 2, 2022

Seth C. Rasmussen, "Mother of Invention: Maria the Jewess and Early Contributions to Chemical Apparatus".

Mary Virginia Orna, "A Commemoration of Ernest Rutherford on the 150th Anniversary of his Birth, Part II: 1907-1937".

Peter E. Childs, "The Iodine Industry in Glasgow and Scotland".

Mary C. Schlembach and Tina Chrzastowski, "A Pioneer in Chemical Literature: Librarian Marion E. Sparks".

Ted W. Reid, Douglas S. Gregory and Jonathan Kopel, "Irwin B. Wilson (1931-2014): The Story of the First Rational Design of a Drug".

Jessica Epstein, "Freeing the Mole from the Kilogram: How the Redefinition of the Kilogram shaped our Definition of the Avogadro Number".

Reinhard W. Hoffmann, "Molecules with Fluxional Structure: An Initial Moment in their Conception".

Gretchen Ihde Serrie and James J. Bohning, edited by Carmen J. Giunta, "HIST Centennial Memories: Aaron John Ihde (1909-2000)".

Ian D. Rae, "HIST Centennial Memories: George Kauffman: A Personal Reminiscence".

Book Reviews

Gary Patterson, *Chemistry in 17th Century New England*. Reviewed by Leonardo Anatrini.

Ursula Klein, *Technoscience in History: Prussia, 1750-1850*. Reviewed by Leonardo Anatrini.

Carmen J. Giunta, Vera V. Mainz and Gregory S. Girolami eds., *150 Years of the Periodic Table: A Commemorative Symposium*. Reviewed by James L. Marshall.

Joachim Schummer and Tom Børsen, eds., *Ethics of Chemistry: From Poison Gas to Climate Engineering*. Reviewed by Carmen J. Giunta.

Jeffrey I. Seeman, *The History of the Woodward Hoffmann Rules*. Reviewed by Arthur Greenberg.

Jeffrey I. Seeman, "The Back Story, Dudley Herschbach, A Doorway to a New World".

Science: Has its Present Past a Future? Selected Essays by Arnold Thackray

Arnold Thackray is a key figure in the growth of the discipline of history of science in the late twentieth century. He received his Ph.D. from Cambridge University in 1966 and was the founding Chairman of the Department of History and Sociology of Science at the University of Pennsylvania, becoming the Joseph Priestley Professor there. He created and is the former president of the Chemical Heritage Foundation (now Science History Institute). Edited by Jeffrey L. Sturchio and Bruce V. Lewenstein, a collection of essays has been published to celebrate Arnold's eightieth birthday and the fiftieth anniversary of Penn's History and Sociology of Science Department. It includes his own introductions to themes in his publications, as well as recollections from his doctoral students including Steven Shapin, Robert Bud, Ruth Barton and David Philip Miller. The book has been independently published, but is available via Amazon for £19.99. ISBN 9798551167730.

The Evolution of the Periodic System between 1800 and 2021

The periodic system emerges by intertwining order and similarity relationships among chemical elements, which in turn arise from known substances at a given time that constitute the chemical space. Although the system has been adjusted to accommodate new elements, the connection with the chemical space has been largely forgotten. This poses the question: what is the effect of the exponentially growing chemical space upon the periodic system? By computationally analysing this from the dawn of the nineteenth century until the present, it was found that although the system has undergone several and significant changes across history, it converges towards a stable structure. Given that the chemical space holds the inertia of more than 200 years of chemical practice, and the limited chemical possibilities for the remaining elements to be synthesised, it is hypothesised that the periodic system will remain largely untouched in the years to come.

See: https://chemrxiv.org/engage/chemrxiv/article-details/6315e936bada38a3b9ba078c

Guillermo Restrepo
Max Planck Institute for Mathematics in the Sciences Leipzig, Germany

***Ambix* Edited Collection: Archaeology, Conservation Science and the History of Chemistry**

Materials and practices have now established themselves as primary sources of information in the historiography of science. This is especially the case of the early modern period, as more material remains are generally available in the archaeological record and museum collections. Moreover, this is also the time when artisanal practices merge with natural philosophy as an approach to understanding and manipulating nature. It is now commonplace for

science historians to address questions around the practical side of "doing chymistry", making use of material sources to explore knowledge-making issues, and tackle the history of alchemy and chemistry from different points of view. As the essays in this collection, edited by Umberto Veronesi, show we witness increasing collaborations between historians and material culture experts.

https://www.tandfonline.com/journals/yamb20/collections/archaeology-conservation-history-of-chemistry

Letters of Thomas Beddoes

The editors, Tim Fulford and Dahlia Porter, are delighted to announce the creation of an open access website making available the letters of Thomas Beddoes (1760-1808), the pioneer of pneumatic medicine, mentor of Humphry Davy, and collaborator with S.T. Coleridge, Erasmus Darwin, Maria Edgeworth, Robert Southey, Thomas Wedgwood and James Watt. The website is part of an AHRC-funded project that culminates in a fully-annotated print edition of all surviving letters written by Beddoes (Cambridge University Press, 2026). Poet, political campaigner and chemical experimentalist as well as medical doctor, Beddoes was, in Roy Porter's words, "a central late-Enlightenment figure" of great influence on the development of science, medicine and literature because of his transmission of ideas in lectures, in print and in letters. His letters provide striking new perspectives on how correspondence networks – both within Britain and internationally – shaped a 'culture of enquiry' in which investigations in literature, medicine, chemistry, philosophy, technology and social reform were pursued together. The website presently contains an introduction and samples of letters. Over the next year, hundreds of letter-texts and several related resources, including love letters by Beddoes's wife Anna Edgeworth, will be uploaded. See: http://beddoes.dmu.ac.uk

NEWS FROM THE RSC LIBRARY

Professor William H. Brock Collection

The Royal Society Of Chemistry Library has recently received a donation of over 350 titles from Professor William Brock's comprehensive book collection on the history of chemistry. This makes an invaluable addition to our collection that will benefit scholars in this field for generations to come; we are immensely grateful to Professor Brock for his generosity. Further details on how to access the collection, what is available, and where they will be situated, will follow.

BOOKS FOR DONATION

Prof. William H. Brock has had to give up academic work and wishes to dispose of around 300 books to a younger active scholar. Additions to departmental libraries also considered. The working collection covers the fields of history of chemistry (especially Liebigiana), history of science, Victorian Studies, and the history of science education. Whilst willing to consider donation of individual volumes, Prof. Brock would prefer requests for lots of 50, 100, 200, or the complete collection. For a catalogue and to discuss arrangements for collection in person, or by courier, e-mail: william.brock@btinternet.com

JOURNAL RUN AVAILABLE

Fred Page has an almost complete run of bound copies of the *Journal of the Society of Chemical Industry* which is looking for a good home. Otherwise it will end up in a skip! The recipient would need to arrange collection from Kington, Herefordshire. Please contact the Newsletter editor, Anna Simmons, if you are interested.

SOCIETY NEWS

ACS Division of History of Chemistry

Formerly known as first the Dexter Award and then the Sidney M. Edelstein Award, the HIST Award for Outstanding Achievement in the History of Chemistry has continued to recognize outstanding careers of contributions to the history of chemistry. Following the death of Sidney M. Edelstein, the support of this award has continued thanks largely to donations from Joseph Lambert, who received the Edelstein Award in 2004 for his contributions to the history of chemistry in the area of archaeological chemistry. HIST has thus determined that it was only fitting to acknowledge his continued support by adding his name to the current award. As such, this award will officially become the Joseph B. Lambert HIST Award for Outstanding Achievement in the History of Chemistry, beginning with the 2023 Award.

Justus Liebig Society – Eduard Alter (1944-2022)

Prof. Dr Eduard Alter, chairman of the Justus Liebig Society, died on 22 June 2022 at the age of seventy-seven. Eduard Alter was born on 21 July 1944 in Karlsbad (today's Czech Republic). After studying chemistry at the Institute for Inorganic and Analytical Chemistry at the Justus-Liebig-Universität, he worked under Prof. Dr Rudolf Hoppe and received his doctorate. He worked from 1973 to 1980 in the production department of a subsidiary of Bayer AG in Cologne/Worringen. As manager of the ethylene oxide plants, he was responsible for the commissioning of what was then the largest plant in the world. From 1980 to 2014 he brought his business experience to bear at the Technical University of Central Hesse, where he taught organic chemistry, instrumental analysis and plastics chemistry and technology in the mathematics, natural sciences and computer science departments until his retirement. In May 2013 he replaced Prof. Dr Wolfgang Laqua as chairman of the Justus Liebig Society. Eduard Alter worked tirelessly for all matters relating to the Liebig Museum, in particular, the preservation of the laboratory as a unique historical site of chemistry with a worldwide reputation.

MUSEUM NEWS

Liebig Museum: Fire Destroys Justus Liebig's Historic Lecture Hall in Giessen

A fire destroyed parts of the Liebig Laboratory's historic auditorium at around 9:30 pm on Monday 5 December 2022. Parts of the analytical and pharmaceutical laboratories and the library were affected. While the other rooms were mainly damaged by the developing soot, the lecture hall was directly affected by the fire. When this issue of the newsletter went to press, further information on the damage and the measures required for restoration was not yet available. According to police spokesman, Jörg Reinemer, there are no indications of intentional arson and the damage is estimated at 100,000 euros.

A Summer of Science: Learning from the Past for a Sustainable Future

19 July - 30 September 2023

Running in parallel with an exhibition on the history of Nantwich's former gas works site, this festival of science and sustainability is for everyone, but with families and young people as its key focus. The Museum's collection includes many fascinating historical objects which illustrate the industrial roots of Nantwich and the surrounding area. A selection of these objects will form starting points to explore sustainability and how science and behavioural changes can have a positive impact for future generations. More information will follow in the summer 2023 newsletter.

SHORT ESSAYS

Monitoring blood-glucose levels during a century of insulin therapy

Just over a century ago, on Monday 23 January 1922, fourteen-year-old Leonard Thompson was in the terminal stages of then-fatal diabetes mellitus (later known as *Type 1 diabetes*). That day, he began a course of injections with the newly discovered hormone, insulin. These proved lifesaving for Leonard and, subsequently, millions of diabetics across the world.

Until well into the 1960s, a newly diagnosed sufferer, usually as a hospital in-patient, would be placed on a specific diet and the amount of insulin "titrated" by daily injections to keep his/her blood-glucose measurements, determined in the hospital laboratory, within acceptable limits. Back home, the patient would have to adhere exactly to the injection regime but could modify the prescribed diet, provided the overall balance of carbohydrates was kept constant. The degree of control of blood glucose at home could only be measured indirectly, by assessing urinary glucose, either by test-tube reactions or colour changes on test strips, as we have previously described [1]. But "glucose in urine" is a poor mirror of blood glucose levels: it is only present when blood glucose levels are already excessive, and even then, it reflects blood glucose levels some time previously. This left those taking insulin in something of a dietary straitjacket, and vulnerable to unexpectedly high or low blood sugars – both a potential cause of a diabetic coma. So the search was on for a way for sufferers to be able to measure blood glucose directly. What was needed was a portable machine that could analyse a drop of blood for glucose, ideally giving a digital output. This would allow patients to adjust both their insulin regime and their diet throughout the day to ensure better blood glucose control and more independence in their lives.

The first step towards this goal was based on the Free/Murray Clinistix test strip first marketed in 1956. Glucose in urine was oxidised by the enzyme glucose oxidase, freeing up hydrogen peroxide. This, assisted by peroxidase catalysis, oxidised an aromatic primary amine, *ortho*-tolidine [1]. The

intensity of the blue dye produced reflected the glucose content of the urine. The patients pricked their fingers with lancets and brought the resulting drops of blood into contact with the strips. These were covered with a semi-permeable membrane that only permitted the passage of aqueous glucose. After a set time, the blood was washed off and the intensity of the blue colour estimated by comparison with a chart to infer the concentration of glucose. These special strips (named Dextrostix) were first marketed in 1965 by the Miles Corporation (then part of the Bayer-AG multinational pharmaceutical corporation) [2]. Anton Clemens, their director of research and development, decided to measure the intensity of the blue colour on the Dextrostix using a reflectance photometer, displaying the result using a moving-coil meter. These 1971 machines were bulky, demanded adherence to a prescribed protocol and were marketed mainly to physicians for use in their surgeries rather than directly to patients. A decade later, these machines (then named *Dextrometers*) were marketed to patients for self-testing, though they remained comparatively bulky. Miniaturisation subsequently led to palm-sized devices requiring ever-smaller amounts of blood (e.g. the Betachek C50, introduced in 2014, that can give a reading from as little as 0.3 microlitres of blood). The chemistry differs from the Dextrostix method. Here a different enzyme, glucose dehydrogenase, oxidises glucose to glucono-1,5-lactone. The hydrogen atoms from the glucose are transferred to a co-factor, flavin adenine dinuclide. In turn this reduces a mediator, quinoneimine acting as an electron transfer medium. This then can pass up its electrons to a leuco dye, and it itself oxidised in a series of cyclic pathways (Fig 1). The leuco dye is phosphomolybdic acid and the reduction product is molybdenum blue [3].

