



9th ICHC

The 9th International Conference
for the History of Chemistry

Uppsala, Sweden
21-24 August 2013

Programme

Wednesday
21 Aug

18.00 Registration and Reception
at Museum Gustavianum

Thursday
22 Aug

Hall A – Museum Gustavianum

Hall B – Universitetshuset, lecture
theatre 8

08.30-08.55 Registration

09.00-09.45 **Keynote lecture 1** (Chair: Hjalmar Fors):
*Uncovering and trading secret materials
in the 17th century, or, How to make the
Bologna stone*
Lawrence Principe, Johns Hopkins
University, USA

09.45-10.15 Coffee

**Session 1: Objects and the philosophy of
chemistry** (Chair: Carsten Reinhardt)

Session 2: 20th century physical chemistry
(Chair: Gábor Palló)

10.15-10.45 *The non-discovery of elements in the 19th
century*
Anders Lundgren, Uppsala University,
Sweden

The early history of electrokinetics
Staffan Wall, University of Gothenburg,
Sweden

10.45-11.15 *Radicals: Between Matter and Substance*
Klaus Ruthenberg, Coburg University of
Applied Sciences and Arts, Germany

*Is Paul Walden really the discoverer of
Ionic liquids?*
Gisela Boeck, University of Rostock,
Germany

11.15-11.45 *Controversies about atomism as a tool in
chemistry teaching*
Maria Elisa Maia, FFCUL, Portugal

*Bragg's law and the birth of chemical
crystallography*
Fabio Pichierri, Tohoku University, Japan

11.45-12.15 *Krausism, a German philosophy for a
Spanish chemistry*
Jordi Mora-Casanova, Universitat
Autònoma de Barcelona, Spain

*Radiumwünsche: A Material
Reassessment of the Rise of the Nuclear
Sciences in Weimar*
Xavier Roqué, Universitat Autònoma de
Barcelona, Spain

12.15-13.45 Lunch

Thursday
22 Aug
(cont.)

Hall A – Museum Gustavianum

13.45-14.30 **Keynote lecture 2** (Chair: Karl Grandin):
The invisible heritage: Increasing relevance and use of material sources in the history of science
Marta Lourenço, University of Lisbon, Portugal

Session 3: Environmental chemistry
(Chair: Geert Vanpaemel)

14.40-15.10 *From good to harm: General Motors' and DuPont's Engagement of developing, producing and banning Chlorofluorocarbons*
Heinrich Kahlert

15.10-15.40 *Energy dilemma in the early 20th century: the chemist's point of view.*
Marco Taddia, University of Bologna, Italy

15.40-16.10 *Solvay's struggles to defend its CFC market*
Ernst Homburg, Maastricht University, The Netherlands

16.10-16.40 Coffee

16.40-17.10 *The scientific development of Green chemistry*
J.A. (Arjan) Linthorst, Utrecht University and Maastricht University, The Netherlands

17.10-17.40 *The Cadmium Poisoning in Japan: The Case of Itai-itai Disease and Beyond*
Masanori Kaji, Tokuo Institute of Technology, Japan

17.45- Meeting of the The Working Party (WP) **on History of Chemistry** of the European Association for **Chemical** and Molecular Sciences (EuCheMS)

Hall B – Universitetshuset, lecture theatre 8

Session 4: Material culture in early modern chemistry (Chair: Pierre Laszlo)

Exhibiting Chemistry: Material Culture, the Museum and the Display of Early Chemistry
Stephen Johnston, University of Oxford, UK

Vesuvius as Testing Bench for Chemical Materials and Theories
Corinna Guerra, Istituto Italiano per gli Studi Storici, Italy

A Vanishing Flame: The Transformation of the Concept of Fire as an Agent in the Pre-Lavoisian Chemistry
Wenjing Li, Chinese Academy of Social Sciences, China

Reconstructing 16th century distillation
Fredrik M. Kirkemo, Norwegian University of Science and Technology, Norway

Reproducibility of eighteenth century recipes of Potable Gold
Joaquín Pérez-Pariente, Instituto de Catálisis y Petroleoquímica (CSIC), Spain

Friday
23 Aug

Hall A – Museum Gustavianum

Session 5: Discipline building and discipline busting (Chair: Xavier Roque)

09.00-09.30 *Emergence of a science of supramolecular systems at the University of Strasbourg (1961-2011)*

Marianne Noël, Université Paris-Est, France

09.30-10.00 *José Casares and the circulation of material culture between textbooks and laboratories.*

Ignacio Suay-Matallana, University of Valencia, Spain

10.00-10.30 *The Discipline Busters: Molecular biology, Rockefeller Foundation and Karolinska Institutet*

Olof Ljungström, Karolinska Institutet, Sweden

Hall B – Universitetshuset, lecture theatre 8

Session 6: Sites of innovation and production (Chair: Peter Morris)

Technology, Economics, Materials and Science: The Rise of Petroleum Chemistry in the United States

Stephen J. Weininger, Worcester Polytechnic Institute, USA

On the history of the development of chemical science and industry in Russia in the first decades of the XX century: innovation activities of the Ledentsov's society.

Elena A. Zaitseva (Baum), Moscow State University, Russia

Acid Towers and Weldon Stills in Leblanc Widnes

Peter Reed, UK

10.30-11.00 Coffee

Session 7: Technologies of visualisation (Chair: Annette Lykknes)

11.00-11.30 *Amedeo Avogadro and the chemistry of colours: a case of privilege*

Mariachiara Di Matteo, University of Pisa, Italy

Session 6. (cont.)

Two Centuries of Chemistry and Chemical Technology in Japan: A Perspective from the "Chemical Heritage of Japan" Project
Masao Uchida, Wako University, Japan

11.30-13.00 Lunch

13.00-13.45 **Morris Award lecture** (Chair: Otto Sibum): *Mine, thine, and ours: Collaboration and the material culture of the 20th Century Chemical Laboratory*
Mary Jo Nye, Oregon State University, USA

13.45-14.15 **Morris Award Reception** at Museum Gustavianum

14.30-15.00 Session 7. (cont.)
Nineteenth century medical photography as physical-chemical inquiry: a collaboration between physicians and photographers
Maria Estela Jardim, University of Lisbon, Portugal

Session 6. (cont.)
Survey of Chemical Sites of Hungary – Results Achieved So Far and Plans for the Next Steps
Éva Vámos, Hungarian Chemical Society, Hungary

15.00-15.30 *Rembrandt's chemist: AP Laurie and the public science of art*
Geert Vanpaemel, KU Leuven, The Netherlands

Session 8: History of laboratories (Chair: Steve Weininger)

Resource and Site: Vitamin C from Paprika
Gábor Palló, Budapest University of Technology and Economics, Hungary

15.30-16.00 Coffee

Friday
23 Aug
(cont.)

Hall A – Museum Gustavianum

- 16.00-16.30 *Periodic comparison of two caftans by non-destructive and micro analysis methods in the Topkapi Palace Museum*
Recep Karadag, Marmara University, Turkey
- 16.30-17.00 Excursion to The Svedberg's Ultracentrifuge (Limited number of participants)

Hall B – Universitetshuset, lecture theatre 8

- Between Natural History and Natural Philosophy: Torbern Bergman's Chemical Laboratory*
Marco Beretta, University of Bologna, Italy
- The laboratories used by Guldberg and Waage*
Bjørn Pedersen, University of Oslo, Norway

- 19.00 Conference dinner at Orangeriet, Botanical Garden (Optional in registration)

Saturday
24 Aug

Hall A – Museum Gustavianum

- 09.30-10.00 **Late announced lecture**
(Chair: Anders Lundgren)
The Industrialization of Death: The Building of the US Chemical Warfare Service 1917-1920
Andrew Ede, University of Alberta, Canada
- Session 9. Material culture around the chemical revolution**
(Chair: Marco Beretta)
- 10.00-10.30 *Elements in the Melting Pot: Merging chemistry, assaying and natural history, c. 1730-1760*
Hjalmar Fors, Uppsala University, Sweden

Hall B – Universitetshuset, lecture theatre 8

- Session 10. Materials in the 20th and 21st century (CHMC)**
(Chair: Brigitte van Tiggelen)
- High Performance Liquid Chromatography and Chemical Practice; the effects of automated high-speed separation in analysis*
Apostolos Gerontas, Norwegian University of Science and Technology, Norway
- How did clays affect the history of chemistry*
Pierre Laszlo, University of Liège, France

- 10.30-11.00 Coffee

- 11.00-11.30 *Backbones of Productivity: Fertilizer, Writing Paper and Ink in the Netherlands, 1780-1815*
Andreas Weber and Joppe van Driel, University of Twente, The Netherlands
- 11.30-12.00 *What Sir Humphry Davy said in 1824, cathodic protection and the relation to Norway*
Finn Øivind Jensen, Norway

- Mastering Nature: the long route to the Navelbine or a story of a university - industry cooperation*
Muriel Le Roux, CNRS, History of Science and Technology, France
- The chemist and the cellulosic plastics - when breaking up is not so hard to do*
Anita Quye, University of Glasgow, UK
- Commentator: Ernst Homburg

- 12.15-18.00 Lunch and Excursion to Stockholm (Optional in registration)

Oral presentations

Between Natural History and Natural Philosophy: Torbern Bergman's Chemical Laboratory

Marco Beretta

(University of Bologna)

For a long time Lavoisier's laboratory in Paris has been regarded by historians as an exceptional case which owed its fame more to the financial resources of the French chemist than to a generalized need of a comprehensive innovation in both the architecture and the chemical apparatus. That this was not the case is shown by an examination of the features of Torbern Bergman's chemical laboratory in Uppsala which antedates that of Lavoisier of more than a decade. This interesting site reflects the efforts to introduce new analytical techniques as well as new standards of precision. It is not therefore surprising that Bergman combined in his teaching and in the laboratory practice with the use of new apparatus, partly coming from natural philosophy and partly from mining. In my presentation I shall explore the sources of Bergman's design of his chemical laboratory and its main characteristics.

Is Paul Walden really the discoverer of Ionic liquids?

Gisela Boeck

University of Rostock, Institute for Chemistry, Germany

Recently thousands of research papers and also special programs like the DFG-SPP1191 deal with Ionic liquids (ILs). This class of salts shows an increasing scientific interest based on its many applications in electrochemical, analytical, synthetic and engineering fields.

Within the first part of the paper ILs will be characterized and discussed if the definition as molten salts or as salts with melting points below 100 °C is sufficient. Consequently, the input of Paul Walden (1863-1957) will be described, since in many related papers it is often mentioned that he is the discoverer of ILs [1].

Walden investigated the electric conductivity and viscosity of salts and was greatly influenced by Wilhelm Ostwald (1853-1932) and his scholar Carl Schall (1856-1939), who enlarged the panoply of quaternary ammonium iodides by homologues alkyl-cholinium triiodides with low melting points [2]. Already in 1905 Walden determined the conductivity of the ‘lovey’-electrolyte ($\text{Et}_4\text{N}^+\text{I}^-$) and described in 1914 a few liquid alkylammonium nitrate salts [3]. His plot of electric conductivity vs. inverse viscosity is still in use as a criterion of ‘good’ and ‘bad’ ILs. However, he did not introduce the term ‘Ionic liquids’ and was not aware of the broad applicability of these compounds.

Other materials with a melting point below 100 °C and a constitution by ions were also described, e.g. in the mid-19th century the ‘red oil’ in connection with Friedel-Crafts reactions, low melting mixtures of copper-(I)-chloride and alkylammonium chlorides in the 1960s and eventually ‘liquid clathrates’ in the 1970s. All these substances differ from those investigated during the development-boom in the last 50 years, which started with the trails by the U.S. Air Force Academy to replace LiCl-KCl molten salt electrolytes in thermal batteries.

Summarizing, it will be shown, that two main questions still exist:

- What is an IL?
- What are the preconditions to be the *discoverer* of a new class of substances?

1. For example: Natalia V. Plechkova, Kenneth R. Seddon, Applications of ionic liquids in the chemical industry, in: *Chemical Society Reviews* 37 (2008) 123-150; Peter Wasserscheid, Tom Welton (ed.), *Ionic liquids in synthesis*, Vol. 1, Weinheim: Wiley-VCH 2008, p. 1-6.
2. Carl Schall, Über organische und geschmolzene Salze (Eine Leitfähigkeitsstudie), in: *Zeitschrift für Elektrochemie* 14 (1908), 397-405.
3. Paul Walden, Ueber die Molekulargroesse und elektrische Leitfähigkeit einiger geschmolzenen Salze, in: *Bulletin de l'Académie Impériale des Sciences de St.-Petersbourg*, 1914, 405-422.
4. Gleb Mamantov, Molten salt electrolytes in secondary batteries, in: *Materials for Advanced Batteries* (ed. D. W. Murphy, J. Broadhead, B. C. H. Steele), New York: Plenum Press 1980, p. 111-122.

Amedeo Avogadro and the chemistry of colours: a case of privilege

Mariachiara Di Matteo

University of Pisa, Italy

As recent historiography has shown, Amedeo Avogadro, acclaimed for the formulation of the renowned hypothesis that took his name in 1811, paid great attention to technological development and to the material culture of his time. Indeed, as member of the Turin Academy of Sciences (to which he was admitted in 1819), Avogadro was involved in many of the activities under the responsibility of the city's institutions. In particular, he dedicated a considerable amount of time to examining requests for privileges and patents sent to the state secretary of the Kingdom of Sardinia, as the Academy was called upon to express technical advice on such requests, availing themselves of the expertise of their members through specially appointed commissions.

These commissions evaluated the possibility of issuing patents on the basis of theoretical-technical parameters, examining both the descriptions of the discoveries, the machines or the methods proposed by the applicants and the scale-models and samples of the product that were presented together with the aforementioned requests.

The case here described is the request for privilege presented by Giovanni Ubertino for the composition of mineral colours, in June 1825, examined by Avogadro (compiler of the report) and by Vittorio Michelotti.

The study of colourants is part of a long period of examinations that lasted throughout the 18th century, yielding interesting results, and that continues to be particularly active also in the 19th century, as archive sources demonstrate.

