The 11th International Conference on the History of Chemistry

11 ICHC

Trondheim, Norway
29 August - 2 September 2017

EuCheMS European Chemical Sciences
Working Party on History of Chemistry

11TH INTERNATIONAL CONFERENCE ON THE HISTORY OF CHEMISTRY, TRONDHEIM 2017

BOOK OF ABSTRACTS

Edited by Annette Lykknes and Ignacio Suay-Matallana

Organised and hosted by:

EuCheMS European Chemical Sciences
Working Party on the History of Chemistry

NTNU – Trondheim
Norwegian University of Science and Technology

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The steering organising committee gratefully acknowledges the continuous support received from the members of the international Advisory Committee in preparing and organising the conference.

The editors of this booklet are particularly grateful to Peter Morris checking some of the texts and to Christoph Meinel for the final copy-editing and layout.

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Welcome address

Dear Conference participants,

This summer we will celebrate the fortieth anniversary of the creation of the Working Party (WP) on History of Chemistry, belonging to what today is called the European Association for Chemical and Molecular Sciences (EuCheMS) – the umbrella organisation for the national chemical societies. The first international conference on history of chemistry (ICHC) was organised in 1991 in Veszprém, Hungary, and since then our conferences have taken place in Hungary, Belgium, Portugal, Germany, and Sweden. The general aim of the biennial conferences organised by the WP is to bring together, and facilitate communication between historically interested chemists/chemistry educators, and historians of chemistry from all over Europe and beyond. We are pleased that the 11th ICHC has attracted more than 100 participants from different national communities in more than 25 countries and six continents.

The steering organising committee is proud to welcome you to Trondheim, a city founded in 997 which served as Norway's capital during the Viking Age. Through history, the city has been important as a centre for knowledge in Norway. The country's first learned society, the Royal Norwegian Society of Sciences and Letters (DKNVS), was established in Trondheim in 1760. This was more than fifty years before the country, which at that time was under Danish rule, had its own university. In the 20th century, Trondheim was given national responsibility for technology education and teacher training. Today, the Norwegian University of Science and Technology (NTNU) continues to fulfil this mission.

The conference has received funding from NTNU's Faculty of Social and Educational Sciences, Department of Teacher Education, Department of Chemistry, Department of Material Science and Engineering, Department of Chemical Engineering, and Department of Biotechnology and Food Science; the Research Council of Norway, the Norwegian Chemical Society and its Division for History of Chemistry; the Chemical Heritage Foundation (CHF), the Society for the History of Alchemy and Chemistry (SHAC), Sintef Materials and Chemistry (Silver sponsor) and INEOS/INOVYN (Gold sponsor).

We wish you an enjoyable time during the 11th ICHC in Trondheim, with plenty of opportunity for fruitful discussions and network building.

The steering organising committee:

Associate professor Annette Lykknes,
Norwegian University of Science and Technology (NTNU), Trondheim (chair of the Local Organising Committee)

Professor Christoph Meinel,
Universität Regensburg (co-chair of the Advisory Committee)

Dr. Brigitte Van Tiggelen,
Mémosciences / Chemical Heritage Foundation (chair of the Working Party on History of Chemistry)

Dr. Ignacio Suay-Matallana,
Centro Interuniversitário de História das Ciências e da Tecnologia, Lisbon (co-chair of the Advisory Committee)

Greetings from the Head of the Department of Teacher Education (NTNU)

Dear participants at the 11th International Conference on the History of Chemistry,

On behalf of the Norwegian University of Science and Technology it is a pleasure to welcome you to Trondheim and four intense days with exchange of scientific ideas and results.

Trondheim was founded by Viking kings more than 1000 years ago. It grew as a trading town in the nineteenth century when copper from the large copper mines around Røros was shipped out of Trondheim. In this period, Røros Copper Works was one of the most successful mining companies in Europe. The charming city of Røros is about 150 kilometers south of Trondheim and is today a UNESCO World Heritage Site. In the Røros area there are ruins of several smelting plants from the more than 300 years long period of making copper.

In the early 20th century, Trondheim became the main city for higher education and research in technology in Norway. The Norwegian Institute of Technology was established in 1910. In 1922 the national parliament established the Norwegian Teachers College in Trondheim. These two historical institutions became the main parts of Norwegian University of Science and Technology. The Department of Teacher Education, inter alia, manage this tradition in cooperation with disciplinary departments at the university, including the departments in the natural sciences. The department offers education of all kinds of competencies needed in primary and secondary schools, with a large range of strong research environments.

I hope you will enjoy the conference.

Torberg Falch
Head of Department

Department of Teacher Education
Norwegian University of Science and Technology

Forty years history of the EuCheMS Working Party on the History of Chemistry (WPHC)

More than 40 years ago, on April 22nd, 1977, a few chemists gathered in Budapest for what they called the „first statutory meeting for a Discussion Group for History of Chemistry". This group emerged in the framework of the Federation of European Chemical Societies (FECS), founded in 1970, and renamed European Association for Chemical and Molecular Sciences (EuCheMS) in 2004. Each member represented his (no women then!) own country. Representatives from Belgium, Czechoslovakia, Denmark, France, Federal Republic of Germany, Hungary, the Netherlands, Poland and Sweden were among the founders, and the Hungarian chemist Ferenc Szabadváry, author of the well-known *History of Analytical Chemistry* (Oxford: Pergamon Press, 1966), was elected chair.

Though the group started small, and without any subsidy, the work programme was quite ambitious.

The first point was to initiate the celebration of anniversaries of chemists and historically important scientific events around Europe. To that aim, a celebration calendar was started, and national chemical societies were invited to inform the Discussion Group about local events, while some events or publications could be put under the auspices of FECS when a wider international scale was more appropriate. In fact, the next meeting of the Discussion Group was held at the Royal Institution in London, to celebrate Humphrey Davy's bicentenary in December 1978.

The second point of the programme was to investigate how the history of chemistry and chemical industry was taught in both secondary schools as well as in universities. The aim was to provide chemists with some information on where to gain „useful knowledge about the past of their science". While all of the founding members were chemists, they were very mindful of the difficulty to attract the attention of their peers.

A guide of European chemical museums constituted the third point of the programme. This guide was to include not only museums of chemistry and chemical industry, but also exhibitions and collections containing some history of chemistry. Such a manuscript actually already had been started in Dutch, at the hand of J.W. van Spronsen, a science teacher, passionate about the history of chemistry. Rupert Hall agreed to revise a shorter English version and in 1981, a *Guide of European Museums and Expositions on Chemistry and History of Chemistry* was published in Budapest under the auspices of FECS, with a third updated edition in 1998, which also included pharmaceutical collections. The group contemplated at a later stage to gather information and list other „places of chemistry", like chemists' houses and venues, chemical laboratories, scientific institutions, parts of factories and industrial plants, etc.

While the three points of the programme seem to be somewhat unrelated, they were all related to a tacit goal the small group embraced: to convince both chemists and the general public of the value of the history and the heritage of chemistry.

As more and more countries and chemists actively engaged in history joined, the group was recognized as a Working Party on the History of Chemistry (WPHC) of FECS. By 1985, 15 countries were represented. The emphasis on chemists and dates progressively gave way to thematic meetings, for instance one on the Philosophy and History of Analytical Chemistry in Vienna in 1985.

Also, efforts were successfully made to connect with historical divisions of national chemical societies, including the American Chemical Society, as well as with general history of science conferences, as was the case for the International Union for the History and Philosophy of Science (IUHPS) conference held in Bucharest in 1981, and later in Zaragoza in 1993, in Liège in 1997 or in Budapest in 2009.

The group thus seized all opportunities to meet during FECS and other large conferences, or to join national meetings, mostly those of the Gesellschaft Deutscher Chemiker (Göttingen 1983, Aachen 1987, Bonn 1995), but the time was ripe for the first International Conference of History of Chemistry, in Veszprem (Hungary) in August 1991, soon followed by a second conference which included the history of the chemical industry (Kesthely, Hungary, 1995). When the third conference took place in 1999, and the fourth in 2003, both in Budapest, this was the start of our biennial ICHCs which have left its Hungarian birthplace to spread all over Europe since Estoril in 2005.

Looking back at the early programme of the Discussion Group, one cannot but be struck at how similar some of the preoccupations of the founders of the WPHC are with our present concerns. How do we connect the local and the regional to the European level, be it in professional networks, in scientific and teaching activities, in historical methods of chemistry and in commemorating practices that many still appreciate? How do we raise awareness for the history and the heritage of chemical and molecular sciences among both chemists and the general public? How do we promote both teaching and scholarship in our field?