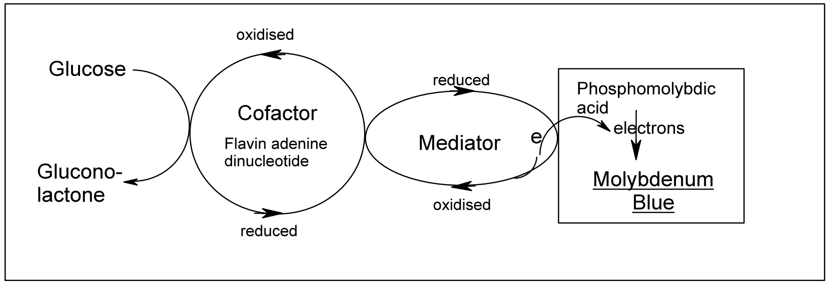

Fig. 1: Schematic principles behind the *Betachek C50* blood-glucose monitor.

This is the colour reaction that underpins the Folin and Wu method for blood glucose analysis, which we believe was employed by Banting and Best when they monitored the effectiveness of their insulin preparations on dog "volunteers" prior to treating young Leonard Thompson [1]. In the Betachek device, the test chemicals are applied to a translucent film which enables the colour to be read from the opposite side to the blood. LEDs are focused onto the test zone and the reflected light is measured by a photodetector. The test zones are spaced along a carrier tape that is stored in a sealed (replaceable) cassette. After testing, the used tests are wound up on a take-up roll in the waste chamber part of the cassette.

An alternative method used in hand-held devices relies on measuring an electron flux proportional to glucose content. Bench-top meters based on this principle were first marketed in 1973. These used a semi-permeable membrane to separate the serum glucose from the blood and then another to separate the hydrogen peroxide liberated by the glucose oxidase in a pure enough state to be catalytically oxidised at a platinum anode [4].

$$H_2O_2 \rightarrow 2H^+ + O_2 + 2e$$

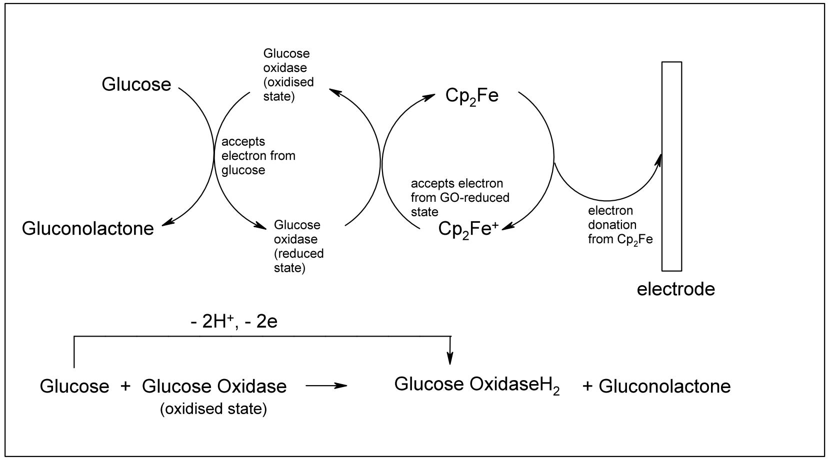

Fig. 2: Glucose-derived electrons being shuttled towards an electrode surface (Cp = cyclopentadiene)

The development of disposable sensors for patient use came from the work of a University of Oxford team in the 1980s. The active parts of the glucose

oxidase enzyme are again flavin adenine dinucleotide centres (GO-FADs), buried deeply within the enzyme, a proteinaceous material covered with carbohydrate chains. Again, a mediator is essential to transfer the electron flux to the electrode surface. The Oxford team found that ferrocene proved an effective mediator for electron transfer, especially if it had solubilising groups attached (typically –COOH) (Fig 2) [5].

Attracting industrial interest in this advance was difficult until Medisense, a nascent company founded in 1981 by young entrepreneur Ron Zwanziger, took the discovery on board. It marketed the new glucose monitoring device in 1989. Manufacturing the sensing units by screen- or inkjet-printing onto a polyethylene terephthalate film [6] (Fig 3) meant relatively cheap disposable sensors could be mass-produced.

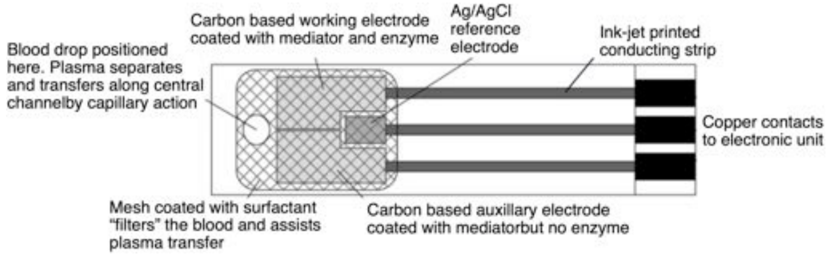

Fig. 3: A typical disposable 3-contact electrode for sensing blood-glucose concentration (adapted from Ref 6)

This proved a lucrative investment. It is estimated that the global market for self-monitoring blood glucose will reach US$16 billion by 2027 [7].

Despite the sophisticated electrochemistry, these devices have two key drawbacks. The user must prick their finger multiple times each day, and the measurements refer only to that moment. Ideally, the user needs constant monitoring of their blood glucose levels. Recording glucose levels in tears, using electrochemical monitoring embedded in contact lenses which transmit to hand-held devices [8] and monitoring glucose in sweat, similarly detected by wristwatches (and/or their straps) and then transmitted to smartphones [9] are being explored. However, in the late 1990s there seemed more potential in monitoring glucose in interstitial fluid just under the skin and transmitting measurements to a smartphone or other device. Three firms have dominated the market [10]. Medtronic received FDA approval for its continuous glucose monitor in 1999. This communicated to the patient's physician, rather than directly to the patient. Subsequently (2006) Dexcom introduced its *STS Continuous Monitor*. The patient uses a device to place the probe sensor some 5 mm into their skin on their shoulder, inner thigh or abdomen, just deep enough to probe the interstitial fluid [11]. The top of the probe connects to an adhering skin-surface unit that contains the electronic wizardry that both supplies the operating voltage and converts the amperometric output to a blood glucose concentration which is then transmitted to a small hand-held dedicated monitor or a smartphone. The patients then use the readings to adjust their insulin doses. The chemistry, essentially a development of that from the 1973 bench top instruments, is shown in Fig. 4 and the sensor is shown in Fig. 5.

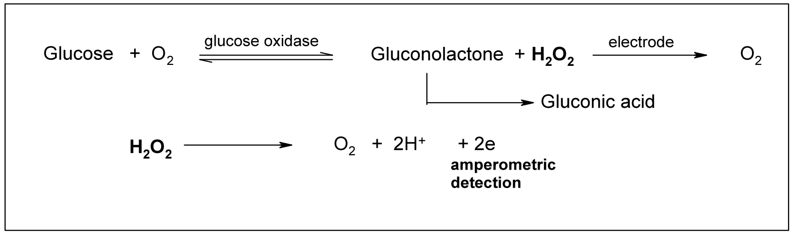

Fig. 4: Conversion of blood-glucose concentration to a current.

Abbott Laboratories' *Freestyle Navigator CGM* was introduced in 2008 and its current iteration, the *Freestyle Libre 2* monitor, relies on the same principles and is widely prescribed in the UK to Type 1 diabetic patients. We believe the electrochemistry occurring in the tip of the filament-like plastic sensor is essentially that shown in Fig. 2, with two modifications. Firstly, using osmium-based mediators permit operation at a lower voltage compared to ferrocene mediation, increasing its selectivity towards glucose compared to other interferents, and secondly, the osmium units are "tethered" to a polymeric backbone. This results in a "wired electrode" that is particularly effective in converting the glucose-derived electrons into a relatively high current, giving stable amperometric readings [12].

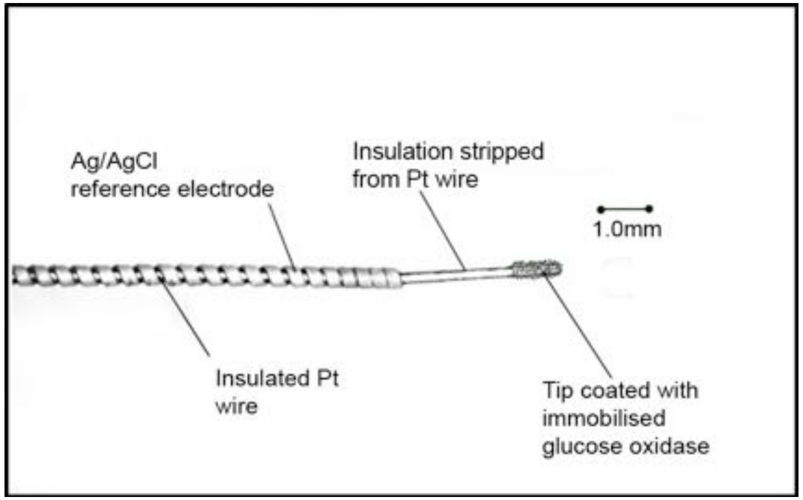

Fig. 5: The "hair-like" Dexcom STS sensor, driven into the skin by a retractable needle. (Adapted from reference 11).

The probe is a hollow semi-rigid plastic filament (5mm x 0.5mm) fastened to the underside of a £2 coin-sized transmitting module. It penetrates the skin using a spring-loaded grooved needle applicator and an adhesive ensures the device remains in place on the skin during its "life-time" of 14 days, after which it is discarded and a fresh filament module spring-loaded into place. The open tip contains the glucose oxidase and electrodes which connect to the transmitting module. Patients experience a minor "prick" on the insertion, but after that, all readings are taken remotely. Information from the sensor can either be read off, wirelessly, on a dedicated reader, or displayed on a Smartphone via the appropriate app. Data manipulation is possible to average readings over time or to supply alerts if the insulin-mediated blood glucose levels are of concern. Each complete probe/sensing/transmitter unit costs about £50.

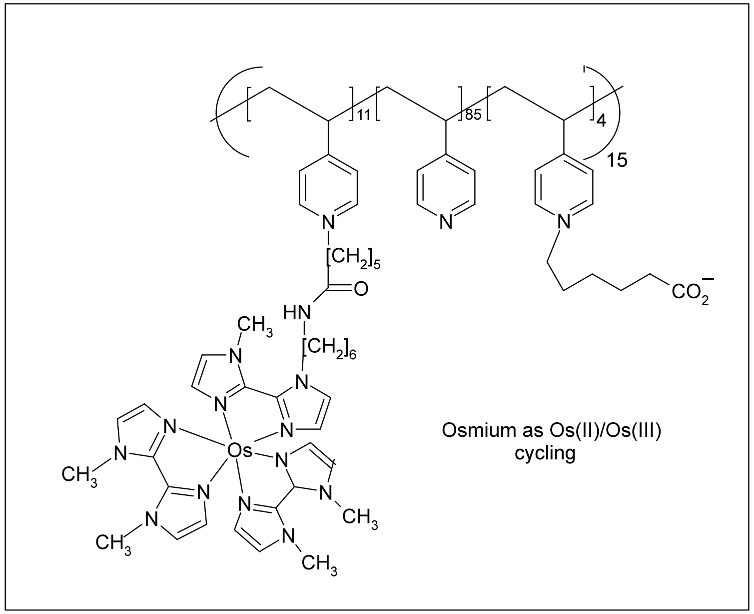

Fig. 6: Part of an osmium-based mediator, showing tethering to a polymeric backbone.

Although these devices require the insertion of a ‘needle’/probe, at least this is applied to a less sensitive area of the body than the fingertip and is only once a fortnight rather than several times a day as demanded by the earlier methods. A further development consists of an array of microneedles, each about 0.5 mm long. Pressed firmly into the skin, these project into the interstitial fluid, but not so deeply that they register with the nerves (Fig 7), providing a pain-free sensor [13].

The needles are micro versions of the three electrodes shown in Fig 3 and the surface module will probably incorporate electronics similar to those in the Dexcom and the Freestyle Libre devices.

Although all these continuous sensors can now provide a clear longitudinal profile of blood glucose control, they require significant commitment on the part of the patient to ‘wear’ them and utilise the data they generate.