References

1. Unpublished archive materials stored within Accademia delle Scienze di Torino, Archivio storico, Categoria V, Attività Scientifiche.
2. Ciardi, Marco. "Amedeo Avogadro's concept of the atom: some new remarks." *Ambix* 48, no.1 (March 2001): 17-24.
3. Ciardi, Marco. *La fine dei privilegi. Scienze fisiche, tecnologia e istituzioni scientifiche sabaude nel Risorgimento*. Firenze: Leo S. Olschki, 1999.
4. Ciardi, Marco. "Theory and technology: the Avogadro manuscripts at the Turin Academy of Sciences." *Nuncius* 13, no.2 (1998): 625-656.
5. Dolza, Luisa. "«A vantaggio di pochi e a danno evidente di molti»: Amedeo Avogadro, la tecnica e i privilegi in Piemonte nella prima metà dell'Ottocento." In *Il fisico sublime. Amedeo Avogadro e la cultura scientifica del primo Ottocento*, edited by Marco Ciardi, 75-92. Bologna: Il Mulino, 2007.
6. Dolza, Luisa and Liliane Hilaire-Perez. "Inventions and privileges in the eighteenth century: norms and practices: a comparison between France and Piedmont." *History of technology* 24, (2002): 21- 44.
7. Dolza, Luisa. "How did they know? The art of dyeing in late-eighteenth century Piedmont." In *Natural Dyestuff and industrial culture in Europe, 1750.1880*, edited by Robert Fox and Augustin Nieto-Galan, 129-159. Canton Ma: Science History Publications, 1999.

The Industrialization of Death: The Building of the US Chemical Warfare Service 1917-1920

Andrew Ede

University of Alberta, Edmonton, Canada

The American response to the introduction of chemical warfare was initially one of confusion as different groups in the military, federal government and scientific community tried to assess and respond to the new form of combat. In 1917, on advice from William Henry Welch, president of the National Academy of Sciences, President Wilson ordered the amalgamation of chemical warfare research and development into one organization, the Chemical Warfare Service (CWS). This presentation traces the massive effort by the CWS to create chemical weapons on an industrial scale, particularly the development of the Edgewood Arsenal, which went from farmland to become the single largest production facility for of chemical weapons in the world in less than two years.

High Performance Liquid Chromatography and Chemical Practice; the effects of automated high-speed separation in analysis

Apostolos Gerontas

Dept. of Chemistry, Norwegian University of Science and Technology

The analytical practice in chemistry has undergone significant changes since the early 1930s, a fact that has led scholars to describe these changes as revolutionary. The modern chemical analyst, now dealing with expensive ultra-sensitive, accurate and “off-the-shelf” instrumentation is less of a scientist involved with chemical separations than in the recent past, and more a “detector” and interpreter of the physical properties of chemical substances and a manager of research resources (materials, instrumentation, personnel). High Performance Liquid Chromatography (HPLC) has played a significant role in this procedure of shifting the focus of the analytical practice from the separation of substances to the physical properties determination by gradually becoming during the last decades the most commonly met tool of chemical separation. This paper attempts to bring into the fore the meteoric growth of share of this instrumentation during the 1970s and relate this growth to the shifts of practice in analytical chemistry of the period. Aim is to document the direct effects that research over biological material and the explicit needs of the pharma sector had over the overall chemical practice through the creation and the dissemination of the HPLC technique. The story is located at the dawn of the biotechnological era and can be used as an exemplary case for the contribution of the chemical research-technologies in the establishment of bridges between chemistry and biology which are taken today almost as granted.

Vesuvius as Testing Bench for Chemical Materials and Theories

Corinna Guerra

Istituto Italiano per gli Studi Storici, Naples
University of Bari, Italy

I wish to show how the explosions of Mount Vesuvius constitute a noteworthy object in the public perception of chemistry. By exploring the various uses of chemical knowledge in this context, I wish to show the importance of observing how scientific ideas were debated and popularized during the Enlightenment.

Following the publications on A. L. Lavoisier, the chemistry of the late 18th century went through a significant theoretical change and I wish to show how this transition from one knowledge system to another formed an interesting backdrop to the ways in which scientific information was accepted or understood by the public or government officials.

The aim is to explore the relationship between both local and foreign chemists and Vesuvius, and to show how the volcano became a source of corroboration for the theories expounded by the so-called new chemistry. By analyzing books and documents relating to volcanic areas, I would be able to list scholars, locations and methods of interpretation.

So the Mount Vesuvius, in the Kingdom of Naples, as volcano produced materials for chemical analysis, but at the same time it produced knowledge for the chemical community of Naples, because scholars were very busy in chemical debates after every phenomena of eruption.

In my opinion Neapolitan chemical studies were constructed as interest in chemical research above all by the description of volcanic reactions too. I will present the chemical sides of some papers about the Vesuvius activity, in particular of the eruption of the Summer 1794. In this way Vesuvius became a physical and mental site for chemical research.

References

1. Antonio Barba, 1794. *Ragionamento fisico-chimico sull'eruzione ultima del Vesuvio accaduta a' 15 giugno 1794*, Naples.
2. Chiosi Elvira, 2007. «Le visite del fuoco». Gli scritti sul Vesuvio, in *Tra res e Imago: in memoria di Augusto Placanica*, Mafrici Mirella, Pelizzari Maria Rosaria (ed.), 2 voll., Salerno, Rubbettino.
3. Ciarallo Annamaria, 2006. *Scienziati a Pompei tra Settecento e Ottocento*, Roma, L'Erma di Bretschneider.
4. Gasparini Paolo, Musella Silvana, 1991. *Un viaggio al Vesuvio: il Vesuvio visto attraverso diari, lettere e resoconti di viaggiatori*, Naples, Liguori.
5. Lavoisier Antoine Laurent, 1791. *Trattato elementare di chimica con nuovo metodo esposto dopo le scoperte moderne e con figure... tradotto in italiano per uso del corpo regale di artiglieria e del genio di Napoli*, 2 voll., trad. di G. La Pira G., L. Paris, Naples, Donato Campo.
6. Pitaro Antonio, 1794. *Esposizione delle sostanze costituenti la cenere vulcanica caduta in questa ultima eruzione de' 16 del prossimo passato Giugno del professore Antonio Pitaro dedicata al Signor D. Gaetano Maria La Pira Professore di Chimica del Corpo Reale*, Naples.
7. Tata Domenico, 1794. *Relazione dell'ultima eruzione del Vesuvio della sera de' 15 giugno*, Naples, Aniello Nobile.

Solvay's struggles to defend its CFC market

Ernst Homburg

Maastricht University

During the 1950s and 1960s the use of chlorofluorocarbons (CFC's) was booming. They were mainly applied in aerosols, and to a lesser extent as refrigerants and solvents. In 1963 the Belgian chemical multinational Solvay jumped on the band wagon and started the production of CFC's.

From 1974 onwards the bright prospects started to change, when the chemists Mario J. Molina and F. Sherwood Rowland published a paper on the destruction of stratospheric ozone by CFC's. Soon US government decided to ban CFC as propellants for nonessential aerosol sprays. When 1985 British scientists published their discovery of "a hole" in the ozone layer over the Antarctic, the issue became of true importance. At conferences in 1987, 1990, and 1992 in steps a total ban of CFC's by 1996 was decided.

The industry responded with a double strategy. On the one hand it emphasized the scientific uncertainties and lobbied for temporization and for a less stringent character of policy measures. On the other hand it embarked on research on alternatives for CFC's. In December 1987, sixteen of the leading CFC producers started the Programme for Alternative Fluorocarbon Toxicity Testing (PAFT). Also Solvay started research on HCFCs (hydrochlorofluorocarbons), the alternatives of the "second generation," that had a smaller impact on the ozone layer, as well as on alternatives of the "third generation": HFCs (hydrofluorocarbons) that contained no chlorine. During the early 1990s more than half of the research budget of the very broad alkalis sector was spent on research on halogenated organic chemicals alone.

Between 1992 and 1995 several new products were introduced to the market. It is one of the ironies of history that these HFCs had almost no impact on the ozone layer, but it soon appeared that they contributed to the Greenhouse effect, a public worry that had emerged in the meantime. In the paper Solvay's research in these areas will be analyzed against the background of the debates on ozone layer destruction and global warming.

Nineteenth century medical photography as physical-chemical inquiry: a collaboration between physicians and photographers

Maria Estela Jardim, Fernanda Madalena Costa*

CFCUL, CCMM, Faculdade de Ciências, Universidade de Lisboa, Portugal, *CCMM, Faculdade de Ciências, Universidade de Lisboa, Portugal

Since its invention in the nineteenth century, the photographic technique, itself the product of physical-chemical experimentation, was understood as the French astronomer Jules Janssen (1824-1907) called it, “the true retina of the scientist”. One of the first scientific applications of photography was in the field of medical sciences: associating a photographic camera to a microscope, the French physician Alfred Donné (1801-1878), obtained, since 1840, photomicrographs of human blood and mucus, which were published in a medical Atlas in 1845. Throughout the nineteenth century, medical photographs will be often obtained with the collaboration of renowned photographers, leading to a high value corpus of photographic iconography related to the practice, diagnosis and communication in medicine. The making of these medical images did benefit from the work of professional photographers who invested on the research of the chemistry of photographic emulsions, photomechanical techniques and instrumentation. Initially, the photographs were executed in photographic studios, but at the end of the nineteenth century, photographic laboratories were installed in hospitals and other medical institutions, integrating photography into their daily routine.

Some of these photographers are now an intrinsic part of the history of photography and medicine, among many others: the chemist Albert Londe (1858-1917), head of the photographic service at the *Hôpital de la Salpêtrière* in Paris, the photomicrographer Fernand Monpillard (1865-1937), who installed a laboratory in Paris, worked with several medical institutions and did research on the chemistry of colour photography, the brothers Felix Nadar (1820-1910) and Adrien Tournachon (1825-1903) who collaborated with the physician Duchenne de Boulogne (1806-1875), Georges Demeny (1850-1917), assistant to the physiologist Étienne-Jules Marey (1830-1904), who conducted with this physician research on how to capture and display moving images of the human body, making also the photographic analysis of the spoken word.

In Portugal, two of the most successful professional photographers, Augusto Bobone (1852-1910) and Emilio Biel (1838-1915) obtained radiographs at the initial period of the medical application of X-rays. Bobone, who worked with the physician Virgílio Machado (1859-1927), published in 1897, a monograph on the research and practice of radiography. Several other photographers collaborated with students of the Medical Schools (*Escolas Médico-cirúrgicas*) of Lisbon and Oporto, making photographs and photomechanical prints for their final thesis.

In this paper we will discuss the role of professional photographers in the evolution of photographic techniques and its relation to medical research and imaging.

References

1. Bobone, Augusto (1897). *Raios-X. Notas práticas de Radiologia sobre as primeiras investigações em Lisboa em 1896*. Lisboa, Livraria de António Maria Pereira
2. Monpillard, Fernand (1926). *Macrophotographie et microphotographie*. Paris, Gaston Doin et Cie

What Sir Humphrey Davy said in 1824, cathodic protection and the relation to Norway.

Finn Øivind Jensen

Vice president, Jotun (Retired)

Sir Humphrey Davy has been regarded as the inventor of cathodic protection all since he presented his first electrochemical experiments for the Royal Society in 1824. This paper will briefly outline the experiments behind Sir Humphrey David's discovery, or invention, and relate it to to-days practice.

Sir Humphrey Davy lived from 1778 till 1829 and became a well known chemist at the time. He worked with many different experiments and discovered potassium, among other things. He made, in 1824, a boat-trip to Norway to make a nearly full scale test program of his electrochemical findings. He visited many cities on his journey, including sailing against the stream on Glomma almost to the Sarpsfossen. The trip was made on the steamship "Comet", a paddle steamer which was one of the first steamships visiting Norway. The last stop in Glomma, Norway's largest river, was at Sannesund, which is where an anode foundry later was established. This foundry manufactures Zn and Al anodes for the ship and offshore industry, and is one of the most recognized anode manufacturer in the world.

The British Admiralty's ships had corrosion and wear of the copper sheeting that covered the underwater hulls. This copper sheeting should stop fouling, which was particular heavy on long journeys, but also to protect from ice and reefs. Sir Humphrey Davy had carried out electrochemical experiments of various metals, and postulated that if "protectors" were soldered to the Cu-sheeting, corrosion will be stopped. The experiments will be described, what he expected and what the results were. This will be linked to closer information about the trip itself, as described in a letter to his mother back in England.

Sir Humphrey Davy presented his results, his findings, and hopes as well as frustrations to the Royal Society in London in four papers :

22 January 1824

17 June 1824

9 June 1825

8 June 1826

The content of these papers will be discussed.

Finally, the outcome of Sir Humphrey Davis experiments and conclusions will be covered. His findings did not make the great success he hoped for, but the marine business has much to thank him for now, almost 200 years later.

Exhibiting Chymistry: Material Culture, the Museum and the Display of Early Chemistry

Stephen Johnston

Museum of the History of Science, University of Oxford

This paper reflects on the experience of planning a chemical exhibition. “Art of Fire: Alchemy and Technology in 17th-Century England” will open in Oxford in May 2014 and coincide with a conference on early-modern sites of chemistry.

The exhibition depends on the recent historiography of alchemy and on the renewed use of ‘chymistry’ as a term to overcome anachronistic oppositions between chemistry and alchemy in the early-modern period. The breadth of chymistry – as a term embracing the laboratory, the library, the lecture hall and the workshop – is particularly beneficial to the museum medium. While there have been exhibitions devoted to alchemical imagery, whether the graphic symbolism found in texts or the genre of painted works depicting the alchemist’s laboratory, material culture has not been so central to recent public display.

As a pre-eminently material science, it is ironic that museum presentations of chemistry have scarcely benefitted from the more general attention given to experiment and practice in the history of science since the 1990s. For the physical sciences and the mathematical arts, material culture has been successfully interpreted as instruments, apparatus and their use. This instrumental vision of material culture may offer useful perspectives for Lavoisier and, to an even greater degree, for the chemistry of the 20th century. But it does not work so well for the earlier chemical arts and sciences, where apparatus remained relatively stable, with similar vessels and furnaces recognisable from late antiquity to the end of the 18th century.