Perhaps a new guide of European museums and collections needs to be collated, and recently a survey on the teaching of the history of chemistry was published. It would seem we have not progressed, but quite the opposite is true. While some of the pre-occupations and tasks remain, our community has expanded, in number and in vitality, in diversity and in professionalism. The fact that a large number of us gathered here in Trondheim, presenting on a wide variety of topics and chronology in two parallel sessions, coming from many different countries of Europe but also from other parts of the world, reflects on the growth of the WPHC and the ICHC. This bodes well for the future, as there will be, no doubt, new challenges ahead. For now, let us proudly celebrate our 40th birthday and reap the fruits of maturity.

Brigitte Van Tiggelen
Chair of the WPHC

Committees

Programme Committee / Steering Organising Committee:

Professor Christoph Meinel, Universität Regensburg (co-chair of the Advisory Committee)

Dr. Ignacio Suay-Matallana, Centro Interuniversitário de História das Ciências e da Tecnologia, Lisbon (co-chair of the Advisory Committee)

Associate professor Annette Lykknes, Norwegian University of Science and Technology (NTNU), Trondheim (chair of the Local Organising Committee)

Dr. Brigitte Van Tiggelen, Mémosciences/Chemical Heritage Foundation (chair of the Working Party on History of Chemistry)

Local Organising Committee:

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Associate professor Per-Odd Eggen, ILU, NTNU

Assistant professor / Higher Executive Officer Ellen Marie Andersson, ILU, NTNU

Advisory Committe:

Marco BERETTA, Università di Bologna, Italy

Carin BERKOWITZ, Chemical Heritage Foundation, USA

José-Ramón BERTOMEU-SANCHEZ, Instituto de Historia de la Medicina y de la Ciencia, Universitat de Valencia, Spain

Gisela BOECK, Universität Rostock, Germany

Danielle FAUQUE, Université Paris-Sud 11, France

Hjalmar FORS, Kungliga Tekniska Hogskolan, Sweden

Practical information and site map

Contact

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Ellen Andersson: (+47) 90024937

Guided warming-up, Tuesday 29th August

Those who would like to join us for the reconstruction and re-enactment of the sixteenth-century distillation furnace, please follow us directly from the welcome party. The distillation furnace is situated behind Suhm-huset (the Suhm building), belonging to the NTNU University Museum – in Elvegata 6 (This is not the main building of the museum).

Venue

The conference takes place in „Banksalen" in the old Trondheim Sparebank quarters from 1882. The conference center is located at Søndre gate 4, tel. (+47) 97061815. Plenary Lectures and A#-Sessions will be in room „Amfiet" on second floor; B#-Sessions will be in room „Lars Tiller" in the basement. Coffee and tee will be served both on the second floor and in the basement, but must not be brought inside Amfiet. Coffee breaks will take place on the second floor.

Organ Concert, Thursday 31st August

Participants who would like to attend the organ concert in Nidaros Cathedral: We will leave from the conference venue at 18:10. Admission to the Cathedral starts at 18:15. From the Cathedral we will go directly to St. Olavs gate, where the vintage tram will be waiting to take us to Lian Restaurant.

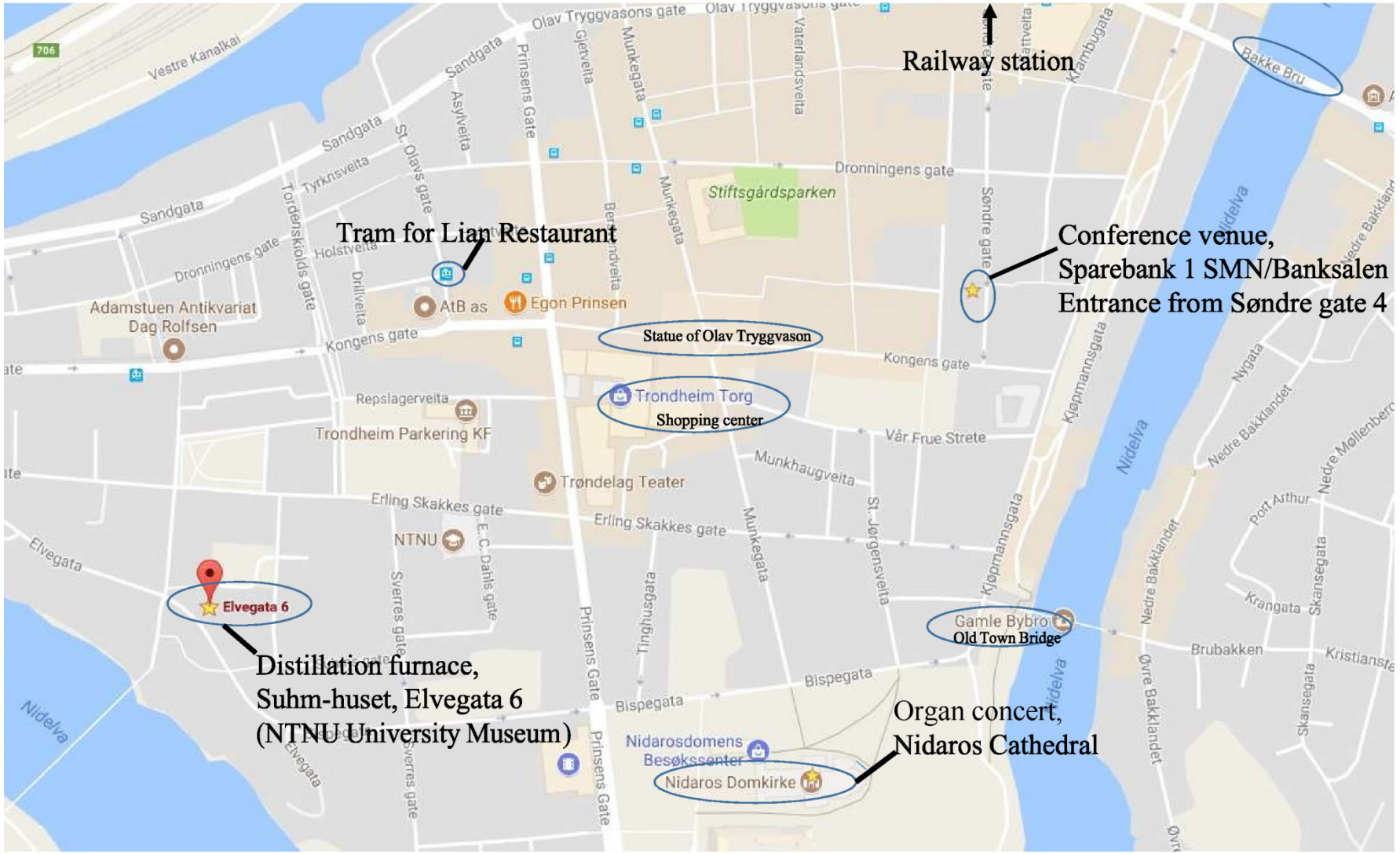
Conference dinner, Thursday 31st August

Participants not coming to the Cathedral, please go to St. Olavs gate, where the tram will wait for us. The tram will leave at 19:30. If you miss the tram, please wait for the regular tram, which will take you to Lian (final stop): every 30 minutes from 19:45. You will see the nice, white building on the top of the hill. Tel. (+47) 72565120.

A bus will take us back to the city centre after the dinner. If you prefer to leave earlier, you may take the regular tram service, which runs every 30 minutes until 23:42.

Excursions to Sverresborg, Ladestien and Røros

For registered participants only. The bus will wait for us outside the conference venue, in Søndre gate (see map). Don't forget to bring comfortable clothes and shoes, and rain coat and trousers if you have. Departure time: to Sverresborg 18:10, to Ladestien 18:00, to Røros 8:00.


Railway station
Tram for Lian Restaurant
Conference venue,
Sparebank 1 SMN/Banksalen
Entrance from Søndre gate 4
Statue of Olav Tryggvason
Trondheim Torg
Shopping center
Gamle Bybro
Old Town Bridge
Elvegata 6
Distillation furnace,
Suhm-huset, Elvegata 6
(NTNU University Museum)
Organ concert,
Nidaros Cathedral
Nidaros Domkirke
Nidarosdomens Besøkssenter
Trøndelag Teater
Trondheim Parkering KF
Adamstuen Antikvariat
Dag Rolfsen
AtB as
Egon Prinsen
Stiftsgårdsparken
NTNU
Nidelva
Bakke Bru
Olav Tryggvasons gate
Dronningens gate
Kongens gate
Erling Skakkes gate
Bispegata
Munkegata
Prinsens Gate
Søndre gate
Kjøpmannsgata
Nedre Bakklandet
Vår Frue Strete
Munkhaugveita
Sandgata
Elvegata
Brubakken
Krangata
Skansegata
Nygata
Port Arthur
Nedre Møllenberg
Vestre Kanalkai
706

Time schedule

<table>
<tr><th>Tuesday, 29 Aug</th><th>Wednesday, 30 Aug</th></tr>
<tr><td rowspan="2">Programme as at 11 August 2017;
papers are listed by short titles.