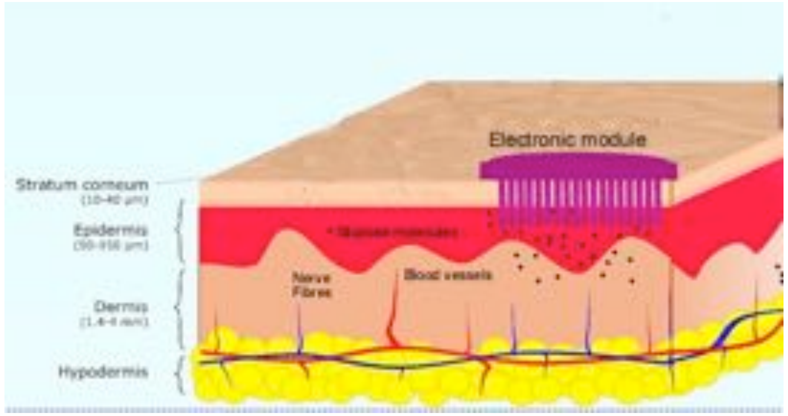

Fig. 7: Part of an array of microneedles for pain-free glucose-sensing. These reach into the interstitial fluid just below the skin surface (adapted from a *Wiki Commons* image [14]).

An alternative approach to assessing long term blood glucose came from the observation by Iranian scientist Samuel Rahbar in 1968 that a subtype of haemoglobin, HbA1c, was present in increased amounts in its glycosylated (or glycated) form in people with diabetes. In 1976 Ronald Koenig and Anthony Cerami [15] (head of Medical Biochemistry at the Rockefeller University, New York), described the correlation between this and long-term glucose regulation. By the 1990s, HbA1c was established as an important clinical marker of overall glucose control.

Haemoglobin, contained in red blood cells, transports oxygen around the body. Red blood cells are produced in the bone marrow and have a lifespan in the circulation of eight to twelve weeks. They have no nucleus of their own, so cannot produce any more haemoglobin once released into the circulation. Once a haemoglobin molecule is glycated, it remains that way. A build-up of glycated haemoglobin within the red cell therefore reflects the average level of glucose to which the cell has been exposed during its life-cycle. Therefore, measures of the proportion of glycosylated HbA1c reflect the average blood sugar level over the preceding two to three months.

The laboratory techniques to measure the ratio are mainly HPLC-based and more recently, capillary electrophoresis [16]. Though “over the counter” tests can be purchased for patient use (at about £25 per test), physicians prefer laboratory testing so they can discuss the results with their patients, including changes to their self-management plans. Details for these over-the-counter tests are sparse, but we believe they are based on lateral flow principles (similar to those presently used for coronavirus self-testing) with the haemoglobin and glycated haemoglobin "spots" being compared by photometric reflectance [17].

It is interesting to reflect on how the key developments in the electrochemistry of glucose detection have evolved over the last fifty years, and how technological progress has allowed progression from laboratory bench to miniature devices controlled by patients themselves. Increasingly sophisticated IT processing of the data now allows automated individualised insulin injections. However, insulin is only one part of the story of diabetes, which makes considerable demands on patients to become expert in balancing their diet and exercise, while mindful of the effects of intercurrent illness, emotional stress, mental health, and other factors on their blood glucose levels. Securing good continuous data on blood glucose has been an essential first step and has relied on chemical expertise. Supporting all patients to become expert collaborators in their own self-management is the next great leap required to address not only type 1 diabetes, but also the emerging tsunami of type 2 diabetes.

Acknowledgments

We thank John Dungate for recounting the methods he has used for determining his blood-glucose concentrations over the past thirty years, and Brandon Bransgrove (Betachek) and Zoë Cholewa (Dexcom) for help about their products outlined in this article.

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RSC Members have free access to an excellent review of the recent history of electrochemical glucose sensors: H. Teymourian and A. Barfidokht, *Chem. Soc. Rev.*, 2020, 49, 7671. Available at:

https://pubs.rsc.org/en/content/articlelanding/2020/cs/d0cs00304b/unauth.

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(Pete Ellis is a retired medical practitioner based in New Zealand)

Calculating Chemistry: How it Used to be Done, a Witness Account

Introduction

Today, chemists do most of their calculating with a pocket calculator or on a personal computer. In the latter case, Microsoft Excel provides a wide range of easy-to-use mathematical functions that can be used in a quite complex way without any programming (*i.e.* writing of computer code) by the user, only the typing in of formulae into a spreadsheet; Excel also has intuitive graphing facilities. More powerful general-purpose tools are MathWorks' MATLAB and Wolfram's MATHEMATICA, respectively claiming to be "used by millions of engineers and scientists" and "the world's definitive system for technical computing" [1]. In addition, proven software is available for specific tasks, for example for crystal structure determination from single-crystal X-ray diffraction data and for computational chemistry – whose workings the user may well not understand. Not so long ago, things were very different.

Mathematical Tables and Slide Rules, 1966

Most science undergraduates arriving at University in 1966, including me personally, carried over from their schooldays two aids to calculation. The first aid was an inexpensive slim booklet of mathematical tables (specimen page in Figure 1, contents page in Figure 3) [2]. The key feature of such tables was that they allowed the user to perform multiplication and divisions *via* hand-additions or -subtractions of logarithms, relying on the mathematical identities log *xy* = log *x* + log *y*, and log *x*/*y* = log *x* – log *y*. The second aid was a slide rule (U.S. "slipstick") as in Figure 2, working on the same principle: scales were marked out logarithmically and the user slid the central portion to and fro to effect "analogue" additions and subtractions [3].

2 LOGARITHMS

	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
10	·0000	0043	0086	0128	0170	0212	0253	0294	0334	0374	4	8	12	17	21	25	29	33	37
11	·0414	0453	0492	0531	0569	0607	0645	0682	0719	0755	4	8	11	15	19	23	26	30	34
12	·0792	0828	0864	0899	0934	0969	1004	1038	1072	1106	3	7	10	14	17	21	24	28	31
13	·1139	1173	1206	1239	1271	1303	1335	1367	1399	1430	3	6	10	13	16	19	23	26	29
14	·1461	1492	1523	1553	1584	1614	1644	1673	1703	1732	3	6	9	12	15	18	21	24	27
15	·1761	1790	1818	1847	1875	1903	1931	1959	1987	2014	3	6	8	11	14	17	20	22	25
16	·2041	2068	2095	2122	2148	2175	2201	2227	2253	2279	3	5	8	11	13	16	18	21	24
17	·2304	2330	2355	2380	2405	2430	2455	2480	2504	2529	2	5	7	10	12	15	17	20	22
18	·2553	2577	2601	2625	2648	2672	2695	2718	2742	2765	2	5	7	9	12	14	16	19	21
19	·2788	2810	2833	2856	2878	2900	2923	2945	2967	2989	2	4	7	9	11	13	16	18	20
20	·3010	3032	3054	3075	3096	3118	3139	3160	3181	3201	2	4	6	8	11	13	15	17	19
21	·3222	3243	3263	3284	3304	3324	3345	3365	3385	3404	2	4	6	8	10	12	14	16	18
22	·3424	3444	3464	3483	3502	3522	3541	3560	3579	3598	2	4	6	8	10	12	14	15	17
23	·3617	3636	3655	3674	3692	3711	3729	3747	3766	3784	2	4	6	7	9	11	13	15	17
24	·3802	3820	3838	3856	3874	3892	3909	3927	3945	3962	2	4	5	7	9	11	12	14	16
25	·3979	3997	4014	4031	4048	4065	4082	4099	4116	4133	2	3	5	7	9	10	12	14	15
26	·4150	4166	4183	4200	4216	4232	4249	4265	4281	4298	2	3	5	7	8	10	11	13	15
27	·4314	4330	4346	4362	4378	4393	4409	4425	4440	4456	2	3	5	6	8	9	11	13	14
28	·4472	4487	4502	4518	4533	4548	4564	4579	4594	4609	2	3	5	6	8	9	11	12	14
29	·4624	4639	4654	4669	4683	4698	4713	4728	4742	4757	1	3	4	6	7	9	10	12	13
30	·4771	4786	4800	4814	4829	4843	4857	4871	4886	4900	1	3	4	6	7	9	10	11	13
31	·4914	4928	4942	4955	4969	4983	4997	5011	5024	5038	1	3	4	6	7	8	10	11	12
32	·5051	5065	5079	5092	5105	5119	5132	5145	5159	5172	1	3	4	5	7	8	9	11	12
33	·5185	5198	5211	5224	5237	5250	5263	5276	5289	5302	1	3	4	5	6	8	9	10	12
34	·5315	5328	5340	5353	5366	5378	5391	5403	5416	5428	1	3	4	5	6	8	9	10	11
35	·5441	5453	5465	5478	5490	5502	5514	5527	5539	5551	1	2	4	5	6	7	9	10	11
36	·5563	5575	5587	5599	5611	5623	5635	5647	5658	5670	1	2	4	5	6	7	8	10	11
37	·5682	5694	5705	5717	5729	5740	5752	5763	5775	5786	1	2	3	5	6	7	8	9	10
38	·5798	5809	5821	5832	5843	5855	5866	5877	5888	5899	1	2	3	5	6	7	8	9	10
39	·5911	5922	5933	5944	5955	5966	5977	5988	5999	6010	1	2	3	4	5	7	8	9	10
40	·6021	6031	6042	6053	6064	6075	6085	6096	6107	6117	1	2	3	4	5	6	8	9	10
41	·6128	6138	6149	6160	6170	6180	6191	6201	6212	6222	1	2	3	4	5	6	7	8	9
42	·6232	6243	6253	6263	6274	6284	6294	6304	6314	6325	1	2	3	4	5	6	7	8	9
43	·6335	6345	6355	6365	6375	6385	6395	6405	6415	6425	1	2	3	4	5	6	7	8	9
44	·6435	6444	6454	6464	6474	6484	6493	6503	6513	6522	1	2	3	4	5	6	7	8	9
45	·6532	6542	6551	6561	6571	6580	6590	6599	6609	6618	1	2	3	4	5	6	7	8	9
46	·6628	6637	6646	6656	6665	6675	6684	6693	6702	6712	1	2	3	4	5	6	7	7	8
47	·6721	6730	6739	6749	6758	6767	6776	6785	6794	6803	1	2	3	4	5	5	6	7	8
48	·6812	6821	6830	6839	6848	6857	6866	6875	6884	6893	1	2	3	4	4	5	6	7	8
49	·6902	6911	6920	6928	6937	6946	6955	6964	6972	6981	1	2	3	4	4	5	6	7	8
50	·6990	6998	7007	7016	7024	7033	7042	7050	7059	7067	1	2	3	3	4	5	6	7	8
51	·7076	7084	7093	7101	7110	7118	7126	7135	7143	7152	1	2	3	3	4	5	6	7	8
52	·7160	7168	7177	7185	7193	7202	7210	7218	7226	7235	1	2	2	3	4	5	6	7	7
53	·7243	7251	7259	7267	7275	7284	7292	7300	7308	7316	1	2	2	3	4	5	6	6	7
54	·7324	7332	7340	7348	7356	7364	7372	7380	7388	7396	1	2	2	3	4	5	6	6	7
	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9

Fig. 1: a page from mathematical tables [2]. The ringed values are referred to in the text.

A commonplace calculation in A-Level physics or chemistry involved multiplication and/or division of several numbers together [4]. Suppose one wished to evaluate 1.5 × 1130 × 0.3035/2.122 (these numbers are chosen to illustrate aspects of the computational technique rather than to reflect a specific scientific problem). The student using mathematical tables would read off logarithms (to the base 10) as indicated by the ringed entries in Figure 1, and adjust the whole number to the left of the decimal point; then, he or she would do the necessary addition and subtraction, and look up the antilogarithm of the difference to get the final result – see "box". (Antilog$_{10}$ $x \equiv 10^x$.)

<u>Calculating of 1.5 x 1130 x 0.3035/2.122 using logarithms to the base 10</u>

log 1.5 =	0.1761
log 1130 = 0.0531 + 3 =	3.0531
log 0.3035 = 0.4814 + 0.0007 – 1 =	$\bar{1}$.4821
Add the above to give	**2.7113**
Subtract from this log 2.122 = 0.3263 + 0.0004 =	0.3267
to give	**2.3846**
Antilog 0.3846 is looked up as 2.424, so	
antilog 2.3846 is 2.424 x 100 =	**242.4** (final result)

Note. In the third line, the bar renders negative the digit immediately beneath it, and only that digit, eliminating the need to perform the subtraction 0.4821– 1.

The final result in the box agrees with the exact value (242.4281338) rounded to four figures, but in general one would not rely fully on the fourth figure (for instance, logarithmic multiplication of 2 by itself gave 3.999). The calculation in the box was tedious compared with using a pocket calculator today. *But* in 1966 the alternative which the A-Level student was seeking to avoid consisted of three successive traditional long multiplications and one long division, tedious and error-prone with twenty-nine lines of workings.

For purposes such as evaluating 1.5 × 1130 × 0.3035/2.122, the slide rule was much faster to use than logarithm tables (and not too much slower to use than a pocket calculator is today). As with logarithms, it was up to the user to get the decimal points in the right place. Use of the slide rule required manual dexterity, visual acuity, and mental concentration. It gave somewhat less accurate results than were obtainable with logarithms, though

probably good enough for examination answers (a recent trial by the author with a slide rule evaluated the above expression as 242.1).