Apparatus can still have an important role, particularly through the analytical study of archaeologically recovered examples. But the exhibition will foreground other aspects of practice: the places of chymistry, its materials and its products. Focusing on the diversity of spaces for chymistry, from the princely court to the pharmacy, provides a rich framework. Substances and their transformations are now deeply unfamiliar and therefore surprising to lay audiences: for example, native silver and copper typically confound familiar expectations of sharp boundaries between the mineral and vegetable realms. Products also make for good displays. The artisanal dimension of chymistry can be effectively made visible through its manufactures: the glassware of George Ravenscroft, the ceramics of John Dwight and the proprietary remedies of numerous apothecaries all make clear the ways in which chemistry reached into commercial practice.

In displaying early-modern chymistry, the exhibition will also seek to make clear that a museum can be an illuminating, suggestive and indeed provocative medium for the history of chemistry.

From good to harm: General Motors' and DuPont's Engagement of developing, producing and banning Chlorofluorocarbons

Dr. Heinrich KAHLERT GOC+Partner GeoOptimizerConsulting (CH, Kreuzlingen)

Midgley[5] "*had more impact on the atmosphere than any other single organism in Earth's history.*"

*It's what makes South Florida habitable in the summer.
It's the one thing standing between us
and heat like nothing else
this side of hell.
In fact, it's a gas.
Freon.[18]*

Chlorofluorocarbon (CFC) is a fascinating compound to study several aspects appendent to this meeting: it is (still) used worldwide [6, 19], so the importance and relevance is obvious. It has a very strong cultural impact [18] –it makes Florida *habitable*- because nearly every western household was in contact several decades for using it in refrigerators, later on air-condition and as a very effective fire extinguisher material. It was a scientific challenge to synthesize, to develop (theoretical thermodynamic mixed with engineering aspects [14, 17]), to produce and to introduce shortly later these compounds into market [17]. Only a few companies were playing an important role, we want to focus on DuPont and GM. CFC is a synonym for “end of pipe” technology, an excellent example for non-sustainable agent and for non-holistic economic behavior. First, we want to show the cultural and economic impact of these chemical objects. Can we assign these substances to an inventor [20]? Then, can we explain who and when were the reasons to do scientific efforts to develop these compounds [1, 2, 17]? Which are the stakeholders, key players [1, 15]? Can we declare a special location as chemical heritage site [4, 19]? What about the fate of these compounds and their following chemical reactions with the environment especially to ozone [8, 11]? What are the political and cultural consequences of banning these stuffs worldwide [5]? Did the protocols hold their promise [6]? Last but not least: CFC is a certain kind of “historical lab experiment” example to demonstrate their impact in: history of chemistry [2, 6], history of technical chemistry [4, 16], invention and innovation history [3, 4, 17], economic history [15, 16], political ecology history [5], political history with their “ ‘regime theory’ and ‘game theory’ concepts” [5, 22].

The Belgian scientist F. Swarts [20] pioneered the synthesis of CFCs in the 1890s. He developed an effective exchange agent to replace chloride in carbon tetrachloride with fluoride to synthesize CFC-11 (CCl₃F) and CFC-12 (CCl₂F₂ later called FREON[®]) [6]. T. Midgley Jr. and A. L. Henne [13] improved the process of synthesis and led the effort to use CFC as refrigerant to replace ammonia (NH₃), chloromethane (“methyl chloride” CH₃Cl), and sulfur dioxide (SO₂), which are toxic, flammable or explosive but were in common use and could result in serious illness, injury or even death in the event of leakage from the system [2, 19]. The Frigidaire division of GM [2] (part of DuPont's “*glamorous stocks*” [16]), at that time a leading manufacturer of such systems, sought a non-toxic, non-flammable alternative to these refrigerants [7]. C. Kettering [1], the vice president of GM Research Corporation at that time, assembled a team (Midgley, Henne, McNary) to develop such a compound. The team soon narrowed their focus to alkyl halides (the combination of carbon chains and halogens), which were known to be highly volatile (a requirement for a refrigerant) [4] and also chemically inert [5, 13]. Since the 1940's the profession “icemen” was displaced by FREON and the refrigerators [2]. The CFC production increased between 1960 and 1974 of “150'000 to 800'000” [!] tones, mostly used in form of industrial solvent – a form which was not foreseen by Midgley. A lot of industrial branches were dependent on these substances, according to Ralph Downing, since 1982 retired of DuPont's “FREON lab” [19].

After the development of his electron capture detector [9], James Lovelock was the first to detect the widespread presence of CFCs in the air, finding a mole fraction of 60 ppt of CFC-11 over Ireland [8] and the Arctic and Antarctic. He concluded wrongly that CFCs are *not* hazardous to the environment. The experiment did however provide the first useful data on the presence of CFCs in the atmosphere. The damage caused by CFCs was discovered by Sherry Rowland and Mario Molina who, after hearing a lecture on the subject of Lovelock's work [10], embarked on research resulting in the first publication suggesting the connection in 1974 [11] – disembodying to Nobel prize of 1995. It turns out that one of CFCs' most attractive features -their low reactivity- is the key to their most destructive effects. CFCs' lack of reactivity gives them a lifespan that can exceed 100 years, giving them time to diffuse into the upper stratosphere. Once in the stratosphere, the sun's ultraviolet radiation is strong enough to cause the homolytic cleavage of the C-Cl bond [21].

In 1978 the United States banned the use of CFCs the beginning of a long series of regulatory actions against their use. The critical DuPont manufacturing patent for FREON was set to expire in 1979. In conjunction with other industrial peers DuPont sponsored efforts such as the "Alliance for Responsible CFC Policy" to question anti-CFC science, but in a turnabout in 1986 DuPont, with new patents in hand, publicly condemned CFCs [12]. DuPont representatives appeared before the Montreal Protocol urging that CFCs be banned worldwide and stated that their new HCFCs would meet the worldwide demand for refrigerants [12].

References

- [1] Biographical Memoir by Charles F. Kettering accessed 13.03.2013; Sloan, Alfred B. & McDonald, John, ed.: My Years with General Motors, Garden City, N.Y. (1964); Autobiography
- [2] Giunta, C.J.: "Thomas Midgley, Jr., and the invention of Chlorofluorocarbon Refrigerants", Bull. Hist. Chem. 31, (2006)
- [3] "Inventors" accessed 21.12.2012 <http://inventors.about.com/library/inventors/blfreon.htm>
- [4] Carlisle, Rodney: Scientific American Inventions and Discoveries, p. 351. John Wiley & Sons, Inc., New Jersey (2004).
- [5] McNeill, J. R. Something New Under the Sun: An Environmental History of the Twentieth-Century World New York: 421 pp, (2001); Sunderasan, S.: „Introducing Pro-environmental Behavior“, Enabling Environment, pp. 127-144, (2013)
- [6] Kauffman, George B.: "Frederic Swarts: 'Pioneer in organic fluorine chemistry' ", *J. Chem. Educ.*, 32 (6), p 301, (1955);
Kauffman, G. B.: "CFCs: On the 75th Anniversary of Their Introduction as Commercial Refrigerants by Thomas Midgley, Jr. (1889-1944)," *Chem. Educator*, 10, 211-220, (2005).
- [7] Sneader, W.: "Chapter 8: Systematic medicine". Drug discovery: a history. Chichester, England: John Wiley and Sons. pp. 74-87, (2005).
- [8] Lovelock, J.E.: "Atmospheric Fluorine Compounds as Indicators of Air Movements" *Nature* 230 (5293): 379. (1971).
- [9] Lovelock, J.E.: "A Physical Basis for Life Detection Experiments". *Nature* 207, 4997: 568-570, (1968).
- [10] Rowland, F. S. & Molina, M. J.: "[CFC-Ozone Puzzle: Lecture](#)". Retrieved 30.12.2012, (7.12.2000).
- [11] Molina, M.J. & Rowland, F.S.: "Stratospheric sink for chlorofluoromethanes: chlorine atom-catalysed destruction of ozone" *Nature*, June 28, (1974)
- [12] Smith B. "Ethics of Du Pont's CFC Strategy 1975-1995", *J. Bus. Ethics*, Vol. 17, Nr. 5, (1998), pp. 557-68
- [13] Midgley, T. Jr. & Henne A. L.: "Organic Fluorides as Refrigerants," *Ind. Eng. Chem.*, (1930), 22, 542-545
- [14] Midgley, T. Jr.; Henne, A. L.; McNary, R. R.: "Heat Transfer," US Patent 1,833,847, issued Nov. 24, (1931)
- [15] Leslie, S.W.: "Thomas Midgley and the Politics of Industrial Research" *Bus. Hist. Rev.*, (1980), 54, 481-503
- [16] Hounshell, D. A. & Smith, J. K. Jr., *Science and Corporate Strategy: Du Pont R&D, 1902-1980*, Cambridge University Press, Cambridge, (1988)
- [17] Midgley, T. Jr., "From the Periodic Table to Production," *Ind. Eng. Chem.*, (1937), 29, 241-244
- [18] Krasner-Khait, B.: "The Impact of Refrigeration" www.history-magazine.com/refrig.html accessed 18.3.2013 see also MARBELLA, J.: "The Stuff That Keeps Florida Cool":. *Sun-Sentinel*, 13.7.(1986)
- [19] Bert [Bernard Nagengast ?]: „Freon-Geschichte: Siebzig Jahre Sicherheit - Fluorkohlenstoff-Kältemittel die Geschichte einer Ära: 1929 bis 1999“, Publ. (1999) of DuPont in ASHRAE-Journal (Refrigerating Air-Conditioning Engineers) www.vhkk.org/vortrag/pdf/Freon-Geschichte_von_DuPont.pdf Retrieved 30.12.2012. Dayton and the Jackson labs of DuPont near Wilmington was the place of invention. The production started in the Chambers Works of DuPont at New Jersey. (1999)
- [20] Swarts, F. : "Étude sur le fluorochloroforme," *Bulletins de l'Académie royale des sciences, des lettres et des beaux-arts de Belgique*, 24, 474-484, (1892).
- [21] Blanksby S.J. & Ellison, G.B. : «Bond Dissociation Energies of Organic Molecules », *Acc. Chem. Res.*, Vol. 36, pp. 255-263, (2003)
- [22] Breitmeier; Helmut: *Wie entstehen globale Umweltregime? Der Konfliktaustrag zum Schutz der Ozonschicht und des globalen Klimas*, Opladen (1996); Young, Oran R.: *The Effectiveness of International Environmental Regimes. Causal Connections and Behavioural Mechanisms*, Cambridge, Massachusetts (1999);

The Cadmium Poisoning in Japan: The Case of Itai-itai Disease and Beyond

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Itai-itai disease is one of major heavy metal pollution-related diseases from 1960s Japan. The disease is characterized by severe pain, so it is called "itai-itai" disease because the Japanese word "itai" means "ouch" or "painful."

Itai-itai disease was first identified in Japan soon after World War II, in the Jinzu River basin in the Toyama prefecture in the Sea of Japan coast of the central Japan. A local medical doctor, an agricultural economist and an analytical chemist in collaboration with local farmers in the disease-riddled area, first showed that the disease must be caused by cadmium poisoning and that the source was the nearby Kamioka Mine of the Mitsui Mining & Smelting Co., Ltd., located upstream along the river.

Professors from a local university's medical school proved that this disease's victims usually suffered from kidney damage, a characteristic of high cadmium exposure, and often experienced serious bone damage, resulting in brittle bones. They also developed osteomalacia, a disease caused by calcium deficiency that is characterized by a softening of the bones, accompanied by pain and weakness.

The victims of Itai-itai disease sued the company in the mid-1960s and won the case in 1972. The company agreed to compensate the victims and treat the contaminated soil. It also signed a pollution control agreement, which allowed victims' groups to enter and inspect the mine and factories at the company's expense and to demand appropriate measures to prevent subsequent pollution. Victims and lawyers, with scientists' cooperation, conducted a complete inspection of the mine every summer beginning in 1972. The 40-year period of continuous inspections and negotiations greatly reduced pollution outflow and improved mining facilities.

Using the case of Itai-itai disease, a rare case of successful pollution control in Japan, the paper looks at experts' role in technology-related problems and shows the significance of victims' participation and collaboration in solving techno-environmental problems.

References

Masanori Kaji, "Role of experts and public participation in pollution control: the case of itai-itai disease in Japan," *Ethics in Science and Environmental Politics*, **12** (2012): 99-111.

Periodic comparison of two caftans by non-destructive and micro analysis methods in the Topkapi Palace Museum

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Ottoman textiles reached their zenith in the 16th century. The wide use of textiles in furniture, home textiles and clothing displayed the wealth of the Ottoman court. Textiles used for clothing were made out of silk, silver and gold threads. Caftans were crafted either with gold threads, silver threads or with both gold and silver threads. The caftans were dated as 16th and 18th century. But, designs of the caftans have been same features (characteristics). One of them was dated 16th century, others was dated 18th century by art historians. That's why, the caftans were investigated by non-destructive and microanalysis methods for compare in the Topkapi Palace Museum. Multi analytical techniques were used for the analyses.

In this work, dyestuffs analyses, technical analyses, weaving analyses, metal analyses and colour measurements of the 16th and 18th century Ottoman silk caftans were done. The Ottoman caftan samples were provided from Topkapi Palace Museum collection. An analytical method based on reversed phase high performance liquid chromatography with diode array detection (RP-HPLC-DAD) was utilized for the identification of dyestuffs in the objects. Extraction from samples were carried out with HCl /methanol/water (2:1:1) solution. Colour data for historical textiles were measured with CIEL*a*b* spectrophotometer/colorimeter. The surface morphology and chemical composition the caftans were investigated by scanning electron microscopy (SEM) equipped with energy-dispersive X-ray spectroscopy (EDX). Technical analysis was determined by optical microscope. Optical microscope was used for weaving analysis. Then, obtained data was compared for two caftans. According to the analyses results, the caftans can be same period.