Rooms: [A] = Amfiet, second floor
[LT] = Lars Tiller, basement</td><td>09:00 Plenary Lecture [A]
Maria Rentetzi, “Living with radiation: What historians of chemistry have to do with science diplomacy and international organizations”
(chair: I. Suay-Matallana)

10:15 Coffee Break

10:45-12:45
Session A1 [A]
<u>Panel:</u> Chemists and the IUPAC: Taking Responsibility and Taking Actions
(organisers: D .Fauque, B. Van Tiggelen)
➢ D. Fauque, chair
• R. Brashear, “The Archives of the IUPAC”
• Y.Kikuchi, “Japan’s Engagement with International Chemistry”
• D. Fauque, “French Chemists in IUPAC”
• E. A. Zaitseva (Baum), “Russian Presidents of the IUPAC”
• A. E. Robinson, “Order and Discipline”
• B. Van Tiggelen, “Commentator and Round Table Discussion”

10:45-12:45
Session B1 [LT]
Alchemy and Early Chemistry
➢ P. Teissier, chair
• A. Wittstock, “Transmitting alchemical knowledge”
• B. T. Moran, “Particles and Panacea”
• B. Petitjean, “Mineral Waters in Tuscany”
• W. Li, “Wilhelm Homberg’s paradigm transition”
• C. Abney Salomon, “Pocket Laboratory in 18th-C Sweden”

12:45 Lunch Break

14:00-15:20
Session A2 [A]
<u>Panel:</u> The chemical innovation system in the „Third Reich“
(organiser: C. Reinhardt)
➢ C. Reinhardt, chair
• H. Maier, “Limits of Growth”
• M. Stöcken, “Documentation of foreign scientific literature”
• S. Große-Wilde, “‘Heimstoffe’ made of cellulose”

14:00-15:20
Session B2 [LT]
Women in Chemistry
➢ S. Štrbánová, chair
• G. Boeck; T. Peppel, “First Women at Rostock”
• Y. Alexiou, “Limits of participation”
• E. Lõhkivi, “Gendered Workplace”

15:30 Coffee Break

16:00-18:00
Session A3 [A]
Elements and the Structure of Matter
➢ C. Nawa, chair
• J. Trofast, “Jacob Berzelius - Cerium, Selenium”
• S. Waring, “Wollaston and Dalton”
• H. Kutzke, “Polymorphic organic compounds”
• D. Liu “Micelles and Molecules”
• K. Ruthenberg; B. Van Tiggelen, “Definition of chemical element”
• H. Kragh, “Superheavy elements”

16:00-17:20
Session B3 [LT]
Dyes and Pigments in History
➢ A. Petersen, chair
• E. Homburg, “Quality Control Dutch Madder”
• M. Pinto, “Historical pigments”
• A. Quye, “Early synthetic dyes”
• F. Saeland, “Titanium White”

17:20-18:00
Session B3a [LT]
Recent Chemistry:
New methodological approaches
➢ Y. Kikuchi, chair
• B. Hervy, M. Quantin, P. Teissier, “Solid State Chemistry”
• M. Indergaard, “Polysaccharide research”</td></tr>
<tr><td>17:30 Registration starts</td></tr>
<tr><td>18:30 <u>Opening Session</u> [A]
(chair: A. Lykknes)</td><td rowspan="4">18:00 Excursion to Sverresborg
(optional, snack/light lunch included)</td></tr>
<tr><td>19:00 <u>Plenary lecture</u> [A]
Hasok Chang, “What history tells us about the nature of chemistry”
(chair: B. Van Tiggelen)</td></tr>
<tr><td>20:00 Welcome Party</td></tr>
<tr><td>21:00 Guided ‘Warming-up’
Reconstruction and re-enactment of a sixteenth-century distillation furnace
L. Kvittingen, F. Kirkemo</td></tr>
</table>

<table>
<tr><th colspan="2">Thursday, 31 Aug</th><th colspan="2">Friday, 1 Sept</th><th>Saturday, 2 Sept</th></tr>
<tr><td colspan="2"></td><td colspan="2" rowspan="2">08:30 Business Meeting Working Party [A]
(delegates only)</td><td rowspan="8">8:00–20:00

Excursion to Røros (optional, advance booking required)</td></tr>
<tr><td colspan="2">09:00 Plenary Lecture [A]
Anders Lundgren, “Science in chemical industry: what did it do?”
(chair: C. Meinel)</td></tr>
<tr><td colspan="2">10:15 Coffee Break</td><td colspan="2">10:15 Coffee Break</td></tr>
<tr><td>10:45-12:45
Session A4 [A]
<u>Panel:</u> Toxic Products: Communicating toxicity
(organisers: X. Guillem, J.R. Bertomeu)
➢ X. Guillem, chair
• C. Florensa; C. Sans Ponseti, “Radiation, Scientists and Publics in Spain”
• A. Nieto-Galan, “Chemical Pollution the Public Sphere”
• J. Gil-Farrero, “Nobody Wants Landfills”
• J. M. Galech, “Negative sculptures of toxicity”
• J. R. Bertomeu, Commentator</td><td>10:45-12:45
Session B4 [LT]
Science teaching: Historical perspectives
➢ G. Boeck, chair
• P. Grapí, “Fourcroy and chemistry education”
• K.Kiprijanov, “Learning with sausages”
• I. Malaquias, “19th-C Portuguese education”
• J.A. Pariente Silván, “Science in the Classroom”
• V. Milanovic; D. D. Trivic, “Chemistry Textbooks in Serbia”
• F.León Olivares, “Material culture of chemistry lecture”</td><td>10:45-12:45
Session A7 [A]
Boundary work: Chemistry and Economy
➢ E. Homburg, chair
• K. Schranz, “Carmichael Smyths’s Nitrous Acid”
• C. Halm, “Agricultural Chemistry”
• I. Suay-Matallana, “Customs Laboratory of Lisbon”
• L. Zwisler, “Flow injection analysis”
• K. A. Nier, “Military industrial tool”</td><td>10:45-12:45
Session B7 [LT]
Biographical approaches
➢ E. Zaitseva, chair
• A. Espelund “Sven Rinman”
• L. Saarlos “Edward Frankland”
• C. Bovolo “Ascanio Sobrero”
• S. Štrbáňová “Bohuslaf Raýman”
• E. Campos, “Edwin Cohn”
• M. Shindell, S. Ramasastry, “Toshiko Mayeda”</td></tr>
<tr><td colspan="2">12:45 Lunch Break</td><td colspan="2">12:45 Lunch Break</td></tr>
<tr><td>14:00-15:20
Session A5 [A]
<u>Panel:</u> Toxic Products: Toxic Risks
(organisers: X. Guillem, José R. Bertomeu)
➢ J. R. Bertomeu, chair
• R. Lutz, “Petroleum Progress”
• P. Punter-Chiva, “Climate Change Spanish Deniers””
• C. Teixeira, M. C. Lourenço, “Toxic Substances in Scientific Collections”
• X. Guillem, Commentator</td><td>14:00-15:20
Session B5 [LT]
Chemistry teaching: new approaches
➢ G. Pallo, chair
• L. Moreno-Martinez, “Modesto Bargallo”
• T. Hagendijk, “Learning from recipes”
• A.Marchal Ingrain, “History of Periodic Table”
• U. Eikeseth, “Asbestos and chemistry teaching”</td><td>14:00-15:20
Session A8 [A]
<u>Panel:</u> Relating Chemistry: Translating Chemistry Across Linguistic, Disciplinary, and Physical Boundaries
(organiser: C. Berkowitz)
➢ C. Berkowitz, chair
• C. Berkowitz, “James Woodhouse and Chemistry”
• J. Beckman, “Jöns Jacob Berzelius and Swedish”
• Y. Siderer, “Historical, Cultural and Linguistic Study in Translation”
• H. Chang, “Huaxue Qiushu: The Peak of the Introduction of Western Chemistry”</td><td>14:00-14:45
Session B8 [LT]
Polymers and Plastics
[sponsor: INEOS/INOVYN]
➢ P. Morris, chair
• A. Petersen “Early Danish Plastics Industry”
• M.E. Callapez, T. Mota “Plastic, Anthropocene and Time”