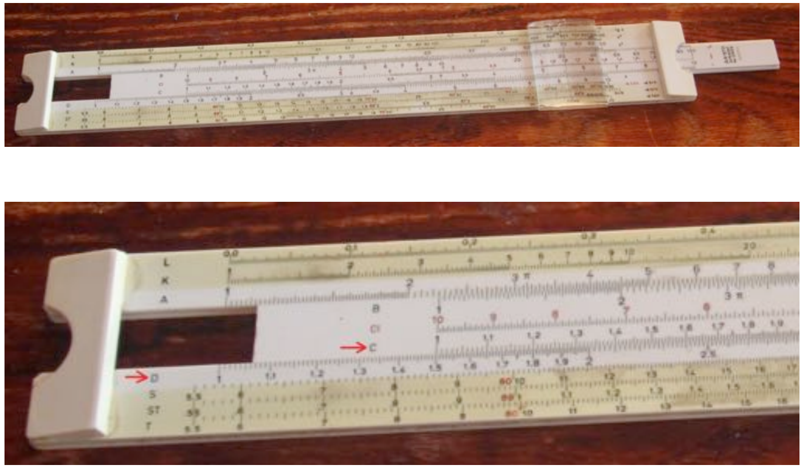

Fig. 2. A typical school or university student's slide rule in the 1960s: a full view and (annotated with arrows) a close up of the left hand side. Like the central portion carrying scales B, CI, and C, the transparent cursor towards the right hand side of the full view is slideable. In the close-up, scales C and D marked by the arrows display a "times table" for 1.5. 1.5 × 1.1 = 1.65, for instance, is fairly obviously displayed. But quoting a value for 1.5 x 1130 (the first step in the calculation discussed in the text) requires estimation by eye between the markings on scale D. The cursor could be used to "capture" a product on scale D without its being written down on paper, ready for use in another multiplication or division by sliding the central portion. Scales K, A, and B were of lower precision.

The mathematical tables included trigonometrical and other mathematical functions (see the table of contents in Figure 3), with the trigonometrical functions especially well served. For instance, there were both "natural sines" (meaning simply "sines") and "log. sines". Consider computing the refractive index μ, relative to air, of a glass block from angles of incidence i and refraction r for light of 59.0° and 34.2°. Snell's law states that $\mu = \sin i / \sin r$, so one obtained the "log. sines" of the two angles ($\bar{1}$.9331 and $\bar{1}$.7498), subtracted the second from the first by hand to give 0.1833, and then looked up the antilogarithm of 0.1833 to give μ = 1.525. Slide rules likewise had additional scales (S, ST, and T in Figure 2) to help with trigonometry; thus "15" on scale S corresponds, within the accuracy of eye estimation and adjusting the decimal point, to sin 15˚ on scale D (accurate to four figures, sin 15˚ = 0.2588).

CONTENTS

Fig. 3: table of contents of mathematical tables [2]. (At page 44, the seven-figure logarithms of nine selected numbers were given, purpose unknown to the present author.)

Oxford Part I Chemistry Undergraduate, 1966-1969; The FACIT Mechanical Calculator

Once one was an Oxford chemistry undergraduate, calculation did not change noticeably so far as examinations were concerned. The examination questions were set so that the accuracy of 4-figure tables and of slide rules

was adequate. However, candidates were not allowed to take *their own* tables into University examinations lest they had written "cribs" in them. The University issued Godrey and Siddons' 4-figure tables [2] to all candidates who might need them, and the candidates were instructed to leave them behind in the examination room.

For laboratory practicals, however, more extensive and/or accurate calculations might be needed. As has been noted, mathematical tables and slide rules converted the processes of multiplication and division into processes of addition and subtraction, but they could not help with *doing* addition or subtraction – the latter still had to be done by hand, and in some cases (say adding a couple of dozen numbers to each other) this can be quite tedious and error-prone. Especially in physical chemistry, small differences between very precise electrical or spectroscopic measurements can be important. Accordingly, the Physical Chemistry Laboratory had a calculating room for undergraduates which was equipped with numerous FACIT hand-cranked calculators (Figure 4). These machines handled all four arithmetical operations to as many digits as were ever needed. Each clockwise turn of the machine's handle adds the number in the lower-left register to the number in the upper-left register, and each anticlockwise turn subtracts it. Multiplication and division is of course simply repeated addition and subtraction. The user of the machine in the Figure has just calculated (see the top left register) 0.9 π to within 0.000 001 by inputting π into the lower left register by use of the keys, and then turning the handle nine times (as recorded in the top right register); if the user now wanted to multiply π by 2.9, he or she would simply use a shift key and turn the handle another two times.

The FACIT machines were Swedish-made precision engineering; they cost the equivalent of at least £500 today, so the Physical Chemistry Laboratory chained them down.

The FACIT machine did nothing beyond the four arithmetical operations, so it had to be used in combination with mathematical tables if, for instance, square roots or trigonometrical functions were involved in a calculation. Also, intermediate results might have to be noted down on paper as well as final results, even with such a simple calculation as (5.3216 + 4.2908) x (1.2349 + 2.9876) – a calculation which with a pocket calculator today can be done without recording intermediate steps, thanks to memory and bracket keys.

Fig. 4: a FACIT machine manufactured in Sweden *ca* 1960, bought from an antiques shop close to the site of the former Atomic Energy Research Establishment, Harwell, where it may have seen service.

Oxford Research Student, 1969-1973 [5]

As a research student needing to do calculations, better calculating aids were available. First, there were some rather noisy electromechanical calculating machines, which like a FACIT performed the four basic arithmetical operations, but which did not require handle-turning and gave a printed record of the calculations one had done, greatly facilitating checking [6]. Secondly, there was a single desktop ANITA electronic calculator in the departmental library, with a luminous display, quiet and fast; the four basic arithmetical operations were performed almost instantly, while the machine paused for a second before displaying a square root [7]. Finally, and very importantly, there was a central University electronic computer, a "KDF9" manufactured by the British firm International Computers Limited, then their "1906A". These computers were housed in large environmentally-conditioned rooms and were tended by technicians who typically dealt with one or more breakdowns every day. Courses on how to write computer code in the "high-level" language FORTRAN were run for beginning scientific researchers, even for those, like the author, who did not need to compute on

a grand scale (grander users were specially provided for). The FORTRAN programs took the form of punched cards (Figure 5) which the researcher created on special typewriters in the computing laboratory. Even to add two inputted numbers together, four program cards were needed, bearing respectively the instructions "READ A", "READ B", "C=A+B", and "WRITE C", followed by a data card bearing the two numbers. If one wanted to add, say, 100 pairs of numbers together, this could be done by means of 100 data cards, together with, in the program proper, a "DO" loop according to which each pair was added sequentially. (Note that this particular program is imagined merely to illustrate principles; an electromechanical machine with a printed output would have done the job just as well, and – see next paragraph – with less "hassle".) The output from the University computer was printed on high-quality "fanfold" paper [8], the reverse side of which once it was finished with was commonly used as superior scrap writing paper.

It could take days to get a program debugged as one ran it repeatedly with intermediate corrections that could be made only by typing replacement or additional cards from scratch, coping with downtimes and also long turn-round times by today's standards, and travelling to and fro between one's own laboratory and the computing laboratory.

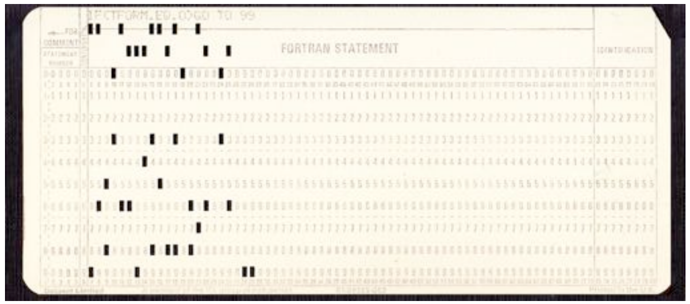

Fig. 5: a card against a black background to show the punched rectangular holes. The instruction on the card was printed out (rather faintly) at the top of the card for easy human reference, but the computer relied on the rectangular holes. The cards were made of high-quality cardboard and fed into mechanical card readers. Even small-scale users like the author would frequently end up with packs of cards many centimetres thick for the program proper even before data cards were added at the back.

Under these conditions, creating a computer program represented a considerable upfront investment in time. Each researcher had to decide whether the calculations he or she needed were complicated enough and/or had to be done often enough to justify that investment. My own first useful exercise in computer programming calculated the function –

$$d_{hkl} = 1/\sqrt{\{[h^2/a^2 + l^2/c^2 - 2\,(hl/ac)\cos\beta]/\sin^2\beta + k^2/b^2\}} \qquad \text{(eq. 1)}$$

– where h, k, and l are positive or negative integers or zero ($h \neq k \neq l \neq 0$ and h, k, and l taking values up to perhaps 10). Without the program, I would have used tables for the trigonometrical functions, and then performed the rest of the calculation with ANITA and its square root function, writing down intermediate and final results on paper in a structured form.

The importance of eq. 1 to me was that it gives the interplanar spacings d_{hkl} for a crystal with a monoclinic unit cell having parameters a, b, c, and β [9]; and I needed these spacings for comparison with the interplanar spacings from X-ray powder diffraction of samples that I had acquired or else prepared myself. Any lines in the powder diffraction pattern not given by eq. 1 indicated impurity. In one case, the mismatch between the pattern and eq. 1 was so gross as to indicate that my sample was in the wrong crystalline form (happily, I discovered that heat-treatment converted it into the right one). In the course of four years, I worked with several compounds each having a monoclinic unit cell with its own parameters, so the effort of creating the programme was worthwhile. (Today, no code-writing skill is necessary for such a task; it would take me only about half an hour to set up a Microsoft Excel spreadsheet capable of giving the desired results for any set of monoclinic parameters.)

Creating a programme to deal with eq. 1 turned out to be good practice for harder tasks. For instance, in the course of my research, I repeatedly determined temperatures between 1.4 K and to 84 K by electrical measurements on a germanium resistance thermometer. The thermometer had been calibrated, and over most of its range the calibration results had been fitted to an equation that expressed its electrical resistance R as a function of absolute temperature T:

$$\ln(R/\Omega) = a_0 + \Sigma\,(a_k\,(T/\mathrm{K})^{-k}$$

where the summation is over k =1 to k =6. (eq. 2)

(a_0 to a_6 were the numerical fitting constants.) Of course, it was R that I directly measured, and T that I wanted to know, and for this purpose eq. 2 is

the "wrong way round" and cannot be rearranged in the form $T = f(R)$. The pre-computer solution to the problem would have been to plot R against T according to eq. 2 on a *very* large (desk-size) graph and to estimate T values from R values by inspection. Instead of this, I wrote (as a subroutine within a larger FORTAN program which delivered final molar heat capacity values ready to go into my thesis) the instructions for a successive approximation procedure that solved eq. 2 for T for any inputted numerical value of R. (Today, a MATLAB user would do little more than type eq. 2 in a specified format; he or she would not have to concern him- or herself with how the successive approximations were done.)

Developments since 1973; Conclusion

In 1975, I spent £40 on *my first pocket scientific calculator*, with most of the features one would expect today, but which had a power-hungry luminous display requiring frequent recharging of the battery. This purchase represented around a week's pre-tax pay in my second year of employment after leaving Oxford. In 1981, I bought a new calculator for £15 with a liquid crystal display and running for many hours on non-rechargeable AA batteries. In 2022, despite general inflation since 1981 of over 400%, the price of a comparable calculator is £10, and even school pupils have them.

I first used a *spreadsheet on a personal computer* in 1988 (Lotus-123, subsequently outcompeted by Microsoft Excel). At that time, the working memory of personal computers could be overloaded by having too many formulae in a spreadsheet, but that problem has long since vanished. Today, as already noted, for tasks that Excel cannot conveniently handle there is readily available sophisticated general-purpose software and software adapted to particular problems.

Personally, I am not at all nostalgic about my experience of calculations while at Oxford. As an undergraduate, I was unable to "play" with important equations so as to get a feel for how they worked, as I would now if I were an undergraduate. As a research student, I was faced with tedious, error-prone work, mitigated only to some degree by use of the relatively primitive University computer [10].

References and Notes

1. https://uk.mathworks.com/products/matlab.html;
   Wolfram, "WOLFRAM MATHEMATICA",

https://www.wolfram.com/mathematica (both accessed 10 November 2022). These company and product names are trade-marks, as are Microsoft and Excel.

2. C. Godfrey and A.W. Siddons, *Four-figure Tables* (Cambridge, England: Cambridge University Press, new ed., corrected reprint, 1962). Godfrey and Siddons' tables dated back to 1913, and had an even more venerable competitor in the tables of Frank Castle (first published in 1908).