References

1. Karadağ, R. (2013). Applying the Techniques Materials I (Identification of Natural Dyes by RP-HPLC-DAD and Natural Dyeing Procedures. *Conservation Science for he Cultural Heritage (Application of Instrumental Analysis)*. Varella, E. A. (Ed) Springer-Verlag (sf 172-186). Berlin Heidelberg
2. Karadağ, R., Yurdun, T. & Dolen, E. (2010). Identification of Natural Red Dyes in 15-17th Centuries Ottoman Silk Textiles (Kaftan, Brocades, Velvets and Skullcaps) by HPLC with Diode Array Detection. *Asian Journal of Chemistry*. Sayı 9. Cilt 22 sf 7043-7056
3. Yurdun, T., Karadağ, R., Dolen, E. & Mubarak, M. S. (2011). Identification of natural yellow, blue, green and black dyes in 15-17th centuries Ottoman silk and wool textiles by HPLC with Diode Array Detection. *Reviews in Analytical Chemistry*. Sayı 1. Cilt 30 sf 153-164

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Reconstructing 16th century distillation

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This is a story describing the construction and use of a distilling furnace as described and depicted in a 1569 edition of *Kreuterbuch*¹, published by the German physician and botanist, Adam Lonicer (1528-1586). Our reconstruction is part of the interdisciplinary MUBIL (Museum and Library – a digital laboratory) project.²

Lonicer's *Kreuterbuch* is a lavishly illustrated herbal, in which distillation is a central theme. Considering the early Western European history of distillation and the fact that distillation has been, and still is, at the heart of both alchemy and chemistry, a full-scale reconstruction of distillation processes from the 16th century is, in our opinion, an interesting endeavour. With the aid of specialized craftsmen and -women from the University's workshop we were able not only to reconstruct the furnace, but also the equipment and glassware needed to reproduce the distillation techniques of the Renaissance. In addition to investigate the equipment and techniques' efficiency with some modern methods, we had ample opportunity to experience the synergetic effect of working with texts in parallel with the actual reconstruction. The methodology of reconstructing historical equipment and experiments in alchemy and chemistry has showed promise in several studies in history of science³. As Martínón-Torres has pointed out⁴, there is "a slant in practice-oriented studies towards the metallurgical aspects of alchemy that leaves much room for research on the practical aspects of iatrochemistry". Robert Anderson has clearly demonstrated⁵ that the archaeological record of historical distillation has a great potential in complementing the written records. In our humble opinion, the form of reconstruction we describe here could also have a place in the further study of distillation in the history of chemistry and alchemy.

References

1. A digital version is available at <http://www.ntnu.no/ub/spesialsamlingene/ebok/kreuterbuch.html>
2. For more information see <http://www.ntnu.no/ub/omubit/bibliotekene/gunnerus/mubil>
3. Essays in Holmes, F. L. and Levere, T. H. 2002. *Instruments and Experimentation in the History of Chemistry*. The MIT Press, London.
4. Martínón-Torres, M. 2011. Some Recent Developments in the Historiography of Alchemy. *Ambix* **58** (3). pp 215–37
5. Anderson, R. G. W. The Archaeology of Alchemy. In Holmes and Levere (*Op. Cit.*)

How did clays affect the history of chemistry

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Clay minerals, ubiquitous features in the landscape, have accompanied mankind since its origins. Archeologists routinely excavate pieces of ceramics, which provide information on the life led by our ancestors. Moreover, many a theory about the origin of life itself implicates clays, as catalysts, templates or precursors of nucleic acids in storing genetic information (Cairns-Smith). Writing appeared, several millennia ago, as signs inscribed on baked clay tablets. Protochemists and alchemists used clay utensils — ovens and crucibles — in the smelting of metals and in many other transformations. During the Renaissance, the French potter Bernard Palissy, who had a role in the onset of experimental science and who probably interacted with Francis Bacon, conceived a whole theory for the water cycle, in which clays had an important role, in creating underground reservoirs of water. The impermeability of clays makes them excellent at preserving different classes of objects, from corpses to radioactive or toxic wastes, a topic of much current interest. Clays are natural polyelectrolytes, which led to their use as ion exchangers. During the nineteenth century and the early twentieth century, this property became used for water softening, in supplies to major cities. At the turn of the twentieth century, fuller's earth — the traditional term for natural clays of the montmorillonite family — found a novel use for catalysing cracking of crude oil into gasoline and other light fractions. Clays were the prototypes for layered materials. Their seemingly indefinite ability at swelling, from incorporation of water (and other) molecules in their interlamellar space, accounts for their plasticity. Man-made plastics have copied this feature of a natural material. The *intégron argileux* concept (Jacques Thorez) expresses the remarkable self-similarity of clays over many orders of magnitude, from nanometers to kilometers. Contemporary chemistry continues to use clays, natural, modified or synthetic, for many applications: superconducting ceramics; catalysis of important organic chemical reactions, are but two important examples.

The talk will consist of an overall panorama as the introduction; followed by focus on a single aspect of the impact of clays on the history of chemistry.

Mastering Nature : the long route to the Navelbine or a story of a university - industry cooperation

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Dealing with the history of the chemistry of natural substances from the beginning of the 1960s to the present time shows that it is not an evident historical object comparing this topic with the history of the biotechnology. This part of chemistry seems too much hybrid, too connected to biology... But, in this presentation, considering the genesis of three anti-cancer pharmaceuticals, I will focus on the process or the interaction, which links academics and industrialists all together, in the quest and the competition in producing new anti-cancer remedies. Pierre Potier, an academic belonging to the most important research organism in France - the CNRS -, discovered Navelbine, hemisynthesis of Taxol and Taxotère. There were developed for the first drug by the French pharmaceutical company Les Laboratoires Pierre Fabre and for the last ones by Rhône-Poulenc-Aventis-Sanofi.

What still strikes historian's mind, despite one century or so separating the story of one the remedy – Navelbine - and the story of the vegetal dyes are the similarities that emerge from historical approaches. During the 19th century, moving from vegetal dye to synthetic dye was not only the result of the emergence of science-based industry, but also the results of the evolutions of in-house practices and of the knowledge inherited from vegetal dye. Because contemporary history of pharmaceuticals is complicated, depending heavily on the efforts of journalists and of the more self-aware participants, it is not so obvious to enlighten the invariants, which characterize the culture of the chemists' community. As it was the case for the synthetic dye, the anti-cancer drugs issue from a reciprocation to go to and fro between academic world and industries of ideas, knowledge, people, raw materials, semi-products, proceedings and even, in this case, patents.

Is the chemistry of natural substances as an academic pursuit, a “public good” compromised by the hopes of private gains that attend its commercial sponsorship and exploitation? If the story can exemplify how complex is this space of research, linking public and private spheres where the final product is the result of a co-construction of knowledge, I will argue in this presentation that very far of being original, natural substances belong to chemistry. I will explain how a common material culture of the laboratory has lead to a fuzzy world, which is a pharmaceutical firm since the 1990s.

1. François Caron *La dynamique de l'innovation, changement technique et changement social (XVI^e-XX^e siècle)*, Paris, Gallimard, 2010.
2. Arnold Thackray (ed.) *Private Science, Biotechnology and the rise of the molecular sciences*, Philadelphia, University of Pennsylvania Press, 1998.
3. Yasu Furukawa, *Inventing polymer science, Staudinger, Carothers, and the emergence of macromolecular chemistry*, Philadelphia, University of Pennsylvania Press, 1998.

A Vanishing Flame: The Transformation of the Concept of Fire as an Agent in the Pre-Lavoisian Chemistry

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Abstract

Fire as a uniquely active agent that causes matter to change has been an important concept since the classical philosophy. This sense has interwove but been distinct from the ontological materiality of the Aristotelian element that participates equally in the processes of changes. Meanwhile, fire had been the dominating chemical practices from the ancient metallurgy to the standardized distillation carried out by the first generation of chemists at *Académie des sciences* at the end of the seventeenth century. Instead of dealing with the reality of phlogiston, this study examines how the concept of fire as an agent was elaborated, challenged, modified, defended, and trivialized in pre-Lavoisian chemistry. By revealing Paracelsus, N. Lemery, Boyle, Homberg, L. Lemery, Boerhaave, Rouelle, Macquer and Lavoisier's efforts to incorporate this concept into the chemical theories that they were constructing, I identify the role played by this traditional philosophical concept in the conceptualization of chemical reaction itself by pre-Lavoisian chemists when they were pursuing for the epistemological legitimacy and disciplinary autonomy.

I would discuss how Paracelsian notion of analysis by fire provided a ideal paradigm of chemical reaction, what questions underlay the debate that raged from the mid sixteenth-century to the mid seventeenth-century and culminated Boyle's *Sceptical Chymist*, to what extent Nicolas Lemery defended the paradigm, why Wilhelm Homberg's notion of the sole active principle of sulfur was vital to the turning of the paradigm of analysis to that of synthesis, to what extent the concept of fire helped establish a new system of substances in the 1720s, how Boerhaave's concept of chemical instruments related the traditional concept about the unique agent of changes to Newtonian concept of force, what tension between the two senses of fire were represented in Rouelle's and Macquer's work in the 1750s and 1760s, and in what sense the concept of fire was finally trivialized through Macquer's rationalization of chemical affinities and Lavoisier's stress shifting from the chemical instruments to the physical instruments.

References

1. Tom Broman, Department of the History of Science, University of Wisconsin, USA
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The scientific development of Green chemistry

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The development of the chemical community in relation to environmental problems and the public image, can be studied well by analyzing the development of ‘green chemistry’ in the USA and Europe. Previously, I have shown that internationalization added an important dimension to the huge growth of green chemistry.¹ For instance, after a start of the field in the USA, the European journal *Green Chemistry* has become the most important journal devoted to green chemistry. Moreover, with a journal impact factor of 4,19 (2006) it belongs to the most important chemistry journals. This stresses the importance to analyze the development of green chemistry research in the USA and Europe, in relation to the different risk cultures in those areas. In particular I will discuss how environmental problems and the public image of chemistry influence the (scientific) development of green chemistry in the USA and Europe.

In this paper, I will analyze the similarities and differences in the development of green chemistry views within the US, British and Dutch chemical societies. This analysis will elucidate to what extent the development of green chemistry is founded on environmental problems, the sharing of a paradigm and/or the negative image of chemistry, using archival research, published literature, and interviews.²

References:

1. Linthorst, J.A.. An Overview: Origins and Development of Green Chemistry. *Foundations of Chemistry*. **2010**, *12*, 55-68.
2. Linthorst, J.A., The Image of Chemistry and Curriculum Changes, *Educacion Quimica*. **2012**, *23*, 240-242.

The Discipline Busters:

Molecular Biology, the Rockefeller Foundation and Karolinska Institutet

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The Karolinska Institutet in Stockholm in the period 1930-1945 managed to provide for promising junior researchers engaged primarily in biochemistry through a series of institutionally innovative moves. The Institute opened up its traditional academic organisational structure, based on clearly delineated disciplines, sorted by department, in favour of a set of more fluid arrangements where it could allow the pursuit of technology-intensive investigations at the margins and intersections between the established disciplines.

This was accomplished in a form of “co-production” between the Rockefeller Foundation and representatives of the so-called “theoretical departments” at the Karolinska. While taking as its starting point the well known Rockefeller Foundation “molecular biology” program as conceived by Warren Weaver as Director of its Natural Science Division (and famously codified in the Foundation’s 1938 annual report), this nevertheless primarily focuses on the internal dynamics at the Karolinska Institutet at a period in time when government support for fundamental (bio-)medical research was restricted in Sweden.

The Karolinska managed to leverage in particular its Rockefeller support (the “Rockefeller magic touch” as referenced by KI researchers at the time) into a series of initiatives to create extraordinary research positions and groups at the margin of the at the time rigid disciplinary, departmental structure at the Institute, and in Swedish academia in general (the classic “one discipline, one department, one professor” model). Most of these were assembled into the so-called “Karolinska Medical Nobel Institute”, as indicated by its name allowing also the marshalling of Nobel funds for the purpose. (Other major financers included from 1922 the so-called Andersson Fund for Medical Research, and in time, from 1940, the Wallenberg Foundation.)

In this fashion the KI “biochemical empire” successfully and early on managed a significant, general move that has characterised the rise of modern biomedical research in general; the devolution of rigid disciplinary structures in favour of more open fields of research. As the Institute has entered into the 21st century, the internal departmental, and disciplinary, structure of the Karolinska Institutet in Stockholm can still be shown to be disproportionately dominated by structures traceable back to the KI Department of Chemistry, often as not by way of the originally extraordinary — at its inception in fact formally placed entirely outside the Institute — KI Medical Nobel Institute.

The paper provides a summary of the monograph study of the same events kindly funded by the Karolinska Institutet in 2005-2010, and published by the Karolinska as part of its 2010 bicentenary celebrations, entitled “Ämnessprängarna”, the Discipline Busters.

The non-discovery of elements in the 19th century

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The wish to pin down the discoverer of new chemical elements has at least earlier been a dear hunt for many historians, at least in Sweden, since the list of elements discovered there, thanks to the role of chemistry in the economical important mining industry, at a first glance is impressive. One might even say that to discover new elements was routine for many chemists in Sweden. In this paper I will turn to the lesser known elements discovered by chemists in Sweden during the 19th century, and the list is even more impressive than during the 19th century: Gahnium, Noricum, Erbium, Svecicum, Ilium, Wasium, Lantan, Didymium and many, many more. The chemist Clemens Ullgren even discovered three new elements within one year.

In my paper I will discuss the reasons behind this wave of discoveries (which was not only a Swedish preoccupation). They were made by chemists, who were trained in an advanced Swedish analytical tradition, who have not received a place in the history of chemistry. I will especially concentrate on the techniques used, which involved delicate classical chemical operations, where the substances had to be solved, precipitated, washed, solved for many times and with the outmost care. It is of special interest that these operations contained important qualitative features, as in the blow pipe technology, and visual observations. The discoverers worked in a well-established tradition, and their work can therefore be used to analyze the work of an average chemist during this epoch. Instead of asking where these chemists went wrong, I rather intend to try to find out why they thought they were right.

However, most of these new elements lost their status as elements and two reasons will be discussed. The first was the rise of spectral analysis, which if used for chemical analysis, made it easier to separate small amount of different substances. However, it should be stressed that also spectral analysis, due to the delicate reading, contains a qualitative feature. The second was the coming of the periodic system, which actually helped in shaping a theoretical limit as to the amount of possible elements, a limit which did not exist before.