14:50-15:30
Session B8a [LT]
“All Things Bakelite”
[sponsor: INEOS/INOVYN]
Preview of a documentary film by Hugh Karraker (great grandson of Leo Baekeland)</td></tr>
<tr><td colspan="2">15:30 Coffee Break</td><td colspan="2">15:30 Coffee Break</td></tr>
<tr><td>16:00-18:00
Session A6 [A]
<u>Panel:</u> Toxic Products: Toxic Risks (contd.)
(organisers: X. Guillem, José R. Bertomeu)
➢ C. Florensa, chair
• J. R. Bertomeu-Sánchez, “Arsenic in Spain (1840-1940)”
• F. Hachez-Leroy, “Aluminium in Food: the forgotten Controversies
• X. Guillem-Llobat, “Fighting pests with hydrogen cyanide”
• S. Arapostathis, “Fertilising Farms and Institutional Authorities”
• E. Aucouturier, “French Chemical Weapons Trials in the Algerian Sahara”
• A. Nieto-Galán, Comments and Concluding Remarks</td><td>16:00-17:20
Session B6 [LT]
Chemistry teaching: new approaches (contd.)
➢ I. Malaquias, chair
• E. Maia; R. Pestana, “Influence of TV series”
• A. Ghosh; C. Wamser, “Arrow Pushing”
• K de Berg, “A view of the iron(III) thiocyanate”
• J. Chamizo, “Fifth Chemical Revolution”</td><td>16:00-17:30 Closing Session
A9 [A]
<u>Panel:</u> What future for the history of recent chemistry and molecular sciences? New Challenges in the History of Chemistry and the Molecular Sciences
(organisers: J. A. Johnson; C. Meinel; B. Van Tiggelen)
➢ B. Van Tiggelen, chair
• B. Bensaude-Vincent
• L. Jiang
• Y. Kikuchi
• C. Mody
• C. Reinhardt</td><td></td></tr>
<tr><td colspan="2">18:30 Organ Concerto, Nidaros Cathedral
(optional and free)</td><td colspan="2" rowspan="2">18:00 Excursion to Ladestien
(optional, snack/light lunch included)</td></tr>
<tr><td colspan="2">20:00 Conference Dinner
(for registered participants, tram to the venue leaves ca. 19:30)</td></tr>
</table>

Plenary lectures

Tuesday, 29 Aug, 19:00
(chair: B. Van Tiggelen)

What history tells us about the nature of chemistry

Hasok Chang
University of Cambridge, hc372@cam.ac.uk

What can the history of science tell the practicing scientist? Knowing about the past is relevant especially because the progress of science is not completely cumulative or linear. Past science is not simply wrong or not simply a poorer version of present science. Our present science has been shaped by the necessities and contingencies of the past, and understanding those past forces will help us in steering future science in desirable directions.

Concerning chemistry more specifically, the first thing we need to understand is why chemistry should have remained a separate discipline rather than becoming a branch of applied physics, even after the advent of quantum chemistry. There are three main reasons: epistemological, industrial, and experiential. (1) Despite the dominance of the reductionist ideology and much labour spent in its service, it has not been possible to do chemistry entirely in terms of physics. (2) A long history of association with chemical industries has made the social location of academic chemistry very separate from that of other sciences. (3) The distinct quality of the quotidian chemical laboratory experience has remained a foundation for the practice of chemistry; this was at the core of the early public flourishing of chemistry, and it remains an essential part of chemical education today.

Wednesday, 30 Aug, 09:00
(chair: I. Suay-Matallana)

Living with Radiation: What Historians of Chemistry Have to do With Science Diplomacy and International Organisations

Maria Rentetzi
Laboratory for HPST, National Technical University of Athens, mrentetz@vt.edu

As historian of radioactivity and nuclear science my conviction has been that the historian's task is to look to the past for insights on contemporary social, political, and cultural concerns. Being interested in the history of the present—how, for example, we ended up living with radiation the ways we do—here I urge us to think how we could address global public concerns with our historical scholarship.

Arguably, radiation protection is the next frontier in nuclear science. It has become evident that aspects of nuclear power production and the use of radiation in medicine have been harmful to humans and the environment. In response, scientists have

proposed technical radiation standards in order to reduce the harmful effects of radiation exposure. But they have not questioned the history behind their implementation and have neglected societal concerns. The effects of this approach can be seen in continuing incidents of radiation overexposure in the nuclear industry and the medical sector. While the socio-historical dimensions of radiation protection have been acknowledged in principle they are not well understood analytically and seldom inform policy efforts.

My argument is that scientific knowledge about radiation protection has been shaped by diplomatic, social, economic, and political concerns. Bringing history of nuclear science together with the history of international organisations and diplomatic relations and thus marking a „diplomatic turn" in history of science, I investigate what has been historically treated as a strictly techno-scientific issue: how best to protect us from ionized radiation.

Thursday, 31 Aug, 09:00

(chair: C. Meinel)

Science in chemical industry – what did it do?

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It is still a common view, that development of chemical industry during the 19th century was the result of the application of science. We now know this is a simplification, but even so I will argue that the significance of science, meaning knowledge produced at universities and academics, for the development of chemical industry during the 19th century has been overestimated. Knowledge behind the success of the chemical industry was mainly of another kind. Concepts like „science" and „technology" are too vague to be useful when describing this knowledge. Instead I will try concepts like analytical, synthetic and production knowledge. The first two are connected with academic chemistry and laboratory work, while the last is connected with industry. It is characterized by the handling of scaled up processes, by local and by mechanical knowledge. These characteristics of production knowledge, whose main object is to make industry profitable, differ from the scientific ideal of the universities. With some examples from sulphuric acid, phosphate, pulp and paper, and electrochemical industry I will argue that production knowledge was much more than applied science, and that it contained essential characteristics to which contemporary science couldn't contribute.

Abstracts of Panels and Sessions

(in chronological order)

WEDNESDAY, 30 AUG, 10:45-12:45, SESSION A1

Panel: Chemists and the IUPAC: Taking Responsibility and Taking Actions

D. Fauque, B. Van Tiggelen (organisers)
D. Fauque (chair)

- R. Brashear, „The Archives of the IUPAC"
- Y.Kikuchi, „Japan's Engagement with International Chemistry"
- D. Fauque, „French Chemists in IUPAC"
- E. A. Zaitseva (Baum), „Russian Presidents of the IUPAC"
- A. E. Robinson, „Order and Discipline"
- B. Van Tiggelen, Comment and Round Table Discussion

Since its foundation in 1919, many famous chemists have contributed to the International Union for Pure and Applied Chemistry (IUPAC), with the drive to improve standardisation of methods, nomenclature, units and standards, among other things. Without a doubt, progress was made, despite power struggles, uncompleted projects and unproductive commissions.

The session aims at shedding light on the activity of chemists invested with responsibilities in the IUPAC, whose actions are often overlooked in national biographical dictionaries. This session falls into the broader project on the centennial of the IUPAC, in 2019. Each paper will focus on the responsibilities and actions of individual chemists, alone or combined in a small national or disciplinary group, inside IUPAC. The case study can however expand on roles in other international organisations (International Research Council, International Council of Scientific Unions – ICSU, or UNESCO to name but a few).

By focusing on individual actions, the aim is to get a better sense of articulation between the local and the international, and how this articulation was constructed through the work and actions of chemists dispersed across the world.

The Archives of the International Union of Pure and Applied Chemistry at the Chemical Heritage Foundation

Ronald Brashear
Arnold Thackray Director of the Othmer Library, Chemical Heritage Foundation, Philadelphia, Pennsylvania, USA, rbrashear@chemheritage.org

In the mid-1990s, the archives of IUPAC's Commission on Atomic Weights and Isotopic Abundances were given to the Chemical Heritage Foundation, thanks to the efforts of Steffen Peiser. In 1997, the impending move of IUPAC's headquarters from Oxford to

Research Triangle Park, North Carolina, provided an opportunity for CHF to become the permanent home of the remaining IUPAC records that were not needed by the current administration. At the present time the total IUPAC archive consists of 388 boxes or 214 linear feet (65 linear meters) and 150 photographs. It is an important source for historians on the development and organisation of science. This paper will discuss the circumstances surrounding the acquisition of the archive, its contents, and how scholars can best gain access to the material. I will also discuss the possibility of finding and adding additional material to the archive.

Japan's Engagement with International Chemistry (1900-1930)

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This paper will examine why and how Japanese chemists started to work with their international colleagues in a variety of arena such as conferences, commissions, and organisations from ca. 1900 through the establishment of the IUPAC in 1919 to 1930. The first such opportunity arose in 1899, when the International Commission on Atomic Weights was organised with the initiative of German-based chemists such as Wilhelm Ostwald. Joji Sakurai and his erstwhile student and colleague Kikunae Ikeda represented the Tokyo Chemical Society. Sakurai was interested in the issue of atomic weights both from the scientific and economic point of view, and Ikeda was then studying physical chemistry with Ostwald and therefore was in a good position to communicate both with Ostwald and Sakurai. Known for his interest in chemical technology, Ikeda was also a key person in Japan's entry to the International Congress of Applied Chemistry (ICAC) in 1903 in Berlin. Japan's participation in the 1912 ICAC in New York was facilitated by New York-based Japanese industrial chemist Jokichi Takamine. These early engagement motivated largely by the practical matters of international chemistry provides an important backdrop for Sakurai's activities as a Vice-President of the IUPAC in 1923-25 and 1928-30.