3. On a slide rule, length is used as the analogue for numbers. In the early days of electronic computing, "analog(ue) computers" used voltages and currents as the analogues of the numbers. They were capable of some tasks that digital computers then were not capable of (Wikipedia, "Analog computer":

   https://en.wikipedia.org/wiki/Analog_computer), accessed 9 November 2022. All electronic computers and calculators referred to in this article are digital.

4. The need for such calculations came from equations such as $pV = nRT$ for the equation of state of a perfect gas and $K_c = \{[CH_3CO_2C_2H_5][H_2O]\}/\{[CH_3CO_2H][C_2H_5OH]\}$ for an equilibrium in a reversible reaction (a reagent formula enclosed by square brackets signifies the molar concentration of the reagent).

5. I worked from 1969 to 1970 in the research group of the late Peter G. Dickens, which had migrated from work on gas phase catalysis by solids to work on the properties of metallic and semi-conducting mixed oxides generally. From 1970-1973, I worked in the group of the late Lionel A.K. Staveley, which had remained rooted in physical chemistry. Both groups were located in the Inorganic Chemistry Laboratory. Jack Morrell and Robert J.P Williams observe that historically Oxford chemistry had been dominated by physical chemistry. Before 1939 physical chemistry had been considered a "better mind trainer as part of a liberal education than inorganic and organic chemistry"; and even after 1945, the Inorganic Chemistry Laboratory was "to some extent a second physical chemistry laboratory". See Robert J.P. Williams, Allan Chapman, and John S. Rowlinson, eds., *Chemistry at Oxford – A History from 1600 to 2005* (Cambridge, England: RSC Publishing, 2005), 152-156, 225-226, and 244.

6. Wikipedia, "Calculator" https://en.wikipedia.org/wiki/Calculator (to 2 November 2022, accessed 6 November 2022).

7. Wikipedia, "Sumlock ANITA Calculator", https://en.wikipedia.org/wiki/Sumlock_ANITA_calculator (to 17 March 2019, accessed 6 November 2022).

8. Reddit, "I Don't Exactly Miss Computer Printer Paper From The 1980s, But It Seemed To Jam A Lot Less", https://www.reddit.com/r/The1980s/comments/qqfuwf/i_dont_exactly_miss_computer_printer_paper_from/ (accessed 7 November 2022).

9. C.W. Bunn, *Chemical Crystallography* (Oxford: Oxford University Press, 2nd edition 1961), 147.

10. Of course, previous generations of research workers did calculations far more challenging than "my" eqs. 1 and 2 but without electronic computers. Particularly famously, Oxford's Dorothy Hodgkin began her career as a crystallographer without any of the electronic aids that we now take for granted.

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A Chemist who was a Photomicrographer: Alton Ewart Clarence Smith (1887-1936)

Alton Ewart Smith was born on 20 March 1887 at Chislehurst, in Kent [1]. He was the seventh of ten children born to Clarence Smith (1849-1941) and Mary Webster. His father had a career in the financial services sector, creating his own stockbroking company (Clarence and Gervase Smith & Co.), later buying various directorships in a number of insurance companies. He was also Sheriff of London and Middlesex for two years, and a Liberal MP for East Hull between 1892 and 1895 (thus sitting alongside Sir Henry Roscoe on the Liberal backbenches). When he lost his seat, he received a knighthood. Alton's name reflected the social aspirations of his parents; his mother claimed descent from the "de Alton" family of Lincolnshire. His second name, Ewart, no doubt reflected Clarence's commitment to the Liberal Party under William Ewart Gladstone.

Group photograph of new students at Corpus Christi College, Cambridge, 1906. Alton is on the far left.

After starting his formal schooling at Skilsmergh House in Margate, from the ages of 8 to 15 [2], Alton attended The Leys School, in Cambridge, which he entered in the Autumn of 1902 [3]. Alton followed three of his elder brothers into the school and was followed in turn by his younger brother. In 1904, he sat his Higher Certificate exams, passing four subjects (probably Biology, Chemistry, Physics and Mathematics) with distinction. It seems also that he had a fascination for microscopy as he was awarded a prize for his microscope slides from the school's Natural History Society in 1905. He was an active member of this society, holding various positions

during his time at school. He became a Sub-Prefect, and then Prefect in his final year. He left The Leys School in the summer of 1905, at the age of eighteen. According to a family anecdote, the school added the father's first name to the surname of any pupil called Smith, in order to distinguish among the many Smiths in its student body.

In the Autumn of 1906, after winning a scholarship [4] to Christ's College, Cambridge in late 1905, Alton read Natural Sciences. He took a First in Part I of the Tripos in 1908, sitting exams in Chemistry, Physics, Zoology, and Comparative Anatomy [5], and Part II in 1910, in Chemistry. He spent time at the Marine Biological Station in Plymouth [6]. Perhaps this course in Plymouth sparked his interest in photomicrography, the focus of his research work in later years. Certainly, he made a large collection of microscope slides during his time there. The Laboratory might have also fired his enduring fascination with Antarctic expeditions as its marine biologists took part in Scott's expeditions of 1901-1904 and 1910-1913, and Shackleton's expedition of 1914-1917 [7].

At the age of twenty-four, Alton went back to Cambridge for a fifth year to do research, but had to abandon this project because of ill health, which was called a nervous breakdown. This may have been mental exhaustion caused by working too much, as his future wife Hilda mentions several times that he was prone to overworking in her letters to her brother Harold [8]. It is clear that his doctors recommended complete rest as Alton spent the next three years sailing on the Norfolk Broads [9] and visiting Norway for long periods, visiting Godøysund, near Bergen, and Finse, inland from Bergen, as shown by his photo album [10]. While in Norway, he learned to speak Norwegian, and edited an English newspaper in Bergen.

Alton also took up winter sports. He spent the Christmas of 1912-1913 and 1913-1914 in St. Moritz, in Switzerland. It was at Christmas in 1913 that he met his future wife, Hilda Salvesen, then just eighteen years old, who was on holiday from her finishing school in Heidelberg. Hilda was born and brought up in Edinburgh, but she – like the rest of the family – was immensely proud of her Norwegian heritage. For much of her childhood, Hilda and her siblings had spent their summers in Norway and spoke Norwegian. This Norwegian connection presumably attracted Alton to Hilda, although when Alton tried to converse with her in Norwegian, she kept lapsing into German, probably a result of being at school in Heidelberg [11].

In 1914, Alton finally started working, being appointed works chemist at the Efandem Company in Wolverhampton. It was a company which made portable electrical appliances, such as dynamo lighting outfits for motor cars, electric pocket lamps, lanterns, and electric bells [12]. Alton supervised the construction of the batteries used in these electrical items.

Alton was not with Efandem very long. In early October 1914, he joined the 11th (Service) Battalion of the South Lancashire Regiment, which had recently been formed as part of Kitchener's New Army, as a 2nd Lieutenant [13]. It was a Pioneer Battalion, which provided the Royal Engineers with skilled labour, digging trenches and dug-outs [14]. However rather than being sent to the Western Front with the rest of his battalion in November 1915, Alton had been quickly promoted to 1st Lieutenant and then to Captain, and at the end of September 1915 he was made acting Commanding Officer of a newly created Battalion, the 13th (Reserve) Battalion. As a reserve battalion, it remained in the UK, and was tasked with training new recruits for the South Lancashire Regiment. By November, the Army had called a senior officer out of retirement and made him the Battalion's Commanding Officer, but Alton reported to Hilda that the fellow was useless, and that he was in effect still running the Battalion [15]. Around the end of 1915, Alton proposed marriage to Hilda, and she accepted. As Hilda put it in a letter to Harold, "Just the shortest note as I am in a frightful hurry to give you a most terribly startling piece of news - I am engaged to be married what ho! To Captain Alton Ewart Clarence Smith, the man I met 2 yrs ago in Switzerland". They were married, in her home town of Edinburgh, in April 1916.

By the middle of July 1916, Alton was on his way to join his old battalion at the Battle of the Somme, but he became ill in Rouen, possibly an acute case of food poisoning although, as his tongue turned green, it may have been a case of lichen planus. Whatever it was, it was serious enough to warrant his return to England. Alton was keen to return to active duty. After a short period of convalescence, he presented himself three times before a medical board. But, for reasons that are not clear from the record, he was not able to persuade the boards that he had recovered, and eventually, in 1917, he was invalided out. So finished, on a rather inglorious note, Alton's military career. He must have felt this failure rather keenly. His eldest child Jack (who was born in 1917) recalled once that Alton would always get depressed at after-dinner sit-arounds in the living room, when his peers began to swap war stories, because he had none of his own to tell.

Upon his discharge from the Army, Alton returned to his job at Efandem. He was with the company for two years, and it was during this period that he devised an electrolytic mixture for the company's torch batteries that was better than that of any competitor. It was also during his stay in Wolverhampton that Alton and Hilda's second child, Nan, was born. Alton was confirmed in the Church of England in 1918, thereby leaving his family's Methodist roots.

In 1919, Alton's brothers Stanley and Jimmy, who were directors in Saxonia Electrical Wire Co. in Greenwich, offered him a directorship in the company [16]. Since the manager at Efandem had made no secret of his desire to give Alton's post to a relative, he resigned. The managing director of Efandem was later convicted of embezzlement and the company was bought up by Ever Ready in 1925. However, the offer at Saxonia fell through almost immediately, because the other two directors refused to accept a third Smith brother. Alton spent time reaching out to various people and exploring options. Finally, in 1919, at the age of thirty-two, Alton was offered the position of lecturer in physical chemistry at the University College of Southampton (as it then was). According to family recollections, he accepted to take the post because he was being asked to create the department of physical chemistry. Alton stayed in the position for the rest of his life. They lived at "Breydon" in Oakmount Avenue, which is a street of typical interwar detached houses near Southampton Common. The last two of Alton and Hilda's children, Dorothy and Ken, were born there.

When Alton was appointed, the physical chemistry laboratory was housed in one of the army huts erected during the occupation of the college buildings as a military hospital during the war. In 1927 physical chemistry moved into a new building and Alton had to plan and fit out the new laboratory, for which he possessed both mechanical talent and a characteristic ingenuity [17].

Alton was first and foremost a teacher. He took great care with in the presentation of physical chemistry, which he presented both clearly and accurately. According to family recollections, "you could hear a pin drop" during his very well attended lectures. When another lecturer asked him how he held everyone's attention, he was baffled by the question, since it came naturally to him, and he never had the slightest trouble. He appreciated the difficulties his students encountered in understanding physical chemistry and in turn they both liked and respected him. He made a major contribution to the running of the department as someone who was "free from all petty jealousies" [18] and he also acted as secretary to the Faculty of Science, in which capacity he showed remarkable gifts of organisation. Alton felt that existing textbooks on physical chemistry were not very good and began to write his own, but only got as far as writing the introduction.

For an academic chemist, Alton's research was – to say the least – unusual. As far as we know, he only published one chemical paper, about the strength of ammonium hydroxide as a base [19]. Robert Caven (1870-1934), following Albert Holleman (1859-1953), had argued that ammonium hydroxide was a strong base which appeared to be weak because of the dissociation of ammonium hydroxide to ammonia and water. Alton argued that this was incorrect, as ammonium hydroxide had been shown by Georg Bredig to be a weak base using conductivity measurements and Alton pointed out that the experimentally measured hydrolysis of ammonium chloride to ammonium hydroxide – the key piece of evidence cited by Caven – was compatible with Bredig's dissociation constant for ammonium hydroxide. While Alton presented a clear argument, it was not dependent on any experimental work he had done himself, but on the reported work of other chemists.

Alton's research work lay elsewhere, namely in the field of photomicrography. He had been interested in this technique since his Plymouth days. Presumably his superiors at Southampton were happy for Alton to pursue this non-chemical research – which did not cost the university very much if anything at all – as long as he gave good lectures. His paper in the *Journal of the Quekett Club* concerned a problem that had troubled microscopists [20]. The tiny marine organisms called diatoms have a silica shell which appeared to have black dots or white dots under the microscope. Were the black dots (or the white dots) an artefact, or could diatoms have both white and black dots? As a physical chemist, Alton had the idea of putting suitable samples of inorganic silica under the microscope and indeed under certain conditions, they showed similar dots. This confirmed the much earlier hypothesis of the renowned microscopist Ernst Abbe (1840-1905) that these dots were a diffraction effect. Alton was then able to show that these dots were a degraded image of tiny rings in the diatom. A posthumous paper in the *Journal of the Photomicrographic Society* discussed the use of short-focus astigmatic lenses [21]. He also wrote three technical notes in *Watsons Microscope Record* [22]. Shortly before his death, he had been awarded the medal of the Royal Photographic Society and had he lived longer, he may well have garnered further honours

in this field as he was regarded one of the most accomplished technicians in photomicrography in Britain. Because of his experience in handling microscopes, he was frequently consulted by biologists, microscopists and manufacturers of these instruments.