Controversies about atomism as a tool in chemistry teaching

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The integration of topics of history and philosophy of science has been proposed lately in some secondary school science curricula and general university courses, aiming at a contextualization in terms of the evolution of science (in our case, chemistry) and its interactions with technology and society. It is considered important to teach/learn not only science, but also about science and its evolution, referring both the contents and the processes, intending to facilitate students' understanding of how science has been constructed along time.

We suggest that a possible process of carrying out this integration is to present and discuss with students some historical controversies related to particular topics considered difficult for them to understand. One of these topics, often referred by teachers and researchers, is the mole and the related basic concepts of atom, molecule, atomic mass, molar mass, Avogadro constant, atomic number, etc.

The study of the long standing controversy *atomism/antiatomism* can be an interesting approach to the introduction of the atomic theories as they are presented usually in chemistry curricula. In particular, the discussion of the antiatomistic positions of Mach (1838-1916) and Ostwald (1853-1932) still held by the beginning of the 20th century and often considered "outdated", can be the starting point of fruitful reflexions on the evolution of chemistry and also physics.

In spite of the growing knowledge about atoms in the 20th century, Mach's ideas did not change until his death. However, we can say that, as Mach wrote, "...The history of the development of mechanics is quite indispensable to a full comprehension of the science in its present condition...", to understand Mach's antiatomism it is fundamental to know the history of the polemics about atomism in the 19th century. On the other hand, the later evolution of the image of the atom also contributes to re-evaluate Mach's positions.

In fact, during the 20th century, with the development of atomic and nuclear physics and chemistry, the ideas on the nature of particles of mass or of energy have changed and are still changing presently. From a Kantian ideal of a "thing in itself" we moved to a duality – wave-particle – which is a new "thing in itself" or a mere auxiliary concept, depending on the perspectives.

In this communication we intend to sketch briefly the main controversies about atomic theories, with particular emphasis on Mach's ideas, and propose an approach to the introduction of this topic in school curricula. We also consider that this approach could be useful in undergraduate teacher training courses, and particularly in master degrees courses, where a deeper understanding of fundamental concepts could be reached.

References

1. E. Mach, *The Science of Mechanics*, transl., 2nd Ed., Open Court Publishing Company, Chicago, 1902.

Krausism, a German philosophy for a Spanish chemistry

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The philosophical system developed by Karl Christian Friedrich Krause in the first decades of the 19th century tried to detach atheist and pantheist interpretations from the German idealism. Krause conceived the concept of “pantheism” in which the material world ontologically belonged to the divine essence of God setting an independent but correlated existence of the spiritual and the material. This philosophy did not succeed very much in its native Germany, though it spread in the second half of the century to other European countries such as Belgium, France or Spain. Nevertheless, only in Spain the impact of this philosophical system was major enough to influence not only in the scholar world, but even in the Spanish politics and in the becoming of contemporary Spanish history (1).

Studies on how scientists related to Spanish Krausism developed a science which intended to harmonize conservative and liberal worldviews, have been made in the last years as for the case of the popularization of thermodynamics (2). The present paper offers a different perspective not attending to the political tendencies of the characters but to the philosophical nuances of Krausism. Laureano Calderón (1847-1894), José Rodríguez-Carracido (1856-1928) and José Rodríguez-Mourelo (1857-1932) are the main characters of this work and I will show how they discussed about the intimate constitution of matter attending to the philosophical meaning of Krausism.

Its ontology of the world led to a scientific corpus in which the dualist separation of matter and forces was rejected. This has brought to the opinion that some of these scientists attached to Ostwald's energetics in the last years of the 19th century (3), but these opinions can no longer be held when considering that Krausist science—as developed in Spain—was incompatible with the ontological deny of matter, although it joined to the fin-de-siècle atomism crisis. The chemistry developed under the influence of Krausism shaped a differentiated science in the European context, characterised by the harmonization of materialist and idealist worldviews.

References

1. Gonzalo Capellán de Miguel, *La España Armónica* (2006).
2. Stefan Pohl-Valero, “The Circulation of Energy” in *Popularizing Science and Technology in the European Periphery* (2009).
3. Antonio Moreno González, *José Rodríguez Carracido* (1991).

Emergence of a science of supramolecular systems at the University of Strasbourg (1961-2011)¹

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Located at the interface of chemistry, physics and biology, supramolecular chemistry is a research field that has grown considerably over the past forty years. Today, 20 to 30% of publications in major journals in chemistry such as *Angewandte Chemie*, *Chemical Communications*, *Chemistry: a European Journal* and *The Journal of the American Chemical Society* report on the practical realization of the concepts and visions developed in the field (Diederich, 2007).

The heart of supramolecular chemistry deals with the study of molecular recognition phenomena and the use of different types of non-covalent interactions to develop molecules able to recognize others (Lehn, 1998). Jean-Marie Lehn was pioneer in laying down the foundations of the field and formalizing major concepts in a seminal article published in 1978 (Lehn, 1978). For this work (and in particular the synthesis of cryptands achieved ten years earlier in his laboratory), he was awarded the Nobel Prize for Chemistry in 1987, an award he shared with Charles J. Pedersen (Du Pont) and Donald J. Cram (UCLA), "for their development and use of molecules with structure-specific interactions of high selectivity". Many stories from leaders and "founding fathers" tell that story (for Strasbourg see for instance Stadler 2011, Vicens 2011). Textbook provide timelines (Steed, 2009). Others insist on the role of a mythology as a legitimizing resource for the developing of a disciplinary community (Nye, 1993). But from the perspective of the social studies of science, history of supramolecular chemistry still needs to be written (Schummer, 2006).

This paper aims to describe the conditions for the emergence of the paradigm of supramolecular chemistry and a research speciality at the University of Strasbourg (France), where Jean-Marie Lehn spent his whole career, going beyond the story of a single career path, however brilliant and gifted it may be. It is based on a sequential 4-steps model, as proposed by Mullins (1972). The presentation is based on a chronology combining three approaches: a scientometric characterization, also nurtured by readings (archival documents -Fonds Guy Ourisson-, Nobel lectures, scientific publications and textbooks) and interviews.

As suggested by Christian Jacob, this paper aims to build a characterization of knowledge crossing the two perspectives of cognitive contents and social embeddedness of scientists (Jacob, 2007). Based on a survey conducted in 2011, the author lists a number of social processes that led to the emergence of this specialty at the University of Strasbourg. She observes the legacy of this field of knowledge using an organizational study of the chemistry department as it currently exists.

References

- Diederich F., "40 years of Supramolecular Chemistry", *Angew. Chem. Int. Ed.*, 46, 68-69, 2007
Jacob C. (dir.), « Lieux de savoir, espaces et communautés », Paris, Albin Michel, 2007
Lehn J.-M., "Cryptates: the chemistry of macropolycyclic inclusion complexes", *Acc. Chem. Res.*, 11, 49-57, 1978
Lehn J.-M., "Supramolecular chemistry-scope and perspectives molecules, supermolecules and molecular devices", *Angew. Chem. Int.*, 27, 89-112, 1998

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Oral presentations

- Mullins N.C., "The Development of a Scientific Specialty: The Phage Group and the Origins of Molecular Biology", *Minerva*, 10, 1, pp. 51-82, 1972
- Nye M.-J., "From Chemical Philosophy to Theoretical Chemistry: Dynamics of matter and dynamics of disciplines, 1800-1940", University of California Press, Berkeley, 1993
- Schummer J., "Gestalt switch in molecular image perception: the aesthetic origin of molecular nanotechnology in supramolecular chemistry", *Foundations of Chemistry*, 8, 5, 3-72, 2006
- Steed J.W. and J.L., Atwood « Supramolecular Chemistry », 2nd Edition, Wiley, 2009
- Vicens J. and Q. Vicens, « Emergences of supramolecular chemistry: from supramolecular chemistry to supramolecular science », *Journal of Inclusion Phenomena and Macrocyclic Chemistry*, Volume 71, 251-279, 2011
- Stadler A.-M. and J. Harrowfield, « Places and chemistry: Strasbourg - a chemical crucible seen through historical personalities », *Chem. Soc. Rev.*, 40, 2061-2108, 2011

Resource and Site: Vitamin C from Paprika

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The term “material culture” has been used widely in cultural studies. Its approach was transferred to science studies in the early 1980s by anthropological studies or laboratory studies done with success for instance by Knorr-Cetina, or Latour and Woolgar. The cultural approach in the history of physics became infamous and suspicious after the Sokal hoax. One of the notions applied in cultural studies, ‘materiality’ established connection between objects and intellectual means applied in science, assuming that ‘things can talk’. Paprika, a kind of vegetable proved to be a great natural resource of vitamin C in the early 1930s. This result was achieved by Albert Szent-Györgyi in Szeged, a rural Hungarian town proud of its production of high quality paprika. The paper shows how biochemistry links various cultural traditions, including adventurous voyaging in faraway seas, local preferences of characteristic Hungarian food, ‘paprikash’, and Cambridge style of biochemistry imported by Szent-Györgyi to Szeged. It is however questionable whether it is the paprika as a material thing or the historian who tells this story.

The laboratories used by Guldberg and Waage

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Abstract

When the work on the *Law of mass action* started in the fall of 1862 Cato M. Guldberg and Peter Waage were still in their twenties.¹ Guldberg had just returned from studies abroad and Waage had been appointed lecturer in chemistry at the university in Christiania the year before, and he was in charge of the chemical laboratories in Domus Media.

The buildings at Karl Johans gate, finished in 1852, were the first permanent buildings specifically built for the university. The space reserved for chemistry in Domus Media was small. When the first professor of chemistry in Christiania, Julius Thaulow (1812-50), came home from studies abroad in 1839, the space for chemistry was already allocated. He argued for more space for chemistry, but did not succeed.² In 1851 the German Adolph Strecker (1820-71) took over the responsibility for chemistry.

Strecker was educated at the university in Giessen and had worked in Justus Liebig's laboratories. He became responsible for the detailed planning of the 12 rooms with a total of 510 m² allocated to chemistry. He also succeeded in getting built a separate building for the chemistry teacher in the university garden (Professorboligen). The picture shows Domus Media from the North. The laboratories were in the two floors to the left of the lecture hall with a capacity of about 130-150 listeners.



Strecker was so proud of what he had accomplished that a detailed description of the chemistry laboratories were published as a separate program from the university in 1854.² The program also contained 15 papers on research carried out in them. (From 1851 to 1854 he also learned Norwegian, lectured in Norwegian for about 150 students and published revised versions of two textbooks by Regnault!)

Guldberg and Waage worked in the laboratories as students from 1854. Guldberg took his masters degree (cand. real.) in 1859. Waage started as a medical student, but finished only the first part. He won a gold medal on a subject proposed by the Faculty of Mathematics and the Natural Sciences in 1858.³ Guldberg won the gold medal a year later on a paper in pure mathematics.⁴ In 1869 he was appointed professor of applied mathematics, and in 1877 he was awarded dr.h.c. (hedersdoktor) at Uppsala University together with a.o. Henrik Ibsen.

References

1. C. M. Guldberg and P. Waage: *Studier over Affiniteten*. Videnskapselskapets forhandlinger for 1864. Christiania 1865.
2. Fredrik Grønvold: *Kjemien, universitetet og Christiania 1811-1850*. Selskabet for Oslo Byes Vel (2011).
2. Adolph Strecker: *Das chemische Laboratorium der Universität Christiania und die darin ausgeführten chemischen Untersuchungen*. Christiania (1854).
3. Peter Waage: *Udvikling af de surstoffholdige Syreradikalers Theori*. Nyt Magazin for Naturvidenskaberne **10** (1859) hefte
4. C. M. Guldberg: *Om Cirklers Berøring*. (1859).

Reproducibility of eighteenth century recipes of Potable Gold

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There has been much historical debate on the preparation of the so-called *aurum potable*, potable gold, as well as on the true chemical nature of the obtained product. Although the Golden Age of this *chymical* preparation could be found in early modern Europe, potable gold recipes were still in use in the eighteenth century.

One of these recipes was included in the 1757 edition of the *Cours de Chymie* of Lemery by his editor, M. Baron, in which he describes the preparation of the “potable gold of Mademoiselle Grimaldi”¹. Macquer commented the recipe in his *Dictionnaire de Chymie* (1766). The procedure is described with enough detail as to be suitable for replication in a modern laboratory. First, gold must be dissolved in *aqua regia* and the resulting clear solution mixed with rosemary essential oil. The supernatant oil layer is removed and mixed with pure ethanol, and this is digested for a month.

By following this procedure, a dark-brown supernatant oily phase is immediately formed as the gold solution in *aqua regia* and the rosemary oil are mixed, which is not described in the 1757 recipe. Moreover, the same preparation is also included in the *New Dispensatory* by William Lewis, 1785 edition, in which the author correctly remarks that, although the gold is actually taken up from the acid by the supernatant oil phase because the solution loses its gold color (the very same observation is also noticed in the *Cours de Chymie*), the gold readily precipitates from the oil covering the walls of the glass, as we have indeed observed. Chemical analysis reveals that more than 99% of the gold initially present in the acid aqueous phase has been removed, in according with those old descriptions, but the oily phase still contain gold, as well as the mixture between the oil phase and the ethanol

The evolution of this complex system has been monitored for several months, and we have examined the ethanol solution by transmission electron microscopy, in order to assess the eventual presence of gold nanoparticles. They are indeed present, very small ones, with a size in the range 2-5 nm, having a very regular polyhedral shape. Therefore, the potable gold of Mademoiselle Grimaldi is indeed a colloidal solution of very uniform gold nanoparticles.

We have also reproduce the procedure published by F. Hoffman in 1722², closely related but not identical to that of the French Grimaldi, which uses cinnamon essential oil. This author correctly describes the formation of a black thick phase as the oil and the gold solution are mixed together.

We believe that the source of inspiration of these recipes shall be found among earlier attempts to extract the Sulphur of metals, a topic extensively reviewed by J. H. Pott at the beginning of eighteenth century³.

References

1. M. Lemery, *Cours de Chymie*, Ed. M. Baron, Paris, 1757.
2. F. Hoffmann, *Observationum Physica-Chymicarum Selectiorum Libri III*, Halle, 1722.
3. J. H. Pott, *Dissertationes Chymiques*, Paris, 1759.