French Chemists in IUPAC after the Second World War: a Strong Engagement

Danielle M.E. Fauque
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In 1945, encouraged by J. Bougault, his patron and vice-president of International Union of Chemistry, Raymond Delaby was named General Secretary (GS), to succeed Jean Gérard, who had been in this post during the first 25 years of the Union. Delaby was a very active man. In place during ten years, he notably restructured the Union following ICSU's new rules. He withdrew in 1955, and was elected vice-president. As president of Société chimique de France, he remained totally devoted to the organisation of the 19th international conference of IUPAC held in Paris in 1957.

In his headway, other chemists of great fame were also engaged in IUPAC Council: notably P. Jolibois (Vice-president), M. Letort (Section president), G. Chaudron (Vice-president), J. Bénard (President), G. Ourisson (GS), Y. Jeannin (President) during the period 1945-1991. French chemists seemed one of the national groups grandly invested in IUPAC administration, as, for example, the American and Soviet groups.

We would want to analyse the work that Delaby and his colleagues did during their offices, as in the view of the administration of IUPAC, as in diplomatic matters, especially during the Cold War.

Russian Presidents of the International Union of Pure and Applied Chemistry until 1995

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Several Russian scientists headed the IUPAC during the period 1967-1995: Kondratiev V.N. (1967-1969), Koptyug V.A. (1987-1989), Zamaraev K.I. (1994-1995). In this paper, based on open sources, interviews and private archives, I examine how this group of most renowned Russian chemists succeeded in their efforts of reorganisation and reorientation of activity of the Union so that it could readily and most effectively to respond to the global changes occurring in the world. Occupying the post of President, Kondratiev did much to bring IUPAC activities closer to the demands of the chemical industry. His memorandum (1967-1968) about reorganisation of Division Committees and Commissions furthered substantively the activities of IUPAC units. Kondratiev took part in founding the CODATA, the Committee on Data for Science and Technology – now it ensures data needs in a broad range of subjects. Paying a lot of attention to the development of computerization in chemical sciences, Koptyug, in turn, initiated and successfully implemented within the limits of the IUPAC a project on creation of electronic databanks on the properties of chemical compounds. His original idea of formation of «horizontal» interdisciplinary programs planned the involvement of different divisions and commissions into cooperative work (1989). The program «Chemistry and the Environment» was developed and led to the organisation of similar specialized Division within IUPAC in 1995 with Zamaraev. Zamaraev's great achievement is the implementation of a consecutive policy for improving the image of chemistry in the society.

„Order and Discipline": W. Conard Fernelius and the Nomenclature of Inorganic Chemistry

Ann E. Robinson
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W. Conard Fernelius (1905-1986) was an industrial and academic chemist, probably most known as a founder of the journal Inorganic Synthesis and of the Inorganic Chemistry Gordon Research Conference, but he had a passion for nomenclature.

During the Manhattan Project, he formed a study group on inorganic nomenclature that met weekly in the evenings. He regularly published articles on nomenclature and became involved with the nomenclature committees of the National Research Council (U.S.), the American Chemical Society, and the IUPAC.

Fernelius was Chair of the IUPAC's Committee on Nomenclature of Inorganic Chemistry (CNIC) at an important time in their history, in which they were engaged in updating the Red Book, the guidebook for inorganic nomenclature, and also struggling to create a systematic nomenclature for elements with an atomic number greater than 100. The support of friendships built within the IUPAC allowed Fernelius to make a bold move that pushed the CNIC's agenda forward despite misunderstandings between the Inorganic Division Chair and the CNIC, as well as opposition from certain sectors within the IUPAC itself.

Comment and Round Table Discussion

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WEDNESDAY, 30 AUG, 10:45-12:45, SESSION B1

Alchemy and Early Chemistry

P. Teissier (chair)

- A. Wittstock, „Transmitting alchemical knowledge”
- B. T. Moran, „Particles and Panacea”
- B. Petitjean, „Mineral Waters in Tuscany”
- W. Li, „Wilhelm Homberg’s Paradigm transition”
- C.Abney Salomon, „Pocket Laboratory in 18th-C Sweden”

Transmitting and forming alchemical knowledge in early modern alchemical compilations

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In the history of alchemy, the transmission of alchemical knowledge in texts plays an important role. However, compilations of alchemical texts do not only collect and hand down traditional knowledge.

They are neither simply ‘containers’ for the knowledge nor just ‘media’ for transmission.

In my paper, I would like to outline that alchemical compilations allow us to draw conclusions on the interpretation of the texts and of the alchemical knowledge that they present. Hereby, the textual transmission of alchemical knowledge is an important part of the history of science. In order to demonstrate the importance of this approach, my paper presents a compilation of manuscripts containing alchemical treatises and texts dealing with learned magic, dating from the 16th century. Most of the texts are written in Low German, some of them specially have been translated from Latin. Formerly possessed by the famous scientist and chemist Joachim Jungius, the codex is today at the 'Staats- und Universitätsbibliothek, Hamburg'. Although it is an intriguing collection of important texts (such as Agrippa von Nettesheim's De occulta philosophia and the only German translation of Marsilio Ficino's De vita coelitus comparanda) this codex hasn't been studied yet and still leaves many questions unanswered – such as the context of formation, the aim of the compilation and the specifics of the translation work. Taking this into consideration, I want to ask which knowledge on alchemy is presented by choosing, combining and translating these texts, and I would like to show to what extent the consideration of the textual transmission can be useful for the history of alchemy.

Particles and the Panacea: Corpuscular Cosmology, Ancient Knowledge, and the Alchemy of Edmund Dickinson

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This paper focuses upon the alchemical practices and the biblically based corpuscular cosmology of the English physician, Edmund Dickinson (1624-1707). I concentrate on four interrelated texts – Dickinson's account of the six days of creation and ancient corpuscular theory, Physicus vetus et vera (1705), his attack upon Peripatetic philosophy, Ad peripateticos, his views concerning transmutation, Epistola . . . ad Theodorum Mundanum (six editions between 1686 and 1705, and parts of which were transcribed by Isaac Newton), and his account of the material basis for exalting a universal circulating mercury in order to create a universal perfecting agent, or panacea (De medicamentis universalibus dissertation, no date).

Dickinson claimed to have partially witnessed the production of a philosophers' elixir by an itinerant adept who went by the name Mundanus. But who was Mundanus? Examining relevant sources, including a remaining manuscript at the British Library, points in an original direction. The paper also examines Dickinson's activities within a community of chemists at Oxford, including Robert Boyle and Peter Stahl, and explores his laboratory practices as they come to light in the notes of the Danish polymath, Ole Borch (1626-1690), who visited Dickinson's laboratory on several occasions in the early 1660s.

Testing the Mineral Waters: Science and Medicine in Early Modern Tuscany

Beth Petitjean
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During the early modern period, several Italian physicians wrote published treatises touting the medical uses of the mineral waters in Tuscany. Although historians of science have noted the testing of mineral waters in the development of chemistry, little attention has been paid directly to the bath treatises and the information they reveal about scientific experimentation that occurred at the baths. In this paper, I argue that baths were key nodes in the network through which knowledge about chemistry and minerals circulated among university medical professors, bagnature, who were the local doctors treating patients at the baths and experimenting with the water, and scientific academies in Italy and elsewhere. Specifically, I focus on the baths of San Casciano near Siena and a treatise published in 1733 by the resident bagnatura, physician Jacopo Filippo Bastiani. In his text De' Bagni di San Casciano, Bastiani included the experiments he performed and an extensive listing of case studies for the patients he treated with mineral water. I posit that Bastiani's relationship with the Sienese Accademia dei Fisiocritici connected him with then recent scholarship produced by physicians and chemists in France, England, and Germany, and, in turn, integrated Tuscan baths into the European scientific community.

Wilhelm Homberg and the Paradigm Transition from Principlism to Compositionism in the Early Eighteenth Century

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The Chemical Revolution has been considered to feature a paradigm transition from principlism to compositionism, without which recent studies hardly explain anti-phlogistonists' triumph in the absence of the self-evident epistemological superiority. The beginning of this change has been traced back to Etienne-François Geoffroy's (1672-1731) Tables des Rapports of 1718 by such researchers as Klein. This article, however, focuses on one of Geoffroy's predecessors in Paris Academy of Sciences, Wilhelm Homberg (1652-1715), and recognize his unique role at the very beginning of the fundamental conceptual transformation. In particular, by identifying Homberg's self-contradiction in his definition and explanation of Souphre Principe, I discuss how his work was connected to the long-standing principle-analysis pattern while at the same time introduced the presumptions of the chemical composition. By doing this, I try to get a better understanding of the complexity of Chemical Revolution.