A persistent family story has it that for some years before his death, Alton was in correspondence with Niels Bohr, the Danish nuclear physicist. More fancifully, some accounts go so far as to suggest that Alton was involved in some way in Niels Bohr's research on heavy water. Despite his grandchildren looking into the subject, no connection related to scientific research has been found between the two men.

One of his daughters, Dorothy, fondly reminisced about Alton coming home to them all, and when they rushed to greet him he would hold his hands up in the air crying "Unclean! Unclean!" because of the chemicals on his hands. She also talked about his habit of regularly throwing his lunch out of the window onto the flowerbeds when he took his lunch in his study, because he thought the lunch boring, and pretended to be very surprised when he was found out.

Alton's early sailing experience on the Norfolk Broads led to a life-long love affair with sailing. Except for 1931, when he and Hilda went to Norway to stay with Hilda's relations, he sailed on the Broads every summer with Hilda, siblings, friends, and – when they were old enough – the children. After many years of hiring boats, Alton turned his skills to designing a boat specifically for the Broads and had it built in a local yard. In 1928, *Sleeping Beauty*, thirty-foot long, constructed in mahogany and with brass fittings throughout, was delivered. He was to sail the Broads on her for the rest of his life. Although she finally passed out of the family's hands in 2006, this beautiful boat still sails the Broads today.

Sailing on the Broads seems to have brought out Alton's pugnacious side. Hilda would recount how, on one of her early trips on the Broads, when she was heavily pregnant with her second child, they were coming in to shore for lunch, when the boom suddenly swung wildly towards her. She panicked and jumped off the boat into the water to avoid being hit and to save her unborn baby. Instead of showing her any sympathy, Alton peremptorily ordered her to clamber into the dinghy being towed behind the boat while he simply busied himself with anchoring the boat's stern. Apart from recording dry facts about the wind and the rain, the ship's log mentions numerous collisions with other boats, and general disapproval of most other people. He also strongly disapproved of motorboats. But, at least in the early years, the logs also give examples of Alton's dry humour, as well as of a self-awareness of his inexperience in the type of sailing needed on the Broads, and a recognition of the fact that his brothers, who seem to have been more relaxed about the sailing, perceived him as a stickler for correctness and detail (a trait shown in abundance in his work). As might be expected, Alton's sailing was self-taught. He worked it out from first principles and a couple of books, and hated the thought of having a paid hand or skipper on board.

Alton sailing on the Broads c. 1935, just before his death. His widow supplied this photograph as the basis for a posthumous portrait.

After the illness which cut short his research work in Cambridge, Alton was never in robust health. He especially suffered from regular migraine headaches and sore throats during the winter that would lay him low. In later life, Hilda told the story that when he was in bed with these ailments it was his habit to bang a walking stick on the floor to summon her when he wanted something. Nevertheless, Alton's contracting leptospirosis on the Broads in the late summer of 1936 came as a bolt from the blue. One of his daughters remembers that he was aware of the danger of catching leptospirosis and was very worried lest his children catch the disease by walking barefoot on the boat's decks or the banks. Since the crews on *Sleeping Beauty* would regularly swim after sailing, it is possible that Alton unwittingly swam in contaminated water. Regardless of how he contracted it, he had a bad case of the disease, and died in hospital in Norwich on 16 September 1936, at the relatively young age of forty-nine; he was outlived by his father who died six days before his ninety-second birthday in 1941.

In 1937, after his death, Alton's students and colleagues at University College founded the A. E. Clarence Smith Prize, to commemorate his work as Senior Lecturer in Physical Chemistry from 1919 to 1936. The prize is still awarded annually for outstanding performance to a student graduating in the honours school of chemistry; in 2022, it is a prize of £100 and a certificate [23]. His widow donated most of his library and much of his scientific apparatus to the university [24].

Note: The above article had an unusual genesis. Peter Morris has shared an interest in the history of rubber with William Clarence-Smith at SOAS for many years, but only recently discovered that his grandfather was a chemistry lecturer at the University of Southampton. This happenstance led to the writing of this article, a biography of a chemist who would have otherwise would not have normally attracted the interest of a historian of chemistry.

References

1. This account of Alton's life is based on the family history of the Smiths which was put together by Jack Clarence Smith, Alton's oldest child, recollections of family stories told by Hilda and Dorothy by Edward Clarence-Smith, William Clarence-Smith and Victoria Baden-Powell, and two obituaries by D. R. Boyd, "Alton Ewart Clarence Smith. 1887-1936". *Journal of the Chemical Society (Resumed)*, 1937, 184-185; and "Mr. A.E. Clarence Smith" *Nature* (17 October 1936), 678.

2. *Bibliographical Register of Christ's College 1505-1905, and of the Earlier Foundation, God's House, 1448-1505*, Vol. II 1666-1905, Compiled by John Peile at the University Press (1913).
3. Unless otherwise specified, all the information in this paragraph comes from documentation supplied by Mrs Alison Lainchbury, Librarian and Archivist at The Leys School.
4. Personal communication from Dr Genny Silvanus, College Archivist, Christ's College, Cambridge, to William Clarence-Smith.
5. Archives at Cambridge University, to William Clarence-Smith.
6. A.J. Southward and E.K. Roberts, *The Marine Biological Association 1884-1984: One Hundred Years of Marine Research*. The Laboratory, Occasional Paper Number 3, Dec. 1984 (Reprinted from *Rep. Trans. Devon. Ass. Advmt. Sc.*, 1984, 116, 155-199).
7. Southward and Roberts, *The Marine Biological Association 1884-1984*.
8. These letters came into the possession of one of Harold's daughters, who recently passed them on to Annette Elliot, one of Alton's grandchildren.
9. Tom Clarence-Smith, one of Alton's grandchildren, holds the old logs for Alton's sailing expeditions on the Broads.
10. This album is currently in the possession of Tom Clarence-Smith.
11. Letter from Hilda to Harold.
12. Bev Parker, The Efandem Co. Ltd., http://www.historywebsite.co.uk/Museum/Engineering/Electronics/Efandem/history.htm; also see Grace's Guide, https://www.gracesguide.co.uk/Efandem_Co. The firm was named after the initials of two of the directors, F and M.
13. The details of Alton's army service come from his record with the War Office, now held by the National Archives (reference: WO 339/20968), as well as from information received from the Lancashire Infantry Museum.
14. K.W. Mitchinson, *Pioneer Battalions in the Great War: Organized and Intelligent* Labour (London: Leo Cooper, 1997); this was republished by Pen & Sword in 2014.
15. Letter from Hilda to Harold.

16. For Saxonia, see Grace's Guide: https://www.gracesguide.co.uk/Saxonia_Electrical_Wire_Co.
17. N.K. Adam and K.R. Webb, "Schools of Chemistry in Great Britain and Ireland: XXIII The University of Southampton" *Journal of the Royal Institute of Chemistry*, 1956, 80, 133-140, on 137.
18. Boyd, "Alton Ewart Clarence Smith. 1887-1936", 185.
19. A.E. Clarence Smith, "The Alkalinity of Ammonia" *Chemistry and Industry*, (15 June 1923) 578.
20. A.E. Clarence Smith, "The 'Ring' Resolution of Diatoms" *Journal of the Quekett Club*, 1932, 22, 231-242.
21. A.E. Clarence Smith, "Short-focus Astigmatic Objectives and their Use" *Journal of the Photomicrographic Society* 16 (April 1937), 44-56.
22. A.E. Clarence Smith, "Some Practical Hints on Vertical Illumination" *Watsons Microscope Record* 2 (September 1924), 14-17; Smith, "Current Microscopy—Photomicrography: The Problem of Exposure" 16 (January 1929) 3-7 (it says "to be continued" but no subsequent paper is in the family's possession); Smith, "Some Resolutions of *Surirella Gemma* with the Holoscopic Series", 21 (September 1930), 14-18.
23. Personal communication from Andrew Hector of Southampton University, dated 10 November 2022.
24. Adam and Webb, "The University of Southampton", 137.

Edward Clarence-Smith, William Clarence-Smith and Peter J. T. Morris

ESSAY REVIEW

José G. Perillán, *Science between Myth and History: The Quest for Common Ground and Its Importance for Scientific Practic*e (New York: Oxford University Press, 2021). Illus., notes, bibliography, index. Pp. xxiii + 341. £35 (hardback with dust jacket). ISBN: 978-0-19-886496-7.

This book is written from a "science (and technology) studies" perspective (pages vii, 4, and 250, footnote 11) by José Perillán, now at Vassar College, New York, who did graduate work in physics and history. For brevity throughout this essay review, the reviewer uses "science", "scientist", "scientific" to include "technology", "technologist", "technological".

Perillán has apparently not practised as a scientist with senior responsibility, by which the reviewer means relying on his or her own scientific judgement when serious matters are at stake (substantial money, other scientists' careers, safety, etc.) [1]. The book's thesis, despite its historical basis, is addressed to such people. Of course, lack of personal practitioner experience does not debar scholars from advising practitioners. Implicitly at least, many historians do this (writing military, diplomatic, political history, etc., mostly without ever having been soldiers, diplomats, politicians, civil servants, etc.); and their work can be highly valued by the practitioners. However, the reviewer believes that the book's weaknesses do derive in part from the author's lack of relevant practitioner experience.

Further, practising scientists – the very people whose behaviour Perillán wishes to change – may well be put off from reading the book by the terminology used, as in the section titles "Myth-History as Chimeric Narrative Category" (page 58) and "Transformative Interrogation in Action" (page 238).

The author says the book is "an invitation to an open, reflective, interdisciplinary discourse" (page 14); but this tentativeness is not reflected elsewhere – for instance, the Foreword by the (recently deceased) Trevor Pinch of Cornell University (page vii) says that "Science is in trouble", that scientists have "have partly brought [the trouble] on themselves", and that with Perillán's book "the source of the trouble is firmly located".

The book covers a range of issues of historical and professional scientific interest because of its discursive nature – the author (page xv) describes it as having "deep, sprawling roots" – and it does stimulate thought.

The reviewer summarises the book's thesis as follows:

In "science pedagogy, consensus work, and the public understanding of science" (page 18), scientists use myth-histories as rhetorical devices, and this practice is potentially dangerous, even though scientists may openly warn their readers of what they are doing.

In the Introduction and Chapter 1, three physics Nobel laureates are discussed in relation to the pedagogic aspect of this thesis: Richard Feynman (1918-1988), Leon Lederman (1922-2018), and Steven Weinberg (1933-2021). All of them used history to assist their teaching of physics, but

admitted that they simplified or selected their history for this purpose, *i.e.* they wrote "myth-histories". Clearly, anyone so using history will view the history from the present day, will tend to ignore blind alleys (if they are now seen to be so), and will use modern terms which the historical figures would not have used. This will often depart from proper historical method, and be justifiably criticised as "Whiggish" or "presentist". (*Newsletter* readers unfamiliar with this strand of historiographical thought are referred to the Annex to this essay review.) Perillán discusses "Whiggishness" and "presentism" at length, but chooses not to criticise Feynman *et al* for being bad historians. Instead, he says that they are failing their profession and their discipline – and therefore society, because "science is progressively becoming more powerful in its ability to change the world" (page 22). He says that myth-histories such as those of Feynman *et al* present these dangers:–

(a) The myth-histories may put some students off science by emphasising "scientific heroes ... flawless solitary geniuses" whom they can never expect to emulate (page 18).

(b) The myth-histories may "present current scientific knowledge as unassailable" (page 21), with implications for science communication in cases where there is uncertainty.

(c) Because of (b), myth-histories can be unhelpful in achieving trust in science and in defending against the "war on science" (many references in the index), especially "in a post-truth world swirling with 'alternative facts'" (page 6), as with Covid.

The implication of this is that scientists, science, and society would benefit, not from objective history but from myth-histories different from those of Feynman *et al*, with an alternative set of simplifications and selections devised to achieve such benefit rather than to facilitate pedagogy as with Feynman *et al*. Thus, one should, apparently, downplay scientists who mostly worked alone – common before (say) 1919. Also, flaws that humanise scientists should apparently be emphasised so as to make science more attractive to students – but what is to be done about flaws that students will find repulsive, such as, topically, those of Erwin Schrödinger (1887-1961) [2]? And, most problematically, is one to suppress the fact that, by practical standards, much current scientific knowledge *is* unassailable beyond any reasonable doubt – above all, the scientific knowledge which underpins the modern world and which asserts, for instance, the nonexistence of phlogiston, the existence of atoms, and electric current in metals as a flow of electrons? In the reviewer's opinion, myth-histories along these alternative lines would be at least as lacking in historical integrity as those of Feynman *et al* and would in any case be unlikely to benefit scientists, science, and society.

Sandwiched between the Chapter 1 and the Conclusion (which, with the Introduction, total 84 pages), Chapters 2 to 5 comprise four historical case studies and total 164 pages. The Conclusion includes a partial case study of Covid. Interesting as the case studies are in themselves, the reviewer does not consider they support Perillán's conclusions.