Bragg's law and the birth of chemical crystallography

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One century ago, on November 11 1912, the then 22 year old William Lawrence Bragg (WLB) presented his scientific results to the Cambridge Philosophical Society [1]. This important talk, which included a discussion of the crystal structure of the mineral zinc blende, paved the way toward the development of chemical crystallography in UK, Europe, and abroad. The researches performed by WLB in collaboration with his father, William Henry Bragg (WHB), were preceded by the discovery of X-ray diffraction by crystals made by von Laue (Nobel Prize in Physics 1914), Friederich, and Knipping in 1911 [2]. In less than three years from WLB's lecture, both WLB and WHB would be awarded the Nobel Prize in Physics 1915 "for their services in the analysis of crystal structure by means of X-rays" [3].

The successful interpretation of the crystal structure of minerals is connected to the discovery of Bragg's law which links the (Bragg) angle of X-rays diffracted by a periodic solid to the wavelength of the incident radiation. The key idea of WLB was that he considered a 3D crystal as 1D array of planes whereas von Laue considered it as an array of points [4]. Soon after, other practitioners started to investigate the crystal structures of other materials; a notable example is that of William Astbury (Leeds) who would soon become a pioneer of the new field of structural biology. Within a decade, the crystal structures of many other crystalline materials were determined by students and co-workers of the Braggs.

In this contribution I will provide an overview of the state-of-the art in chemical crystallography during the first quarter of the 20-th century as attested by the information contained in the book *X-ray and Crystal Structure* co-authored by WHB and WLB and published in 1925 (5-th edition) [5]. Of note is the attempted determination of the crystal structure of tartaric acid which represents an important step toward establishing the concept of molecular chirality discovered by Pasteur in 1848 [6]. Also, another important aspect of Braggs' work was to definitively disprove the existence of NaCl molecules as showed by the crystal structure of table salt where each cation (anion) is surrounded by six anions (cations) at equal distances. Several chemists did not accept the experimental evidence produced by WLB. Among them, H.E. Armstrong (then Emeritus Professor of Chemistry at the Imperial College London) in a Letter published in the prestigious journal *Nature* and titled "Poor common salt!" [7] stated that the result was repugnant to common sense because the pairing of atoms resulted from geometry rather than the chemical combination of elements to yield NaCl molecules.

References

1. W.L. Bragg, *Proc. Cambridge Philos. Soc.* 17 (1912) 43-57.
2. W. Friedrich, P. Knipping, and M. von Laue, *Sitzungsberichte. Bayerische Akademie der Wissenschaften* (1912) 303-322.
3. "The Nobel Prize in Physics 1914". Nobelprize.org.
4. G.K. Hunter, *Light is a Messenger, the Life and Science of William Lawrence Bragg*, Oxford University Press (2004).
5. W.H. Bragg and W.L. Bragg, *X-ray and Crystal Structure*, G. Bell & Sons, 5-th edition (1925).
6. H.D. Flack, *Acta Cryst. A* 65 (2009) 371-389.
7. H.E. Armstrong, *Nature* 120 (1927) 478.

The chemist and the cellulosic plastics - when breaking up is not so hard to do

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Amongst the many industrial chemistry triumphs of the nineteenth and early twentieth centuries, the semi-synthetic plastics cellulose nitrate and cellulose acetate must surely count amongst those with the greatest impact on modern living. Synthesised by the chemical modification of natural cellulose polymers in wood and cotton with acidic mixtures, this highly versatile suite of thermoplastics were, and still are, rolled into sheets, moulded into solid shapes, cast into film, solvated for lacquers and, for the acetates, extruded into fibres. Sold under their trade names 'Celluloid', 'Xylonite' and 'Celanese' amongst others, these semi-synthetic plastics in their transparent, opaque, coloured and filled forms have worked their way into just about every corner of society¹. Their success over many decades along the full commercial spectrum of mass production to designer exclusives for household, technological and textile applications, as well as creative and functional materials for the decorative and performing arts, has secured the place of cellulose nitrate and cellulose acetate plastics in the collections of museums, galleries and archives worldwide.

Today we can admire and study much of the historical material culture that these semi-synthetic cellulosic plastics have created to understand their means and methods of production and socioeconomic value. Unfortunately this may not be the case for the decades ahead because within their very chemical composition is the potential for physical degradation on a much shorter timescale than ever anticipated. Over the past twenty years, museum conservation scientists have pooled their expertise with polymer chemists to understand the chemical reasons for the breakdown of historical plastics²⁻⁴. Aligning past manufacturing chemistry with analytical evidence from the historical artefacts themselves reveals inherent chemical degradative triggers that influence the physical stability of ageing cellulose⁷. For the early cellulose, a chemical understanding of their industrial production methods enlightens the seemingly unpredictable breakdown of the aged objects^{5,6} but also makes the preservation of these ephemeral legacies more important when it reveals materially-invaluable insights into past industries.

References

1. Shashoua, Y. Conservation of Plastics: materials science, degradation and preservation. Oxford: Butterworth-Heinemann, 2008
2. Saving the Twentieth Century: The Conservation of Modern Materials, Ottawa: Canadian Conservation Institute, 1993
3. Quye, A. and C. Williamson. Plastics: collecting and conserving. Edinburgh: National Museums of Scotland Publications, 1999
4. POPART, a European Commission 7th Framework programme project for the Preservation of Plastic ART works in museums collections <http://popart.mnhn.fr/spip.php?article160> (Accessed 25 March 2013)
5. Quye, A., D. Littlejohn, R.A. Pethrick, R.A. Stewart. Investigation of inherent degradation in cellulose nitrate museum artefacts. *Polymer Stability and Degradation*, 96 (2011), pp. 1369-1376
6. Littlejohn, D., R.A. Pethrick, A. Quye, J.M. Ballany. Investigation of the degradation of cellulose acetate museum artefacts. *Polymer Stability and Degradation*, 98 (2013), pp. 416-424
7. Quye, A., D. Littlejohn, R.A. Pethrick and R.A. Stewart. Accelerated aging to study the degradation of cellulose nitrate museum artefacts. *Polymer Stability and Degradation*, 96 (2011), pp. 1934-1939

Acid Towers and Weldon Stills in Leblanc Widnes

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Widnes (in north-west England) became an iconic chemical town during the second-half of the nineteenth century. Between 1841 and the 1890s Widnes developed into a remarkable site of chemistry and chemical industry; in 1841 Widnes was a rural community with a population of 2,209, and yet by 1891 the population was close to 30,000 and Widnes had developed into the iconic chemical town with thirty-five industrial concerns of which about twenty-four were chemical works, in the main operating the Leblanc process. This process was introduced into Britain from France in 1814 so that soda (or sodium carbonate, either crystals or anhydrous) could be produced from salt rather than relying on natural sources such as barilla and kelp. The raw materials for the process were salt, coal and limestone and the Mersey region became a major centre together with Tyneside and Glasgow.

While the Leblanc process brought prosperity and jobs, it also was accompanied by major pollution because of the inability of manufacturers at the time to recycle waste products. Sometimes this was due to technological limitations or lack of markets but mainly because manufacturers were so focused on the primary product, in this case soda. The Leblanc process was accompanied by pollution from two principal sources – hydrogen chloride gas (or muriatic acid gas as it was known in the trade) and sulfur waste (which was often known as alkali waste, vat waste or by the marvellous onomatopoeic word, “galligu”). This paper is concerned with two important elements in the material culture associated with the control of hydrogen chloride gas from Leblanc chemical works; the “acid tower” invented by William Gossage in 1836 and the “Weldon still” developed by Walter Weldon between 1866 and 1869. The “acid tower” was used to condense the acid gas in water rather than allow the gas to escape from tall chimneys to wreak havoc in the surrounding environment. In developing the “Weldon still”, Weldon first drew on Scheele’s discovery of chlorine in 1770 and then recovered the manganese (IV) oxide to produce further quantities of chlorine. By these two inventions the polluting acid gas was recycled to produce chlorine and then bleaching powder for which demand increased markedly from the 1860s with the importation of esparto grass to supplement rags in the manufacture of paper.

This paper draws on archaeological evidence gathered during the late-1970s and early-1980s to interpret the construction, operation and later developments of both these key inventions in the battle to control air pollution during the second-half of the nineteenth century. Interestingly, although the sites were subject to land reclamation schemes from the early 1980s, substantial elements of these inventions remain in situ, albeit hidden for future generations of archaeologists to ruminate over.

Radiumwünsche: A Material Reassessment of the Rise of the Nuclear Sciences in Weimar

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Together with the Cavendish Laboratory in Cambridge, the Institut Curie in Paris, and the Institut für Radiumforschung in Vienna, the Kaiser-Wilhelm Institute for Chemistry (KWIC) in Berlin was an important node in the international radioactive network and played a key role in the transition to the nuclear sciences in the interwar years. Unlike the other nodes, however, the KWIC has not been thoroughly researched, for reasons having to do both with the standard, theory-centred, bomb-driven account of the rise of nuclear science, and with the new account that has challenged it (ref. 1).

Through the Weimar years (1918–1933), the Austrian physicist Lise Meitner (1878–1968) and the German chemist Otto Hahn (1879–1968), each as head of their own lab, were responsible for the radioactive department of the KWIC. Eventually commanding most of the institute's space and budget, the *Hahn-Meitner Abteilung* became Germany's leading centre for radioactive research (refs. 2 and 3).

In this paper I seek to reassess the role the KWIC in the rise of nuclear science by taking into account the financial and material layout of the laboratory, in particular its stock of radioactive substances. The KWIC appears to have been under-stocked for an elite radioactive centre, having to make do with 1/10 the amount of radium available in Cambridge or Paris. “Even mesothorium and radiothorium, which were discovered and are produced in Germany, are available in much larger amounts at the other institutes” (ref. 4). How did researchers at the KWIC cope with this situation? And how did they manage to keep abreast? Sources were inextricably linked to research aims, and Meitner and Hahn explicitly deemed the constitution of nuclei a research priority. Building on extant budgets, inventories of radioactive sources and instruments, lists of researchers and assistants, correspondence and plans, I will describe the material constraints on nuclear research in Berlin through the Weimar years.

References

1. Jeff Hughes, “Radioactivity and nuclear physics,” in M. Jo-Nye, ed., *Cambridge History of Science*, vol. 5. *The Modern Physical and Mathematical Sciences* (Cambridge: Cambridge University Press, 2002), 350–374.
2. Ruth L. Sime, *Lise Meitner. A Life in Physics* (Berkeley: University of California Press, 1996).
3. Horst Kant, “Vom KWI für Chemie zur KWI für Radioaktivität: Die Abteilung(en) Hahn/ Meitner am Kaiser-Wilhelm-Institut für Chemie”, *Dahlemer Archivgespräche* 8 (2002): 57–92.
4. O. Hahn and L. Meitner to F. Glum, 20 Jan 1927 (Archiv zur Geschichte der Max-Planck-Gesellschaft, Berlin, Abt. I, Rep. 11).

Radicals: Between Matter and Substance

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Since Lavoisier's *Traité* in 1789, many influential chemists of the 19th century applied and developed the radical notion, like, for example, Berzelius, Liebig, and Dumas. Berzelius gave radicals the meaning of "element imitators", and the latter two proposed to consider organic chemistry as the science of "complex radicals", and inorganic chemistry as the science of "simple radicals".

Although their definition has been shifted in modern chemistry to "particles with unpaired electrons", these early concepts of radicals are still vivid in chemistry, for example referring to the denotation of molecular fragments in the description of structures.

From very early on the question whether or not radicals could be isolated was extremely fascinating for chemists. However, the first successful preparation of such a "free radical" was reported by Moses Gomberg only in 1900. Although he did not at all aim at the synthesis of a free radical, and moreover failed to reach his original aim – namely the preparation of hexaphenyl ethane – he came up with results which eventually convinced the reluctant scientific community that free radicals can be real, stable stuff.

About 30 years later Friedrich Paneth and his co-workers published empirical evidence for the "existence" of the methyl- and ethyl radicals in sophisticated experiments. The present contribution is an attempt to come to terms with the settlement of the modern radical concept. The following main questions which refer to *materiality*, *realism*, and *experiments* shall be discussed: (1) What kind of "material substance" or "object" is a radical? (2) What did the involved chemists mean when they claimed that a radical "exists"? (3) How does a radical come to life? Reference will be made to models or approaches of the following authors: Latour, Paneth, Soentgen, Timmermans, van Brakel, Wald (materiality), van Fraassen, Chang (observability, realism), and Heidelberger (experiments).

Chang, H. (2012) *Is Water H₂O?* Heidelberg etc.: Springer.

Gomberg, M. (1900) Triphenylmethyl, ein Fall von dreiwertigem Kohlenstoff, *Berichte der Deutschen Chemischen Gesellschaft* 33, 3150-3163.

Heidelberger, M. (1998) Die Erweiterung der Wirklichkeit im Experiment, in M. Heidelberger and F. Steinle (eds.), *Experimental Essays-Versuche zum Experiment*, Baden-Baden: Nomos, 71-92.

Ihde, A. (1967) The History of Free Radicals and Moses Gomberg's Contributions. *Pure and Applied Chemistry* 15, 1-13.

Latour, B. (1999) *Pandora's Hope*, Cambridge: Harvard University Press.

Paneth, F., Hofeditz, W. (1929) Über die Darstellung von freiem Methyl. *Berichte der Deutschen Chemischen Gesellschaft* 62, 1335-1347.

Paneth, F. (1931) Über die erkenntnistheoretische Stellung des chemischen Elementbegriffs. *Schriften der Königsberger Gelehrten Gesellschaft* 8, 101-125.

Ruthenberg, K., van Brakel, J., Eds. (2008) *Stuff – The Nature of Chemical Substances*, Würzburg: Königshausen&Neumann.

Soentgen, J. (2008) Stuff: A Phenomenological Definition. In: Ruthenberg and van Brakel (Eds.) *Stuff*.

Timmermans, J. (1940) *Chemical Species*, New York: Chemical Publishing.

van Brakel, J. (2000) *Philosophy of Chemistry*, Leuven: Leuven University Press.

van Fraassen, B. (2008) *Scientific Representation: Paradoxes of Perspective*. Oxford: Clarendon Press.