Chemical Analysis, Scientific Authority, and the Pocket Laboratory: Mineralogy in Eighteenth-Century Sweden

Charlotte A. Abney Salomon
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The field of chemical mineralogy in Europe was essentially established with the publication of mineralogical texts by three Swedish researchers, Johan Gottschalk Wallerius (1747), Axel Fredrik Cronstedt (1758), and Torbern Bergman (1783), each cited within the following decades as the field's „founder." All three texts circulated widely in multiple translations and heavily influenced the development of mineralogy, chemistry, and geology throughout the nineteenth century, as evidenced by the works' continuous presence both in citations and in personal libraries. These works advanced new, chemical systems of analysis and organisation for rocks and minerals, ideas developed, as this paper shows, within a research community driven by the needs of the Swedish mining industry to an extent largely unrecognized today.

In this paper, I examine the authoritative intellectual position that these academics and mining scientists occupied in cosmopolitan chemistry, detailing the scientific, rhetorical, and publication techniques that these three chemists each used, in the construction of these texts and elsewhere, to assert and maintain natural philosophic and scientific authority across Europe while their research was deeply entwined with the practical demands of industry. In particular, I emphasize the role of the use and promotion of the method of blowpipe analysis, developed by the Swedish chemical community from an ancient artisanal skill into a modern scientific practice, bringing the technique out of the workshop and laboratory and into the field with the introduction of the „pocket laboratory" portable blowpipe kit.

WEDNESDAY, 30 AUG, 14:00-15:20, SESSION A2

Panel: The chemical innovation system in the „Third Reich"

C. Reinhardt (organiser and chair)

- H. Maier, „Limits of Growth"
- M. Stöcken, „Documentation of foreign scientific literature"
- S. Große-Wilde, „'Heimstoffe' made of cellulose"

As historical research has shown, the German chemical industry and science played a key role in the National Socialist innovation system for ideological, economic and political reasons. Based on these results, the session will develop new questions and present some findings regarded from three perspectives.

The first presentation will discuss the conditions of the expansion of German chemical research and development in the context of the „Four Year Plan". In contrast to recent historical studies, Helmut Maier will argue that the growth rates of the chemical

innovation system stayed on course up to 1943. Furthermore, he will discuss the conditions of the system's growth and will provide answers for the question why this growth stagnated from 1944 until the end of the war.

Obtaining and analysing scientific literature was a central aspect for the function of the chemical innovation system. But the import of foreign publications became problematic in the course of the war. Malte Stöcken will show how the civil association of German chemists, the „Deutsche Chemische Gesellschaft", mobilized their network and cooperated with military and public authorities to procure and distribute foreign literature even until the very end of the war.

Subsequently, Simon Große-Wilde will analyse the connections between vulcanized fibre, a historical plastic based on cellulose, and the Nazi-Regime. Before the war, vulcanized fibre had been produced from imported cotton-linters, and the lecture will accordingly ask the question of how the transformation of the resource base to materials of German origin happened and which role vulcanized fibre achieved in the system of German autarchy.

Limits of Growth: Expansion and Stagnation of the German Chemical Innovation System up to 1945

Helmut Maier
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From its very beginning, the Nazi-regime introduced a policy of rearmament and economic autarky in which chemistry played a key role. In consequence, chemical research and development benefited tremendously. From 1936 onwards, with the proclamation of the „Four Year Plan", new chemical plants were erected for the production of substitute raw materials. As recent studies show, along with this, the funding for R&D grew to before unreached heights. Against the traditional perspective in HTS, the growth of the chemical innovation system kept on after the beginning of the war in 1939, and even up to 1943. The presentation will discuss the conditions of the systems growth and the question, why this growth stagnated from 1944 onwards.

Documentation of foreign scientific literature by the German Chemical Society in the Second World War

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The procurement of scientific literature from abroad was difficult for German chemists in the course of the Second World War. The communication links to foreign partners and connections to friendly states significantly decreased, with the effect that the possibilities of importing literature had become increasingly smaller in the course of the war. Furthermore, air strikes became a big problem, as they hit libraries of universities, the science-based industry and laboratories.

Opposite to previous historical studies on this topic, the presentation will show that academic journals and books could be transmitted from foreign countries into Germany during the war. It will be shown how the civil chemical sector, represented by the German Chemical Society, the „Deutsche Chemische Gesellschaft", mobilised its resources to establish an intelligent system for the rationalisation of the procurement, the examination and distribution of foreign publications to the various chemical institutes of the military, the industry and the state. Through cooperation with the governmental research council, the „Reichsforschungsrat", and the Reich's Security Main Office (Reichssicherheitshauptamt) the DChG was able to insure the access to foreign publications even almost the end of the war.

'Heimstoffe' made of cellulose: Vulcanized fibre in the „Third Reich"

Simon Große-Wilde
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Vulcanized fibre is one of the first industrially produced plastics in the world. Based on the patent of Thomas Taylor at 1859, layers of paper are combined in a hot solvation of zinc chloride to form a homogeneous material. The paper is made of cotton-linters, which cannot be used in the spinning process and got a high amount of cellulose (99.8%).

This presentation will focus on the history of vulcanized fibre in the context of the „Third Reich". Based on the political and ideological attempts of economical autarchy by the Nazi-regime, it will be discussed, how the transformation of the resource base from imported cotton-linters to materials of German origin, the so-called „Heimstoffe", happened and which role vulcanized fibre achieved in the system of German autarchy.

In this case the presentation is part of the dissertation of the author and has got two different purposes: Until now, the history of vulcanized fibre has not been told, so that this is one part of it. Furthermore there is still a small number of companies, which produce vulcanized fibre. Because of this and the fact, that in the context of the „Wirtschaftswunder" and the rise of synthetic plastics between 1950-1960, a high amount of technical know-how and knowledge about producing vulcanized fibre „has been lost", the author wants to re-discover this material. Climatic change and the limited availability of resources have become a big problem nowadays, so that materials based on renewable resources like vulcanized fibre could be part of the solution.

WEDNESDAY, 30 AUG, 14:00-15:20, SESSION B2

Women in Chemistry

S. Štrbáňová (chair)

- G. Boeck, „First Women at Rostock"
- Y. Alexiou, „Limits of participation"
- E. Lõhkivi, „Gendered Workplace"

First Women in Natural Sciences at Rostock University

Gisela Boeck, Tim Peppel
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Mecklenburg was the last German state which allowed the enrolment of women in 1909. Nevertheless, already some years earlier women studied at the Faculty of Philosophy and of Medicine as so called guest auditors (Gasthörer). This permission for attending lectures and seminars at German universities was granted in 1895. The number of women who entered the universities as Gasthörer increased rapidly but the portion of women who studied chemistry was small.

Else Hirschberg (1892-1942) was the first Gasthörer in chemistry and she was the first female student at Rostock University who passed the association exam (Verbandsexamen) introduced in 1898 by the 1897 founded Association of Laboratory Directors at German Universities and Colleges (Verband der Laboratoriumsvorstände an Deutschen Hochschulen). But in comparison with other German female students passing also the doctoral examination Else's request for it was denied by the Ministry of Education.

This rejection will be discussed on the background of other doctoral examinations at Rostock University, and the first women who earned the doctoral degree Dr. phil. or Dr. med. with papers in the field of Natural Sciences will be presented. These papers dealt with problems in chemistry, botany and physiology. The biographies will show that only few of them had the possibility of further scientific work like Else Hirschberg – in her case under difficult circumstances with low-payed positions and in consequence of her Jewish family background.

The Limits of Participation: Lucia de Brouckère, a Female Professor at the Solvay Conferences on Chemistry

Yoanna Alexiou
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Lucia de Brouckère (1904–1982) was a Belgian chemist. As chairman and vice-chairman of the Faculty of Science between 1959 and 1963, she was undertaken to support a new curriculum, and helped to rebuild the Université Libre de Bruxelles (ULB) chemistry department after 1968. When women were still fighting for their rights and a better place in society, she distinguished herself. She appeared as a pioneer in the teaching of chemistry and the study of analytical and mineral chemistry.

She was not only the first woman to become a professor at the Faculty of Science of the ULB but also the first Belgian woman to participate in Solvay conferences on chemistry. She attended each of them from October 1928 (the third one) until her death in 1982. Despite her knowledge of chemistry and her positions in scientific institutions, as for example headmaster of the Belgian Chemical Society in 1960, she never was a speaker at the Solvay conferences.

While only very few women were allowed to access higher education and university, even less entered an academic career before the 1940s in Belgium, Lucia de Brouckère's definitely profile strikes as exceptional. And her systematic attendance as a passive actor at the Solvay councils provides a unique case-study of what it meant to be a female scientist in a prestigious men-only environment, what kind of role was available to her in The Limits of Participation. Lucia de Brouckère, a Female Professor at the Solvay Conferences on Chemistry.