The case study of Chapter 2 is unconvincing. Perillán argues that the hidden variable theory of quantum mechanics of Louis de Broglie (1927) was not taught to university students as a result of "myth-history" that excluded it in favour of the Copenhagen interpretation; specifically, it was not taught to John Bell at university in the late 1940s. He thinks teachers were not justified in ignoring it by the fact that in 1930 de Broglie himself had abandoned it as "not ... satisfactory" (page 95). (Instead, most quantum theorists ignored the deep issues and just got on with their calculations, for instance creating quantum chemistry.) Perillán may have himself fallen into a "Whiggish" or "presentist" trap. Has hindsight led him to imagine that physics teachers in the 1930s and 1940s should somehow have sensed that an exit from de Broglie's blind alley (as it then seemed to be) would be discovered post-1950 by David Bohm, John Bell, and others? Teachers' primary aim is to enable students to "do" science for themselves; they would not have wanted to take up student time with difficult-to-understand and inconclusive ideas that did not, contemporaneously, contribute to that aim. Strangely, Perillán himself ignores his own implied injunction in (a) above; he presents David Bohm and John Bell as heroic solitary geniuses, entitling one section, "David Bohm Climbs Mt. Impossible" (pages 98–103).

Chapter 3 describes scientists arguing about the past when professional priority and money is at stake in relation to CRISPR gene-editing techniques [3] – a situation familiar to chemists who have been involved with patents. Chapter 4 describes the disparagement of a gravitation-wave researcher by other scientists in the field (partly out of self-interest), and their acknowledgement of his contributions only after his death, somewhat similar to the case of Rosalind Franklin (1920-1958) familiar to chemists. Chapter 5 is on the Italian scientists who failed adequately to warn the town of L'Aquila of the 2009 earthquake and who were subsequently tried in

court. This, with the discussion of Covid in the Conclusion, describes the difficulty of translating scientific opinion into life-and-death practical advice for non-experts (as chemists have to do from time to time).

The reviewer is not convinced that the bad or ineffective behaviour in relation to CRISPR, gravitational waves, earthquakes, and Covid would have been prevented if scientists had been dealing with history in a different way: more direct preventatives – better ethics enforcement and communications training – would have been needed; in the reviewer's opinion, the former at least is still today widely lacking.

The book is printed on good-quality paper that does justice to numerous photographs and illustrations, including cartoons amusingly drawn by Zeyu [Margaret] Liu. Readers primarily interested in quantum mechanics should note (page xviii) that Chapter 2 has been previously published as a journal article.

Annex: Objections to "Whiggishness", "Presentism", and Anachronism in Science History Writing

This topic is relegated to an Annex because Perillán chooses not to make such objections himself. Nevertheless, as he says, the topic "polariz[es]" history of science and reflects a "fundamental tension" (pages 10 and 24). It may be new to some readers this *Newsletter*, who, being mostly professional scientists, are especially exposed.

In 1931, Herbert Butterfield (1900-1979) in *The Whig Interpretation of History* [4] famously disapproved of writers who had distorted history so as to give a false impression of political and social progress leading to present conditions, with the motivation of encouraging yet further progress. The derogatory use of the word "Whig" and its derivatives in relation to historical writing subsequently became "implant[ed] ... in the professional language of historians" [5]. Perillán describes two instances of transferring this idea into history of science:–

(i) Stephen Shapin (b. 1943), professor of history of science at Harvard, reviewed the book *To Explain the World* by Steven Weinberg (*qv*) under the title "Why scientists should not write history".

(ii) A postgraduate student of Thomas Kuhn (1922-1996, famous for his concept of the scientific "paradigm" [6]), alleged that Kuhn had thrown an ashtray in his direction, by way of emphasising his, Kuhn's, aversion to "Whiggishness", "presentism", and "all anachronistic language and concepts" (pages 23-24) [7].

Perillán does not discuss the interesting question of whether a bar on "all anachronistic language and concepts" would prohibit a historical scholar from using modern knowledge to consider what actually went on in a historical experiment, when the experimenter did not know or else thought the wrong thing. A refereed history journal may well not expect authors to provide such a consideration, even when it could be easily done [8], and the style of some journals [9] may actively discourage scientific analysis. But Butterfield himself, around two decades after defining "Whig history", did not hesitate to use modern scientific terminology to guide the reader, for example by identifying Joseph Black's "fixed air" of 1754 with "what we should call carbon dioxide", while acknowledging that Black had no comparable concept [10].

References and Notes

1. Many Historical Group members do so practise, or have done, including the reviewer.
2. Mairead Maguire, "Schrödinger Theatre to be Named 'Physics Lecture Theatre' ", *University Times*, 8 February 2022, https://universitytimes.ie/2022/02/schrodinger-theatre-to-be-named-physics-lecture-theatre/ (accessed 11 October 2022). The theatre, in Trinity College Dublin, was indeed renamed (reviewer's personal observation, June 2022) on account of Schrödinger's "abuse of young women and girls". Students actively promoted the change.
3. "CRISPR" stands for "clustered regularly interspaced short palindromic repeats" in DNA.
4. Herbert Butterfield, *The Whig Interpretation of History* (London: G. Bell and Sons, 1931).
5. A. Wilson and T. Ashplant, "Whig History and Present-centred History", *The Historical Journal*, 1988, 31(1), 1-16 at 1.
6. Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago and London: University of Chicago Press, 1962).
7. Perillán says that the student caricatured Kuhn's ideas (page 255, footnote 11). The ashtray story lacks corroboration.

8. Amy Fisher, "Robert Hare's Theory of Galvanism: A Study of Heat and Electricity in Early Nineteenth-Century American Literature", *Ambix*, 2018, 65(2), 169-180. In this, no attempt is made scientifically to understand the electrochemical experiments that Robert Hare (1781-1858) performed in 1819, even as they might have been understood by the end of the nineteenth century – and as they would still be understood today.
9. Peter J.T. Morris and Jeffrey I. Seeman, "The Importance of Plurality and Mutual Respect in the Practice of the History of Chemistry", *Bull. Hist. Chem.*, 2022, 47(1), 124-137, especially Table 2 at page 127.
10. Herbert Butterfield, *The Origins of Modern Science 1300-1800* (New York: First Free Press Paperback Edition, 1965), 214. Butterfield's book originated with lectures delivered in 1948.

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BOOK REVIEW

Stephen M. Cohen, *O Mg! How Chemistry Came to Be* (London: World Scientific, 2022). Illus., index. Pp. 212. £60 (hardback). ISBN: 978-981-125-040-8. Softcover and e-book available.

With an ongoing discussion about putting chemistry back into the history of chemistry, the converse is also important, particularly in relation to schools. Whilst many inspiring chemistry teachers use history to attempt to capture the enthusiasm of their students, there are few publications aimed at engaging those studying chemistry at secondary school in the history of the field. Stephen M. Cohen's graphic novel aims to correct this. With a target audience of teenagers, and also adult non-experts, it takes readers on a journey from ancient times through alchemy, the chemical revolution, the rise of organic chemistry and the periodic table, to polymers, chemical warfare, environmental chemistry and nano-chemistry.

The story of the process required to create such a book was explained by the author in a short essay in the previous *RSCHG Newsletter* (Stephen M. Cohen, "*O Mg! How Chemistry Came to Be*: The Creation of a New Graphic History of Chemistry", *RSCHG Newsletter*, Summer 2022, No. 82, 32-41). Cohen is ideally suited to producing such a history. There must be very few individuals who possess the artistic talent, combined with chemical and historical expertise, to draw cartoons and write a witty and informative accompanying text. The book's strength lies in the way in which history and cartoons are used to explain how chemical principles and concepts evolved into their current form. The diagrams and equations will be very familiar to anyone studying chemistry. The author then cleverly interweaves the historical context, adding a multitude of facts, figures and personalities. Thus terms such as racemic, dextrorotatory and laevorotatory are introduced via nineteenth-century studies of polarized light, the recognition by chemists of two forms of tartaric acid and Louis Pasteur's examination of crystals of sodium ammonium tartrate. Moving on through Jacobus Van't Hoff, Joseph-Achille Le Bel, Emil Fischer and Viktor Meyer, in four pages a lesson in optical isomerism and stereochemistry is distilled. Later Frederick Soddy teaches the reader to play the "Radioactive Element Game", Margaret Todd coins the term 'isotope' and Stefanie Horowitz proves their existence.

This book deserves to be widely read and used if we are to increase the prominence of chemistry in both the public consciousness and on the popular science shelves in bookshops. Chemists who are historically inclined will delight in the detail and those involved in education should find plenty to inspire their students, although the hardback price appears aimed at institutional rather than individual purchasers. I shall leave the final part of this review to my son who I have long wished to convert to the joys of history of chemistry.

This book is a graphic novel which tells you the story of chemistry, how it started and progressed, and of many major discoveries. It takes the reader on a journey from ancient science to the present day, using a character called Ben Zene to narrate it. Its aim is to get teenagers into the history of chemistry and it worked for me! My favourite section was on nano-chemistry. Lots of well-known chemists are featured and some less well-known ones too. There are clear descriptions of concepts such as the periodic system, as well as electrons, protons and neutrons, which all make it useful for budding chemists. The illustrations are very eye-catching and contain some amusing jokes. Overall, I think this is an excellent book.

Anna Simmons and Alex Woodman

RSCHG MEETING REPORT

Women in Chemistry

Thursday 13 October 2022, Burlington House Piccadilly, London

The topic of Women in Chemistry has received significant attention in recent years. This upsurge of interest has been assisted by the recent publication of three major studies. Marelene and Geoff Rayner-Canham produced *Pioneering British Women Chemists, Their Lives and Contributions* (World Scientific, 2020), Annette Lykknes and Brigitte van Tiggelen were co-editors and contributors to *Women in their Element*, *Selected Women's Contributions to the Periodic System* (World Scientific, 2019), and Anne Barrett wrote *Women at Imperial College; Past, Present and Future* (World Scientific, 2017). Four of these authors were among those who gave presentations at the meeting. Each covered a different aspect of the subject, and together they served to emphasise how broad the topic is and how much research still needs to be done. Before giving her paper Sally Horrocks was presented with the Group's Wheeler Award for her historical contributions. We were honoured that the meeting was attended by the President of the RSC, Gill Reid, who gave the final presentation, *My Journey with Chemistry*. This described her career to date and the research she is leading in compounds for use in positron emission tomography for cancer treatment. The meeting was well supported, and it was pleasing that the audience included a party of chemistry sixth formers.

How Archives Can Reveal Hidden Women in Chemistry

Anne Barrett, College Archivist and Corporate Records Manager Imperial College London

Where are the women? If they are not obvious, what can we do to make them so? By describing projects which have addressed this problem, discussing research sources, and illustrating these with case studies, access will be revealed via the use of archives. But first one huge obstacle we need to overcome is in scientists themselves, not believing their personal papers are of any value. Scientists are people too – and live and work under the same influences of everyone else, which actually archives can reveal, but only if their manuscript papers, notes, diaries correspondence, drawings and ephemera are saved.

It is essential that scientists are educated to see that their manuscript papers, their communications and other interests form the valuable material that should be saved for cataloguing. Their published output is not indicative of the whole person, important though it is to their career, and this is a message that should begin with students in the academic environment and early career scientists. This applies particularly now in the digital age, as the dangers of loss are inherent in this material, and training in keeping personal archives to track a career could be part of scientific training, (or general academic training for that matter.) Therefore, researchers may also come up against the problem of there being no archives – so some organisations have proactively begun to fill those gaps, creating collections through specific projects.

Various examples of creating archives which look at women in science and medicine were shared and a checklist of archival material to begin research from a university viewpoint provided. Other useful sources highlighted included The British Library National Life Stories: https://www.bl.uk/voices-of-science/about-the-project and The Royal Society of Chemistry's *175 Faces of Chemistry Celebrating Diversity in Science*, images and texts of interviews: http://www.rsc.org/diversity/175-faces/

The 'Two Person Career' and the British Chemical Community in the Mid-Twentieth Century

Sally Horrocks, Associate Professor of Contemporary British History in the School of History, Politics and International Relations at Leicester University

In August 1954 *Chemistry and Industry*, the weekly newsletter of the Society of Chemical Industry (SCI), reported the speech given by Mr J.A. Oriel, the master of ceremonies at the dinner held during the annual meeting in Liverpool. In proposing the toast to "The Guests" he welcomed the ladies, "without whose presence no party would be complete. If the other ladies present would permit him, he would like to take the opportunity of paying special tribute to the wives of the members of the Society, without whose patient forbearance and a variety of other womanly qualities the members would not be able to carry on as industrial chemists".