José Casares and the circulation of material culture between textbooks and laboratories.

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Abstract:

Scientific sites and laboratories as well as material culture -scientific instrument collections or textbooks-, had a growing importance in history of science for the study of scientific circulation and the appropriation of ideas, techniques and scientific knowledge. Material culture as well as scientific knowledge is a product of specific spaces, these geographies include: sites, regions and circulations¹.

The possibilities of “thinking geographically” include the study of scientific circulation done by chemists of the European periphery². José Casares Gil (1866-1961) was a well known Spanish analytical expert and a prominent scientific authority who contributed significantly to scientific renovation of Spanish universities. Casares was chair of analytical chemistry in the faculties of pharmacy of Barcelona and Madrid, where he was dean too. On the other hand, he held relevant public positions, such as senator, and he had relevant international contacts due his travels of learning as well as his travels as a public authority.

His handbooks and textbooks show his active paper for the appropriation of techniques and material culture that he observed during his travels to the most prominent chemical laboratories, mainly in Germany. His *Tratado de química analítica (Treaty of Analytical Chemistry)* -published between 1909-1978- included a great number of suggestions to improve the laboratory practice, as well as practical information useful to design and redesign chemical laboratories, such as how to design a lab-bench, who to choose an useful gas extractor or who to select a good scale. Furthermore, his *Tratado de técnica física (Treaty of physics techniques)* -published between 1908-1932- was a key book for the introduction of optical instruments, such as the spectrometers or the polarimeter, to pharmacy and chemistry students.

On the other hand, his positions on the public arena allow him to discuss an educational reform at the Spanish Senate or to encourage the reorganization of the faculty of pharmacy of Madrid, by the renovation of its scientific collections or the management and equipment of its laboratories.

This paper will discuss the circulation of material culture between the ideas that Casares learned during his travels of learning to the textbooks and from the textbooks to the laboratories.

¹ LIVINGSTONE, D., (2003), *Putting Science in its Place: Geographies of Scientific Knowledge*, Chicago, University Press, 234 p.

² LIVINGSTONE, D., WITHERS, C., (eds.), *Geographies of Nineteenth-Century Science*, Chicago, University Press, 536 p.

Energy dilemma in the early 20th century: the chemist's point of view

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The current proposals concerning energy are varied, but there is a general consensus on the need to avoid waste of energy, to promote efficiency of production, and to favor a balanced mix in which renewable sources cover a substantial part. During recent years, chemists have taken a lion's share of the discussion, but we should not forget that some famous representatives of the category had started working on the problem already in the first years of the previous century. Indeed within the single biennium 1911-1912 three important meetings were devoted to respectively the energy question and the food question, strictly connected to one another. First came the Portsmouth Meeting of the British Association for the Advancement of Sciences (August 1911). This organization had been created in 1831, one year after the publication of the celebrated *Reflection on the decline of Science in England on some of its causes* by Charles Babbage (1791-1871). The inaugural speech entitled *Sources of Energy* was held by the Scottish chemist William Ramsay (1852-1916), Nobel laureate in the year 1904 for his discovery of noble gases. He spoke mainly of coal, ascribing to its qualities as energy donor the reasons for the prosperity of the British subjects, whom he went on warning of the scarcity of the national supply, a harbinger of recession if the prices were to increase. After carefully assessing the available data and investigating possible alternatives, professor Ramsay came to the conclusion that no other single resource was as important as coal, therefore one had just to save on stocked material. In 1900, coal was the source of 95% of the commercial energy. The British production reached its historical maximum in 1910. Coal had induced a paramount development of productive activities, described synthetically as industrial revolution, but the environment had suffered from tremendous damages. During the first decade of the twentieth century coal pollution was felt everywhere. Scientists started wondering what the future of mankind would be, not only from the point of view of energy sources and environmental pollution, but also insofar as the availability of food for the world population. Supply and consumption of coal was the subject of the lecture "*Über Zerfallprozesse in der Natur*" held by Prof. Carl Engler (1842-1925) on Sept. 25, 1911 in Karlsruhe. According to the calculations of Prof. Engler, Europe possessed about 700 billion tons of coal and America about as much; to this must be added the coal of the unknown parts of Asia. The supply was enormous but, with increasing consumption, the mining of coal became more expensive on account of the greater depth to which it was necessary to go. The year later, during the VIII International Congress of Applied Chemistry held in New York and Washington D.C. in 1912, the Italian chemist Giacomo Ciamician (Trieste, 1857 – Bologna 1922) criticized the "increasing avidity and careless prodigality" with which coal was used. He stated that the coal-beds were not to last forever, and claimed that coal was not perhaps the best material to use for the needs of the modern society and solar energy would be the best choice for the future. A century later the energy problem still poses unsolved dilemmas.

References

1. Ramsay W. in Meeting of the British Association, *Scottish Geographical Mag.*, 27(10), 1911, p. 516
2. Engler C., "Über Zerfallprozesse in der Natur", *Am. J. Science*, 1912, 33, p. 590
3. Ciamician G., "The Photochemistry of the Future", *Science*, 36, 1912, p. 38

Two Centuries of Chemistry and Chemical Technology in Japan: A Perspective from the “Chemical Heritage of Japan” Project

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I would like to attempt to outline the history of chemistry and chemical technology in Japan by showcasing the profiles of “Chemical Heritage” objects.

In 2005 the Chemical Society of Japan (CSJ) created the Chemical Heritage Committee, which aims to help preserve historically significant records and objects in chemistry and chemical technology in Japan and to make that history open to the public. The projects of the Chemical Heritage Committee include: (1) collecting historical materials and information and conducting research on them, (2) interviewing senior chemists, and (3) sponsoring public lectures and exhibits. In 2009 the committee started the “Chemical Heritage of Japan” project. The CSJ applies the “Chemical Heritage” designation to particularly important artifacts to honor both the work that originally produced those objects and the efforts of those who preserved those items to this day.

The number of the heritage items reached 22 this spring. These items, which are listed below, each represent a particular aspect of the history of chemistry and chemical technology in modern Japan. Though the record is not all-inclusive—the selection of designations is not systematic and the post-war period has not yet been covered, for example—it does offer 22 stories that we can present to the audience. These objects offer fascinating glimpses into much larger histories. For example, the combination of #001, #007 and #008 may give insight into Western learning in Yedo era (called *Rangaku*, or learning by Dutch language).

“Chemical Heritage of Japan” Objects Designated by CSJ by 2013 [in chronological order]

- #001 [c.1830-47] Archive (including *Seimi-Kaiso*) of Yoh-an Udagawa (1798-1846).
- #007 [1859] Transcripts of lectures on chemistry delivered by Pompe van Meerdervoort.
- #008 [c.1850-61] Archive (including *Kagakusinsho*) of Komin Kawamoto (1818-1871).
- #017 [1875-] Apparatus used in the early cement industry in 1870s and 1880s.
- #004 [1891] Remains of granite towers for absorbing HCl gas from the Leblanc process.
- #002 [1900] A laboratory notebook of Keizo Uenaka (1876-1960) on adrenaline.
- #018 [1908-] Research records on *Nipponium*, by Masataka Ogawa (1865-1930).
- #009 [1908-] Objects which illustrate the development of the celluloid industry.
- #003 [1908] A sample of glutamic acid (*umami*) by Kikunae Ikeda (1864-1936).
- #010 [1909-] Materials which show the origin of the sheet glass industry.
- #022 [1910-56] Electrolysis vessels and factory building used for the production of KClO₃.
- #013 [1910] Samples and documents of *Orizandin*, i.e. vitamin B₁, by Umetaro Suzuki.
- #012 [1912-44] Photographs and letters of Setsuro Tamaru (1879-1944), a physical chemist.
- #011 [1912] A sample of *urushiol* and instruments used by Riko Majima (1874-1962).
- #014 [1914] Parts of the plant used for purifying benzene.
- #005 [1916] Samples, instruments and documents on manufacturing viscose rayon.
- #019 [1918-68] Archive of Chika Kuroda (1884-1968), the first female chemist in Japan.
- #006 [1923] Apparatus and documents for ammonia production by the Casale process.
- #021 [1927-] Apparatus and documents on the *To-Ko-Shi* process for ammonia production.
- #020 [1938-45] Samples and documents on artificial petroleum production.
- #016 [1939-50] Samples, apparatus and manuscripts on the synthetic fibre “Vinyon.”
- #015 [1949-51] The first samples of PVC pipes and PVC covered electric cables.

The early history of electrokinetics

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Surface and colloid chemistry is an important branch of physical chemistry. Colloidal dispersions are systems of small particles (1 nm -1 μm) dispersed in a liquid or a gas. Dispersed in water (or any other liquid with a high dielectric constant) the particle surfaces carry electrical charges. These electrical charges and the compensating charges (counterions) close to the surface form what is called an electrical double layer. When the surface charges and the counterions move relative to each other the so called electrokinetic phenomena arise. The best known of the electrokinetic phenomena is perhaps electrophoresis used in numerous practical applications like separation of proteins and at DNA analysis. Many more of these phenomena are well known such as electroosmosis, streaming potential and sedimentation potential. Electrokinetic phenomena have been known for more than 200 years. Many of the concepts used today in electrokinetics were created during the nineteenth century. Also many of the scientists involved in the research on electrokinetic phenomena are forgotten by the modern chemists. Such an important concept as the electrical double layer was conceived in order to explain streaming potential and electroosmosis by George Quincke and Hermann Helmholtz. The important concept of electrokinetic potential, discussed by Horacio Lamb and Jean Perrin, and how it finally received the name zeta potential will be elucidated. The Finnish scientist Uno Saxén and his important reciprocity rules for the electrokinetic phenomena will be discussed and how they were discovered to be important examples of Onsager's reciprocity relations. Important early pioneers like Ferdinand Friedrich Reuss and Robert Porrett will also be emphasized. They were those who actually independently discovered the electrokinetic phenomena by serendipity. Reuss published the discovery in 1809 and Porrett in 1816.

Survey of Chemical Sites of Hungary – Results Achieved So Far and Plans for the Next Steps

Éva Vámos

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The Hungarian Chemical Society (HChS) is widely renowned for efficiently supporting research of history of chemistry and chemical industry, and of presenting its results. One of its first initiatives was registering the European Museums and Exhibitions on Chemistry and History of Chemistry in 1981. The register was compiled by J. W. van Spronsen, and published by the Hungarian Museum for Science and Technology with the financial support of the EuCheMS Working Party for History of Chemistry.

Stock taking and protection of chemical sites in Hungary has emerged as ever again recurring demand during the over 3 decades elapsed since. Factories wanted to popularize the exhibitions organized on their own sites, schools wished to protect their historical laboratories, and universities wanted to explain, to the students, the busts erected in their lobbies and gardens. Such a work was published, in 2009, on the occasion of the 7th International Conference on History of Chemistry in Sopron (Hungary). This bilingual (Hungarian and English) publication gives short summaries on the busts of the professors of Budapest universities, and on the tablets commemorating famous chemists.

A great impetus is given to the compilation of such a register by external interest in the subject (e. g. from abroad). In 2012 a demand has reached the HChS from the Association of Central European Thematic Trails to bring into being chemical thematic trails, as a first step in Hungary, and later in Central Europe. The seat of the Association of Central European Thematic Trails is in Leoben (Austria). It is closely related to the Association of European Thematic Trails with its seat in Luxemburg.

The bringing into being of such thematic trails comprises collecting the memorial sites into a register, publishing a map of the country marking these sites, and publishing folded leaflets and books on them. This means a lot of meticulous work as not only research has to be done but municipalities have to be convinced as well. Establishing a thematic trail of chemical sites will be given a great impulse by our joining the Project Chemical Sites 1600-2000.

The paper will present, in detail, 12 chemical sites of Hungary (museums, universities and factories).

Backbones of Productivity: Fertilizer, Writing Paper and Ink in the Netherlands, 1780-1815

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Fertilizer, paper, and ink offer a fresh view on material practices of chemistry and management in the late Dutch Republic. The first part of the paper zooms in on concrete agricultural sites in the provisioning zone of Amsterdam. Here, different types of wood, peat and so-called 'industrial crops' were produced to provide the city and its various industries with supplies. Leftovers of industries and 'dirt' from the city were used in turn to help fertilize the land. These material cycles connecting industry and agriculture were constitutive of chemical knowledge. Such local material practices were translated into a normative system of land management through chemical discourse. Oeconomic chemistry was said to teach how to maintain a 'proper proportion' of the lands nutrients, yielding 'sustainable profit' by keeping the land 'fat'. Pursuing new forms of (land) management also involved enormous paperwork. By zooming in on the production and circulation of writing paper and ink, the second part of the paper makes two interrelated points: on the one hand it shows how papermakers and producers of ink mobilized practical chemical and other knowledge to process domestic and foreign raw materials in a productive way. On the other hand it examines how the availability of cheap writing paper and ink fed into a rising 'culture of bureaucratic writing' that bound socially and spatially disparate groups together. Taken together, this paper blurs traditional investigative divisions between (scientific) knowledge and (applied) material practice. Moreover, it demonstrates how chemistry shaped and was shaped by social, cultural, economic and political developments within the Netherlands and the global networks in which the Dutch operated.

Rembrandt's chemist: AP Laurie and the public science of art

Geert Vanpaemel

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During the first decades of the twentieth century, the Scottish chemist A.P. Laurie (1861-1949) was considered a world authority on the scientific examination of paintings. Following his initial interest in ancient painting techniques and medieval pigment recipes, he became involved in the authentication of paintings and the detection of art forgeries. As his fame grew, he became more bold in his attacks on fraudulent or ignorant art dealers and connoisseurs. This culminated in his major work on Rembrandt in the 1930's. Yet, as he was fully aware himself, the validity of his scientific expertise was not easily accepted in the art world. To support his claims, Laurie therefore often had recourse to the public domain. He wrote popular books and numerous newspaper articles, showing less restraint in his denunciation of the art world than in his scholarly writings.

This paper will examine the role of media representation of scientific procedures as an independent argument in support of his scientific claims. I will argue that by making use of public statements, Laurie sought to overcome more easily the scholarly reluctance in dealing with scientific evidence. However, in the absence of a proper scientific community to back up his claims, Laurie's work did not find the general acclaim he had hoped for.