Gendered Workplace Cultures at Chemistry Departments in Estonia

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Over at least four decades, the career paths of female researchers have received remarkable attention – many international research projects for the study of gender inequality in academia have been carried out. Several mechanisms prohibiting talented female researchers from advancing their academic careers have been identified such as glass-ceiling, leaky pipeline, cultural stereotypes, etc. It has been argued that despite the gender action plans and gender mainstreaming, gender equality has not been achieved, and due to hostile local workplace cultures and unfair competition, many talented researchers are lost for academia. A particular phenomenon of epistemic injustice – that socially weaker groups, or sub-groups, in academia are measured as epistemically weaker via local cultural patterns of division of labour – appears to be one of the subtle mechanisms of exclusion.

In my paper, I shall analyse the issue epistemic injustice and exclusion on the example of interview material collected at the Estonian academic research institutions of

chemistry and physics about ten to twelve years ago (2005-2007) and now, in 2016-2017. The method of culture contrast of social psychology along with the positioning theory of the discourse analysis have been applied for the analysis of empirical data.

WEDNESDAY, 30 AUG, 16:00-18:00, SESSION A3

Elements and the Structure of Matter

C. Nawa (chair)

- J. Trofast, „Jacob Berzelius – Cerium, Selenium"
- S. Waring, „Wollaston and Dalton"
- H. Kutzke, „Polymorphic organic compounds"
- D. Liu „Micelles and Molecules"
- K. Ruthenberg; B. Van Tiggelen, „Definition of chemical element"
- H. Kragh, „Superheavy elements"

Jacob Berzelius – The Discovery of Cerium, Selenium, Silicon, Zirconium and Thorium

Jan Trofast
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The discovery of a new element is not an isolated event. Several small consecutive observations often lead to new approaches of a problem. When the time has risen and the different observations combine with new knowledge, all the bits and pieces fit together and a new beautiful discovery is made.

The present treatment is limited to the discoveries that could be linked to Jacob Berzelius himself. The availability of his laboratory journals, letters, chemical samples etc. being kept at the Royal Swedish Academy of Sciences in Stockholm will give us authentic sources and thereby give us details about how and why certain experiments were initiated and how the argumentation of the experimental results was intensified.

Berzelius expressed his science with clarity and style in a simple and pleasant way. The experiments were performed in a planned way with a proper analytical methodology, and if not available, he had to pave the ways for the development of new methods. Berzelius's own statements will therefore be the pole star in the descriptions of the work around the discovery of the elements.

• Cerium – A Fascinating Story (1804) – with Wilhelm Hisinger

• Selenium – An Unforeseen Occurrence (1818)

• Silicon – Pioneering work (1824)

• Zirconium – A Methodological Success (1824)

• Thorium – The Triumph of Science (1829)

Reason and Measurement: William Hyde Wollaston's chemical slide rule and John Dalton's atomic theory

Sophie Waring
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'The quantifying spirit' of the late eighteenth- and early nineteenth-century has been well research and documented. Precision measurement and mathematical forms of expression enjoyed a wide application in Enlightenment rationalism. Chemistry was central to this movement and also caught in its controversies. By placing William Hyde Wollaston's chemical slide rules in the context of debates surrounding measurement by equivalents and what it was to be a 'gentleman of science' this paper will demonstrate the significance of instruments to historical understanding of the role of precision measurement in the Age of Reform.

Furthermore by charting the growing utilisation of William Hyde Wollaston's 'slide rule of chemical equivalents' within the framework of Wollaston's own inconsistent attitude towards John Dalton's atomic theory, this paper will provide fresh insight to the relationship between theoretical and experimental chemistry. Finally the paper will look to link this tension, between practical experiment and abstract theory in chemistry, to potentially parallel debates in the physical sciences. Particularly the gravimetric experimental work done in the pursuit of an accurate determination of the figure of the earth, where controversies surrounding measurement by ratio where again debated by men of science and politics, reason and reform.

Kryptochemical polymorphism and the discovery of the first polymorphic organic compounds

Hartmut Kutzke
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Today polymorphism is well known as a widespread property of organic materials. However, in the days of its first observation it was considered as a mysterious phenomenon. The presentation will trace the discovery of the first organic polymorphs and describe contemporary theories on polymorphism. Results of recent crystallographic studies of those historical polymorphs will round up the picture.

A metastable modification of benzophenone was first prepared and described in 1871 by Zincke in Bonn and became soon the most studied organic polymorph around the turn of the century.

However, the preparation of the metastable phase was not reproducible and the transformation from the metastable monoclinic to the stable orthorhombic form occurred spontaneously and unpredictable. Schaum, a student of Zincke, called the phenomenon therefore 'kryptochemical polymorphism'.

The discovery of metastable benzophenone stimulated a rich research activity. Many organic compounds were found to exhibit a similar behaviour. A wide range of

theoretical explanations were suggested which give insight into the thinking of chemists and crystallographers in the period between 1871 and 1920.

After 1920 the interest in organic polymorphism decreased and benzophenone can be described as what Bernstein called a ‘disappearing polymorph’. The today’s high importance of organic polymorphism in science and industry was the motivation to ‘go back to the roots’ and study formation, crystal growth and crystal structures of those first described organic polymorphs by means of modern crystallography. For benzophenone, it could be shown that the ‘kryptochemical polymorphism’ is caused by the existence of two enantiomorphic forms of the compound.

Of Micelles and Molecules: Seven Lives of Non-Molecular Theories of Chemical Matter from 1858–1938

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The constantly shifting conception of the molecule has been a mainstay in the historiography of chemistry, and has provided a way for historians to explore everything from the metaphysical to the practical basis of chemistry as a discipline. Yet, for nearly a century, the micelle existed alongside the molecule as a fundamental unit of matter, one whose turbulent history mirrored the history of atomic and molecular theory in the late 19th and eary-20th centuries. In this paper I will explore the long history of the micelle in seven episodes, as it transformed from a theory of crystalline matter in plants, becoming a theory structural theory in soap chemistry, and finally into a rhetorical weapon in the hands of biochemists wielded against biophysics. I will argue that the micelle became a kind of alternative or pidgin-chemistry for biologists and physicists working at the boundaries of the chemical disciplines, and that micellar theory was a way for biologists and chemists to approach chemical topics in their own idioms: visual identification and comparison for biologists, precision measurement and thermodynamic analysis for physicists. By exploring the history of the micelle, I aim to outline where some of the outer disciplinary and intellectual boundaries of chemistry might be found, and illuminate how an alternative form of chemistry managed to flourish during the interwar period.

The definition of a chemical element by the IUPAC and Friedrich Paneth – a misunderstanding?

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”A chemical element is a substance the entire atoms of which contain the same nuclear charge.” This definitory statement (which equals the official description by the International Union of Pure and Applied Chemistry (IUPAC) since 1921) can be found

in a paper by Friedrich Paneth from 1920. Already five years earlier, the same author discussed the applicability of the traditional Boyle-Lavoisierian definition and compared it with this modern version, which might be labelled „physicalistic".

Helge Kragh writes: „Paneth's new definition of an element had roots going back to Lavoisier and it remains the one accepted even today". At various other places in the literature, Paneth is similarly mentioned as the originator of the modern definition, though it is not always clear, which part of Paneth´s statements on the elemental status is addressed.

In this paper, the influence of his statements on the early IUPAC decision is investigated in more detail. On the one hand, we discuss the received view particularly before the background of Paneth´s well-known „Königsberg lecture" from 1931, in which he presents an elaborated dualist interpretation of an element. On the other hand, we seek to elucidate Paneth´s personal role in this story by studying his correspondence.

The end of the periodic system: Speculations and discoveries of superheavy elements

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On 28 November 2016, the International Union of Pure and Applied Chemistry officially recognized the discoveries of element 118 (oganesson, Og) and also of elements with atomic numbers 113, 115, and 117. Speculations about transuranic elements go back to the late nineteenth century. For example, in 1895 the Danish chemist Julius Thomsen suggested the existence of an inactive gas with atomic weight ca. 292 at the end of the 7th period. During the 1920s several hypotheses of transuranic elements were based on the new quantum theory, but the first such element (neptunium) was produced only in 1940. The talk will review some of the early ideas of very heavy elements and then turn to a discussion of the recent manufacture of superheavy elements. What does it mean to have „discovered" an element such as number 118? Can one reasonably say that these elements exist? What are the official criteria for accepting discovery claims and the associated names of new elements? How is it that they are considered the domain of the chemists rather than the physicists? These and related questions, partly of a philosophical nature, will be discussed within the relevant historical perspective.