In making these remarks Oriel was recognising the role women played in supporting their husband's careers not just in the private realm of the home, but also through their public involvement in occasions such as the SCI annual meeting. This paper examined the significance of the work done by these women in sustaining the chemical community in mid-twentieth century Britain and the implications of this gendered division of labour for women who themselves pursued careers in chemistry, relegated by Oriel to the category of "other ladies present". It argued that the pervasive expectation that women's primary role was to support their husbands made

it difficult for women who were trained chemists to establish positions for themselves within the chemical community that accorded recognition for their technical expertise and professional competence. It also suggests that this created particular challenges for women who wished to continue their careers after themselves marrying and having children. While the focus of this study is chemistry, it contributes to a broader discussion of the history of professional work for women and of its relationship to prevailing expectations around gender roles during this period.

Presentation of the Wheeler Award to Sally Horrocks by Peter Morris, RSCHG Chair

Listening to the Canaries: Munitions Workers in World War One

Dr Patricia Fara, Emeritus Fellow, Clare College, Cambridge

By 1914, scientific innovations had permanently changed international warfare: now it was fought at home as well as overseas. Large numbers of women worked in munitions factories during the First World War, but their memories have been overshadowed by men who died on battlefields abroad. Often young and untrained, they carried out dangerous chemical procedures that caused chronic illness or death. Because ingredients such as TNT died their skin yellow and their hair green, they were colloquially known as 'canaries' and shunned by society.

Female employment boomed after 1915, when a major military defeat prompted new manufacturing legislation. Influenced by government posters glamorizing the work involved, around a million women eventually signed up, even though Trades Union hostility ensured that wages remained low. Arguably, this unprecedented female involvement in the War effort played a greater role in winning the vote than all the previous suffrage activity.

Manufacturing munitions is intrinsically a dangerous task. Despite safety precautions, a few city-based factories exploded in fatal disasters that destroyed surrounding homes. In contrast, Britain's largest plant was constructed on the Scottish-English border near Gretna Green in an isolated spot. This purpose-built complex was about nine miles long, including several production centres linked by internal railways and surrounded by vast housing developments with their own amenities such as shops, kitchens and churches.

Militarily, this project was a huge if expensive success that produced more cordite than all the other factories in the country put together. Yet this planned community was socially stratified: the youngest and least-educated female staff lived in cramped communal huts, were subjected to the greatest daily risks and received minimal medical care, while their leisure activities were closely monitored by police and senior administrators.

A Seat at the Table: Women and the Periodic System

Annette Lykknes, NTNU, Trondheim, Norway (co-author: Brigitte Van Tiggelen)

The history of the periodic system is more multifaceted than conveyed in the traditional and popular accounts. The unique place the periodic system occupies in chemistry and chemistry teaching makes it an excellent lens through which women's contributions in chemistry overall can be viewed. Indeed, history of chemistry cannot be written without considering the many roles women occupied in the joint endeavour, as the many chapters in the collective volume *Women in their Element: Selected Women's Contributions to the Periodic System* has demonstrated.

In this talk, the speaker discussed four primary opportunities which enabled women to take part in chemical work on the elements and atoms: pursuing kitchen-like analytical-chemical work, entering emerging fields with no established male-dominated structures, teaming up with established scientist-partners, and taking up 'invisible' jobs that enabled (some) women to grow with the job. She also discussed how women's career trajectories have often led to niches of invisibility, partly due to the emphasis on thinkers and leaders in traditional historiography of science.

"Let us in!": The Opposition to the Admission of Women to the Professional Societies

Marelene Rayner-Canham and Geoff Rayner-Canham

Grenfell Campus, Memorial University, Corner Brook, NL Canada

A variety of chemistry-related professional societies were founded in Britain in the nineteenth and early twentieth centuries. Each one faced the admission of women in a different way. The talk began by considering the London Chemical Society of 1824. The focus of the talk was the Chemical Society founded in 1841, where the fight for the admission of women lasted for forty years. The presentation considered the role of the male members of the Society, some of whom, such as William Ramsay and William Tilden, ardently supported the admission of women. Equally vociferous were the opponents especially William Perkin senior and Henry Armstrong. The talk also introduced the women who aggressively advocated their own cause, including Ida Smedley and Martha Whitely.

Edith Humphrey: A Pioneer of Co-ordination Chemistry

One of the women who originally petitioned the Chemical Society for admission in 1904 and was finally admitted after the bye-law was passed in 1920 was the co-ordination chemist, Edith Humphrey. Born in Kentish Town in 1875, Edith attended North London Collegiate School for Girls and then Bedford College in 1893. Following completion of her BSc in 1897, she gained a PhD at Zurich University, where she worked under Alfred Werner. Amongst the compounds she synthesised was bis(ethylenediamine)dinitrocobalt (III) bromide and the paper describing the synthesis was published under their two names (Werner and Humphrey) in 1901. There was no indication of gender, so it was not apparent at the time was that the student was a woman (and British). The compound was of significance in that it helped to confirm the octahedral nature of these cobalt complexes. It was also the first chiral octahedral cobalt complex to be synthesised, although its structure was not resolved at the time. The sample was donated to the RSC in 1991 by the Swiss Committee on Chemistry on the occasion of its 150^{th} anniversary. David Allen, RSC Librarian, arranged for the crystals, along with Humphrey's 'Form of Recommendation' for joining the Chemical Society, to be displayed at the meeting on 13 October 2022. Edith Humphrey was also noteworthy for apparently being the first British woman to be awarded a PhD in chemistry.

Boxed sample of bis(ethylenediamine)dinitrocobalt (III) bromide prepared by Edith Humphrey in Alfred Werner's Laboratory in Zurich in 1901

My Journey with Chemistry

Prof. Gill Reid, University of Southampton, President RSC

This presentation began with a brief discussion of some of the key decision points over the speaker's career, highlighting some of the lessons learned that might be useful for others. This was followed by her personal perspectives on the value of working closely with the RSC, touching on aspects of RSC strategy and key current projects. The presentation finished with a brief description of one area of current research in her group, developing metal complexes for effective binding of fluorine-18, towards next generation PET (positron emission tomography) imaging agents in medicine.

REPORTS OF RSCHG ONLINE LECTURE SERIES

Discovery of Sodium Cromoglycate (Intal) – Robert Slinn (September 2022)

This talk highlighted the history of Fisons Pharmaceuticals Ltd (previously Bengers) and the discovery there in 1965 of the 'blockbuster' anti-asthma drug Sodium Cromoglycate (INTAL), along with the story of one remarkable man, Dr Roger Altounyan, its discoverer. Roger, a physician and lifelong chronic asthma sufferer, discovered (along with Fisons Pharma researchers) this life-saving drug Sodium Cromoglycate (FPL 670) following a period of eight years research at Bengers and Fisons Pharmaceuticals, then located in Holmes Chapel, Cheshire. Its chemical synthesis, structure and clinical pharmacology were determined collaboratively by Fisons chemists and pharmacologists at Holmes Chapel and then later confirmed at their new research laboratories at Loughborough in Leicestershire. Roger had accomplished this feat in his own clinics following years of self-experimentation (as a human 'guinea pig'), inhaling numerous compounds including Khellin (an active ingredient from the Khella plant), taken well in advance of an asthma attack. Over a period of some eight years, testing ninety prepared compounds a year, Roger and Fisons Pharma found that FPL 670, one of the synthesised chromone derivatives, was pharmacologically very active. Sodium Cromoglycate (or Disodium Cromoglycate) was originally marketed as an oral anti-asthmatic, anti-inflammatory/anti-allergy drug (trademark Intal), and is still used nowadays in eye drops (Opticrom) and in nasal drops (Rhinacrom) for hay fever and allergic rhinitis. Roger then also developed the Spinhaler, the propeller-driven dry-powder drug inhaler in order to self-administer Intal.

History and Practice of Scientific Glassblowing from the Viewpoint of Glassblowers Ayako Tani and John Liddell (October 2022)

This talk provided an overview of scientific glassblowing in the UK, introducing the history of glassblowing. Being trained in glassblowing in Sunderland and recently transferred to the University of Glasgow, Ayako Tani has closely observed the history of British Pyrex and the glassblowers in this region and beyond. Sunderland had been one of the most prominent UK centres of scientific glassblowing, partly due to the presence of the James A. Jobling Ltd. Pyrex factory. After the downturn of the heavy industry in the 1970s, many scientific glassblowers applied their skills to ornamental work, chiefly the glass ships in bottles.

Life on the Edge: Chemistry and Inuit Life and Culture - Geoff Rayner-Canham (November 2022)

The Canadian Inuit live in some of the harshest environments on the planet. In fact, the northern thirty-five percent of Canada is Inuit lands. How do the Inuit survive? How do the Inuit thrive? The answers lie in chemistry! In this presentation, Geoff looked at different aspects of Inuit life in a chemistry context. In addition to describing the crucial importance of snow and ice, he surveyed the unique protein-fat based traditional diet, the Inuit use of traditional composite materials, the sources of metal for the Inuit woman's ulu knife, the pharmacologically-active plant-based remedies, and the ever-ingenious incorporation of chemical modernity into Inuit life.

The Chemistry of Christmas – Peter Morris (December 2022)

This talk discussed chemical aspects of the festive season including the silvering of Christmas tree baubles, the snap in Christmas crackers, party poppers and the composition of indoor fireworks. Just five days before Christmas, the audience was able to find out more about the interplay between chemistry and Christmas.

Historical Group Online Lecture Series on the History of Chemistry

Revolution and Reaction: Politics and Chemistry – Victor Boantza (September 2022)

The Chemical Revolution of the late eighteenth century is still widely considered the wellspring of modern chemistry. This lecture presented key aspects of this reformation in chemical theory, method and language by focusing on two of its most iconic protagonists, Joseph Priestley (1733–

1804) and Antoine Lavoisier (1743–1794), and their respective cultural and political backgrounds.

Chemistry in the Mid-Eighteenth Century - John Powers (October 2022)

This journey through chemistry in the mid-eighteenth century began in 1720s Leiden, where the Dutch Professor of medicine and chemistry, Herman Boerhaave (1668-1738), was reforming the way chemistry was taught and using his new thermometer, crafted by Daniel Fahrenheit (1686-1736), to unlock the secrets of fire. The talk then moved to Halle to see Georg Stahl (1659-1734) developing his phlogiston theory, and took a jaunt over to Paris to watch Etienne-François Geoffroy (1672-1731) develop his table of chemical affinities. Finally, it sailed across the channel to observe how all of these traditions came together in Scotland through the work of William Cullen (1710-1790) and Joseph Black (1728-1799).

Where were Women in Chemistry in the 1600s? – Michelle Di Meo (November 2022)

Where were women in chemistry in the 1600s? The answer might not be what you think! While previous historical accounts purported that women were excluded from practising early science due to limited educational opportunities and an inability to participate in professional institutions, recent research suggests that there were more opportunities for women than previously realised. This talk gave an overview of women's scientific practices across the seventeenth century – a supposed turning point for when chemistry became modernised and women were excluded from the field. By contrasting the remarkable lives of two prolific women scientists of the seventeenth century - Lady Margaret Cavendish (1623-1673) and Lady Katherine Ranelagh (1615-1691) – the talk revealed two opposing pathways for women who worked with the Founding Fellows of the Royal Society. Based on these two women's biographies, Michelle offered a reflection on how early modern social conventions have made it challenging for historians today to find evidence of and to recreate these women's untold stories.

FUTURE WEBINARS, MEETINGS AND CONFERENCES

Society for the History of Alchemy and Chemistry Webinars

The next SHAC webinar will be live on Zoom on Thursday 19 January 2023 beginning at 5.00pm GMT (6.00pm CET, 12 noon EST, 9.00am PST). The format will be a talk of twenty to thirty minutes, followed by a moderated discussion of half an hour. Anyone, member of SHAC or not, may attend with registration via Eventbrite. Please check www.ambix.org and SHAC social media for updates on speakers and subjects.

International Conference on the History of Chemistry

The 13th International Conference on History of Chemistry (13ICHC) organized by the EuChemS Working Party on the History of Chemistry (WPHC) will be held in Vilnius, Lithuania, on 23-27 May 2023. For further information on the conference please visit: https://www.ichc2023vilnius.chgf.vu.lt/

The timescale for the conference is as follows:

Revised deadline for submitting proposals for the conference: 9 January 2023

Notification of acceptance: January 2023

Provisional programme: Early February 2023

Final programme: April 2023

Grants to support attendance at ICHC13 in Vilnius, May 2023

Applicants are invited to apply for grants under a Special Award Scheme from the Society for the History of Alchemy and Chemistry (SHAC) to support attendance of early-career scholars and independent scholars at the 13th International Conference on the History of Chemistry in Vilnius, Lithuania, on 23 May to 27 May 2023. Awards of up to £400 will be made as a contribution towards the cost of travel, accommodation, and registration fees for those giving a paper at the conference. Applicants must be members of the Society for the History of Alchemy and Chemistry in good standing at the time of making an application and if successful through the period of the award. For more information and application forms please contact grants@ambix.org .The deadline for applications to this Award Scheme is **28 February 2023**. It is expected that applicants will be advised of the outcome of their application in time to register for early-bird conference fees which are available until **1 April 2023**. See www.ambix.org for further information.