Materials in the XXth and XXIth century

Session of the Commission for the Modern History of Chemistry

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It has become almost commonplace since the 19th century to emphasize how much chemists shape matter and build new materials, not only to enhance natural knowledge, but also in the hope of improving the human condition. By creating new, hopefully useful substances, chemists have established a role, not only in science and technology but also as architects of both matter and society. Less often stressed is how materials may in turn shape chemists and their science, both by creating or reorganizing disciplinary fields, communities, instrumental consensus and experimental practice and objects, and by initiating new behaviours in society and consumption or adding to the ever growing number of synthetics.

This panel aims at considering more closely the mirror dynamism between people and materials in a wide range of interacting fields and levels of activity from bench research through engineering to human society and the natural environment. Up to now this has been mostly underlined in the field of inert or non-living materials, as in our example (other examples from the twentieth century could include the development of synthetic polymers and plastics); we also welcome case-studies and considerations from the life sciences, where the creation of new drugs or food ingredients may follow a similar trajectory (or not).

Technology, Economics, Materials and Science:

The Rise of Petroleum Chemistry in the United States

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Petroleum refining began in the mid-19th century as a totally empirical technology – it lacked scientific content and its direction was shaped solely by economic considerations. Thus, petroleum chemistry developed essentially separately from classical organic chemistry, just as petroleum refining did from organic industrial chemistry. Underlying this divergence was the composition of petroleum. It was rich in paraffins (alkanes and cycloalkanes), which underwent very few reactions; were not easily differentiable by available analytical techniques; and were too physically and chemically similar to be isolated in pure form from the complex petroleum mixture.

Abundant US petroleum supplies, and monopoly control by Rockefeller's Standard Oil trust, stifled incentives for doing more than distilling and desulfurizing crude petroleum. However, increasing reliance on the internal combustion engine, the breakup of Standard Oil and seemingly dwindling petroleum reserves motivated attempts to recover a larger fraction of gasoline from crude oil refining. Thermal cracking, commercialized by Burton in 1913, doubled the gasoline yield. Two decades later Rice proposed a free-radical chain mechanism for the cracking process. Unfortunately, it had little impact on cracking technology due to lack of adequate analytical methods. Rice's mechanism was also directly applicable to addition polymerization although that attracted little notice.

The growing demand for higher octane-rated fuels, especially for aircraft engines, was met by Houdry's catalytic cracking process in the 1930s. Catalytic cracking rearranged linear to branched alkanes, which had higher octane numbers. This process also involved a chain reaction; in this case carbonium ions were the reactive intermediates, as shown by Harvard's Paul Bartlett in 1944. All the cracking technologies depended crucially on the creation and manipulation of new materials in order to obtain previously inaccessible reaction conditions. This talk will demonstrate the interaction among the disparate elements that shaped the rise of petroleum chemistry in the US.

On the history of the development of chemical science and industry in Russia in the first decades of the XX century: innovation activities of the Ledentsov's society.

Elena A.Zaitseva (Baum)

Chemical Faculty, Moscow State University

"The Society for Assistance to the Advancement of Natural Science and its Applications" was founded in Russia in 1909 per the testament of the millionaire merchant Kh.S.Ledentsov (1842-1907) (existed until 1918) under two higher educational institutions: the Moscow Imperial University and the Imperial Higher Technical School. Its goal was to promote scientific discoveries and research in science and to contribute to testing and enforcement of scientific and technological inventions and new production technologies through cash allowances (grants). General meetings and the elected council of the leading professors mainly from the two above-mentioned institutions managed all the affairs of the society. The expenditure was funded from the interest on the emergency capital left by Ledentsov for these purposes. In 1910, the Society began to publish its own periodical issue ("Vremennik"), which fully covered the question of the grant policy, followed by the financial reporting. In addition to the major issues the Society published the "Prilozheniya" (applications) dedicated to the urgent scientific and technical problems developed by those who had received grants.

The sources mentioned above contained only general information (themes) about the projects implemented with the support of the society. The archives of the society retain a detailed description of all the projects submitted for funding and detailed reports on their implementation. The present paper is the first study with the detailed analyses of the records of the chemical expert commission meetings based on these archives. We investigated the fate of the following projects: A.E.Chichibabin - on the study of the waste products from oil refining; I.I.Ostromyslenskiy - the development of the methods of synthetic rubber production; I.A.Kablukov - the production of potash fertilizer from the waters of the Crimea lakes; N.D.Zelinsky - the study of the naphthenic hydrocarbons dehydrogenation; V.I.Vernadsky - the study of radioactive minerals, in particular, which led to the organization of the first radium plant in Russia. The archives show that the funds assigned to a young chemist G.S.Petrov allowed him to develop a method of sulfonic acids used as a fat splitter by 1911, and later - as a catalyst in the production of phenol-formaldehyde polymer: the first Russian plastic "carbolite", the manufacturing of which was launched in 1914.

The first short-term attempt to use stock financing arrangements undertaken in the pre-revolutionary Russia, as shown in the present study, initiated the rapid development of many sciences, especially the chemistry, and ensured the creation of new industrial plants.

References

1. Fedorov S.A. In memory Kh.S.Ledentsov. Moscow.1910
2. Volkov V.A., Kulikova M.V. Society of support of scientific researches- Voprosy istorii (1997), №9, p.135-143
3. Central Historical Archive of Moscow. Stock 224. (Archives of the Ledentsov's society)

Poster presentations

ETWIE: the importance of (virtual) networking for scientific heritage in Flanders (Belgium)

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ETWIE vzw (Center of Expertise for Technical, Scientific and Industrial Heritage), * ETWIE vzw (Center of Expertise for Technical, Scientific and Industrial Heritage)

Within the framework of the Cultural Heritage Decree (2008), the Flemish government launched a new instrument for the recognition and funding of centers of expertise in the field of moveable/intangible heritage. These centers of expertise preferably have a thematic focus and they should unite their scope, in order to counter the ongoing fragmentation of the different heritage organizations. Rural heritage, religious heritage and heritage participation have been embedded in the daily activities of such centers for several years now. However, the technical, scientific and industrial heritage remained fairly unattended to. In 2009, a broad and varied group of technical, scientific and industrial heritage experts analyzed the needs in their sector and assessed the opportunities to found a new center of expertise.¹ As a result, ETWIE – Center of Expertise for Technical, Scientific and Industrial Heritage – was created and structural funding was approved for five years (2012-2016).

In the first place, ETWIE aims at supporting, stimulating and activating the ‘heritage community’ in Flanders and Brussels. This community consists of a broad variety of stakeholders, including not only professional organizations, but several volunteer organizations, museums and archives and individuals as well, all of them concerned with the safeguarding of technical, scientific and industrial heritage.

As a network organization, ETWIE is dedicated to bring these people and organizations together and to stimulate the sharing of knowledge and expertise amongst them. It will try to identify any possible hiatuses in knowledge and it will stimulate the community to address these issues. Therefore, ETWIE started mapping the available expertise in Flanders. This year, 2013, a digital platform will be developed, making all of this information available and, consequently, enabling a more efficient communication (not just between experts, but for the public as well). ETWIE wants to raise the general public’s awareness about the importance of the technical, scientific and industrial heritage. For this purpose, ETWIE collaborates with other sectors like tourism, education, research, media and so on.

During this poster presentation, I would like to introduce the (tentative) digital ETWIE platform to the audience and stimulate the debate about whether or not such platforms are an interesting tool to safeguard our scientific heritage. I would also like to make use of this opportunity to discuss the (non)sense of the content of the ETWIE platform with an international group of peers. For example, should we add a social network to our platform? Should we opt for membership or not? What type of information would you definitely look for on our platform? And what would be superfluous?

¹ Technical, scientific and industrial heritage were combined, to answer to the government’s forementioned request for clustering. A center of expertise dedicated solely to, for example, scientific heritage would not have been allocated structural funding.

On the use of persistent luminescent pigments in works of art

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The idea that a product of artistic interest can emit its own light has always fascinated humanity and research on this phenomenon has been carried out since ancient times. The first documented case of using persistent luminescent pigments dates back to the 10th century AD in China (1).

However the golden age of the "phosphors" were the 17th – 19th centuries, when in the early days of modern chemistry, substances capable of emitting light as a result of sunlight irradiation were discovered. The famous "Stone of Bologna", was of particular interest, to generations of intellectuals, from Galileo Galilei to Goethe. However, there is little documentation regarding their use in the arts. (2)

In recent years there has been renewed interest in persistent luminescent materials, also because of the greater understanding of the mechanisms of luminescence (3, 4, 5).

Within the framework of a collaboration between the Chemical Science for the Safeguard of Cultural Heritage Group (SCIBEC) together with the Master Painter Luca Battini, we are setting up a new methodology to apply pigments based on barium sulphide on "a secco" wall painting technique. The main results will be described.

References

1. E. Newton Harvey, "A History of Luminescence: From the Earliest Times until 1900", Chapter 1, Amer. Phil. Soc., Philadelphia (1957), 18-20
2. *ibid.*, Chapter 8, 307-309
3. J. Hölsä, "Persistent luminescence beats the afterglow: 400 years of persistent luminescence" *Electrochem. Soc. Interface* **18**(4), 42–45 (2009).
4. Koen Van den Eeckhout, Philippe F. Smet and Dirk Poelman "Persistent Luminescence in Eu²⁺-Doped Compounds: A Review" *Materials* **2010**, 3, 2536-2566
5. Hermi F. Brito, Jorma Hölsä, Taneli Laamanen, Mika Lastusaari, Marja Malkamäki, Lucas C. V. Rodrigues "Persistent luminescence mechanisms: human imagination at work" *Opt. Mater. Express* **2**(4) 371-381 (2012)

ReINVENT: reconnecting and recreating 19th century Scottish textile manufacture

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The interpretation of coloured textiles in museum collections tends to be in terms of values and viewpoints of design, fashion and socioeconomics. When there is interest in the fibre type of the yarn, fabric or the colorants for provenance, dating and authentication, analytical methods can be applied to the historical textiles to interrogate the polymer chemistry of the fibres and the chromatic chemistry of the colorants. The analytical results then become primary tangible evidence of chemistry in material culture, but it is essential for the analytical chemist to be able to interpret the results through contextualisation with historical methods of production. Archives of dyeing manuals, pattern books, chemists' notebooks, technical literature, samples of original manufacturing materials and such like, alongside research publications and knowledge dissemination by historians of chemistry and science, are invaluable resources to the analyst.

Added value comes to the historical picture through reconstruction, which often takes the experimental chemist beyond the product to the literal nuts and bolts of the technology of production. With ventures into this area come questions about supplies, tools, power and suchlike. A new knowledge exchange project called 'ReINVENT' is underway to aid reconstructions for Scottish textiles of the Industrial Revolution. Well-known and forgotten nineteenth century Scottish manufacturing practices will be explored by reconnecting material culture evidence from historical artefacts with science and engineering evidence from historical technology for iconic Scottish textiles like Paisley shawls, Stoddard Templeton carpets and Turkey red printed textiles. Three cross-disciplinary workshops of novel knowledge exchange between conservators, historians, scientists and engineers will reconnect material and technical knowledge gained from interpreting and preserving historical textile and technology collections, and from recreations of historical industrial practices. The aim is to develop a shared inventory of Scottish industrial heritage as testament to the lasting legacy of Scotland's worldwide reputation for manufacturing innovation. Discussions from the first two workshops, one on materials and the other on tools, will be presented.

Textile dyeing in late nineteenth-century Glasgow: Interpreting and re-creating the dye chemists' experiments from lab to manufacture

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From 1785 to 1900, the booming textile industry in Glasgow saw great advances in textile dyeing. A major part of its success was due to Turkey red, the bright and fast hue imparted to cotton that was exported from Glasgow all over the world. The records that exist from firms such as the United Turkey Red Company, Ltd. (UTRC), part of whose archives are now located at the University of Glasgow, can only tell us part of the story because of the highly-secretive nature of textile dyeing.

This project aims to re-create the Turkey red process from documents in the UTRC collection and contemporary publications such as Knecht's *A Manual of Dyeing*¹, published in 1893. While parts of the chemistry of Turkey red have been discussed, such as the proposed calcium-aluminium-alizarate complex², there is no definitive or comprehensive study of what made Turkey red so chemically distinct. Difficulties so far include replacing historic ingredients with chemically similar modern ones and working with materials like sheep droppings that are now subject to modern regulations. It is ingredients like this, however, which we do not know the exact purpose for but nevertheless survived over a century of innovation as well as the development of synthetic dyestuffs.

Perkin's 1856 development of synthetic dye rapidly changed the industry within a few decades. Alizarin, the primary colourant in Turkey red, was originally extracted from madder. It became the first naturally occurring dye to be synthesized, linking Turkey red closely to synthetics. This aspect of the industry will also be investigated and re-created to compare the chemistry of madder-derived dye and its synthetic replacement. We hope to tell the story of the underemphasized role of British chemists in synthetic textile dye manufacture and the links between the UTRC and the British Alizarine Company.

This project aims to determine the chemical nature of Turkey red and compare natural versus synthetic dye. We will develop a micro-analytical method by ultra high-performance liquid chromatography to identify the chemical profile of textile artefacts and hopefully determine pre- or post-synthetic origin. These methods will be adapted to identify and separate later, fully-synthetic dyes with no natural origins. It fits within the framework of the ReINVENT knowledge exchange network³, which aims to address ways in which to "explore well-known and forgotten nineteenth century Scottish manufacturing practices by reconnecting material culture evidence from historical artefacts with science and engineering evidence from historical technology."

¹ Knecht, Edmund, Christopher Rawson, and Richard Loewenthal. 1893. *A Manual of Dyeing*. Vol. 2. London: Charles Giffin & Company, Limited. 11

² François Delamare and Bernard Monasse, "Le Rôle De L'Alun Comme Mordant en Teinture. Une Approche Par La Simulation Numérique. Cas De La Teinture De La Cellulose À L'Alizarine." (presented at the L'alun de Méditerranée, Naples, 2003), 277–290.

³ <http://www.stickssn.org/site/pages/projects/reinvent.php>. Funded by the Royal Society of Edinburgh- Scottish Government.

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