WEDNESDAY, 30 AUG, 16:00-17:20, SESSION B3

Dyes and Pigments in History

A. Petersen (chair)

- E. Homburg, „Quality Control Dutch Madder"
- M. Pinto, „Historical pigments"
- A. Quye, „Early synthetic dyes"
- F. Sæland, „Titanium White"

Quality Control of Natural Dyestuffs: The Case of Dutch Madder, 1450-1850

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In museum collections in the south-western part of the Netherlands dozens of instruments, objects, paintings, and other artefacts can be found that are supposed to be associated with the quality control of madder by government officials. The root of the madder plant was a red dyestuff of enormous economic significance for that region since the 13th century, or even earlier.

A closer look of these artefacts, together with a study of old written sources, including governments regulations, reveals that several of these paintings and instruments are seriously misunderstood in the historical literature of the 19th and 20th centuries. In my paper I will argue that there were in fact three different 'interfaces' of quality control:

- 1. between the farmer/ producers and the government officials;

- 2. between the farmer/ producers and the traders;

- 3. between the traders and the textile industries.

In all three cases totally different properties were tested and measured, but always by physical means. I will reflect on the consequences of this – from a modern viewpoint rather bizarre – situation, which lasted until the advent of the synthetic dye industry. I will also discuss which artefacts belonged to which testing phase.

In the last part of my paper I will discuss in some detail the rise of chemical testing methods between ca. 1790 and 1830. Although propagated by the Dutch Academy of Sciences, they never entered the practical stage; probably because of the complete lack of 'chemical literacy' in the Dutch countryside.

Chemical analysis of historical pigments in the 19th century

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Chemistry and conservation are nowadays closely related. More specifically, chemical analyses of pigments can be considered as a fundamental step in the conservation of artworks. In the first place, knowledge of the chemical properties of pigments may provide important information about the degree of deterioration of a polychrome surface, and could therefore influence the decision-making process for an artwork's conservation treatment. Moreover, the analysis of pigments can inform the conservator about possible past interventions. However, while conservation practice has a long history, use of chemical analysis of pigments has only become common in conservation practice, and its usefulness more generally recognized, during the twentieth century. As part of larger study of the recognition of chemical expertise in conservation practice, this paper offers a comparative study of early practices of pigment analyses in the nineteenth century, presenting cases from the English and Italian context. On the one hand, an interesting case can be observed in England, where figures from the scientific world –such as Faraday- not only carried out pigment analyses, but were also part of several debates within the artistic community. On the other hand, Italy offered well-known archaeological sites, typical places of provenance for paint samples analysed in several countries. This paper investigates the discussions that these pigment analyses generated in the scientific and artistic professional communities against the background of increasingly specialised disciplinary landscape.

Patterns of early synthetic dyes: analytical chemistry investigations of textile samples in 19th c. British dyeing manuals

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Dyed textile samples with synthetic dyes were often inserted into published 19th century dyeing manuals aimed at industrial dyers. Good use was made of 'patterns' with named dyestuffs by eminent authors like Knecht, Crace-Calvert and Crookes to illustrate their writings about the synthesis, chemistry and dyeing properties of aniline and other synthetic dyes. Even Perkin included patterns with his Journal of the Chemical Society papers on artificial alizarin and bromo-alizarin. While the technical texts in historical dyeing manuals are valued for their scientific detail of early synthetic dye manufacture in seminal works by Travis, Homberg, Nieto-Galan and others, the patterns are rarely mentioned. Yet far from being decorative, the dyed textiles offer direct primary chemical evidence for commercial dyes of significance to the past textile industry. This is invaluable material knowledge for conservation science research of dyed heritage textiles. Chemical analysis can unlock this information from the patterns, but also raises interesting questions. Do the dyes match the accompanying textual

information? Is there chemical variance between the dyed patterns in different copies of the same book?

The 'Dye-versity' project is a long-term analytical study by chromatography and spectrometry to profile the composition of dyed patterns in some well-known dyeing manuals. The first phase has focussed on aniline red, purple, purple, blue and magenta dyes in British books published between 1862 and 1893. Results encouragingly reveal consistency and provide compelling corroboration of the textual information with insight into quality, differentiating chemistry (or not) between similar dyes, and compositions reflecting synthetic routes.

The Innovation of Titanium White 1907-1920

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Titanium white is titanium dioxide used as pigment, known for its opacity, brightness and high refractive index. Titanium pigments were developed simultaneously in North America and Norway in the first decades of the 20th century. Referring to the European development only, the paper thematises the innovation of titanium white in a neo-Schumpeterian perspective, emphasising the social, technological, and institutional conditions for the innovation. An innovation process usually includes three phases; an invention phase, an innovation phase and a diffusion phase. The paper presents a non-linear analysis of this innovation process, emphasising ruptures, reorientations and adjustments in a complex, science-based industrial development.

The paper will present four successive phases of the process, discussing central problems and challenges distinguishing each phase. Regarding the invention phase (1908-1910), a discussion of the nature of the discoveries made by chemical engineers Dr Peter Farup and Dr Gustav Jebsen will be given. A premature innovation phase (1910-1913), will be analysed with regard to the negative marked response of the titanium pigments subject to commercialisation. A new research and development phase (1914-1918), will be analysed with regard to the invention of the crystal optics of titanium pigments by Professor Victor Goldschmidt. A final diffusion phase (1916-1920), will be discussed with regard to the strategic dilemmas facing the manufacturing firm Titan Co., fending off competition from the American rival The Titanium Pigment Company.

Titanium white was a typically resource driven innovation, succeeding by a unique combination of visionary entrepreneurs, academic and entrepreneurial chemists, pioneer scientist and engineering knowledge.

WEDNESDAY, 30 AUG, 17:20-18:00, SESSION B3A

Recent Chemistry: New methodological approaches

K. Kikuchi (chair)

- B. Hervy, M. Quantin, P. Teissier, „Solid State Chemistry"
- M. Indergaard, „Polysaccharide research"

Quantitative versus Qualitative Analyses of Oral Archives: The Case of Solid-State Chemistry in the Twentieth Century

Benjamin Hervy[a], Matthieu Quantin[b], Pierre Teissier[c]
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Our paper compares quantitative and qualitative analyses of the same corpus of oral archives, dedicated to the history of solid-state chemistry in the twentieth century. It investigates three research levels: pragmatic, epistemological, and reflexive. Firstly, the approach is pragmatic since it applies an original numerical method, developed by the first two authors, to the study of a corpus, constituted by the third author. The numerical method generates graphs linking the interviews according to their semantic proximity, without presupposing links. The selection of visualization criteria, by contrast, reveals three types of graphs. They can be in coherence with the historical work, unexpected, which allows the formulation of new hypotheses, or meaningless. These results lead to an epistemological reflection about the dual function of numerical methods for the history of science and technology: a validation tool (of earlier studies), a heuristic tool (to open future perspectives). A typology of inferences is proposed according to the degree of intervention of the man and the machine in the numerical method. The third and reflexive level calls for caution: quantitative results take significance only in relation to a priori knowledge of the corpus. The historical knowledge acts both as a methodological safeguard and a variable of adjustment to define relevant criteria. Interdisciplinary collaboration is needed to strengthen the robustness of the numerical method. This laborious process, made of critical interactions between algorithmic programming and historical questioning, is at the very opposite of the incantations of automation of digital humanities.

Into the history of polysaccharide research: The glucan laminaran in brown seaweeds

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The (1→3)-β-D-glucan laminaran was first mentioned in 1885 by the Baltic German pharmacologist Johann Ernst Oswald Schmiedeberg. He extracted a gelatinous carbohydrate („a kind of dextrin") from the brown seaweed Laminaria sp. Its detailed macromolecular structure was established in the late 1950s, revealing branching by (1→6)-β-linkages. In some seaweed species the sugar alcohol D-mannitol occurs as an end-group in a few percent of the polymer chains.

Due to the complexity of biopolymers early organic chemists regarded these (then) impure and heterogeneous compounds (i.e. polysaccharides and proteins) as „chemistry of grease" („Schmiere-Chemie"), and both organic and colloidal chemists denied the existence of biopolymers as true macromolecules. The breakthrough for the macromolecule concept came with the work on synthetic polymers in the 1920s, and the existence of true macromolecules was finally widely accepted in the early 1930s.

Among the biopolymers the success of the DNA structure has led to nucleic acids receiving most of the historical attention, the proteins far less so, and the polysaccharides – except for disciplinary reviews of cellulose and starch chemistry – hardly any.

The intent is to contribute to polysaccharide history by presenting the conditions for doing chemistry on what turned out to be a polysaccharide, and the ensuing evolution of methods in carbohydrate chemistry that eventually elucidated the basic structure of laminaran. I will argue for the history of laminaran as an example of polysaccharide science trying to find its own way, battling with the influence from the dominating groups of traditional organic chemists and „colloidalists" at a time when both equally scorned the concept of true macromolecules.

THURSDAY, 31 AUG, 10:45-12:45, SESSION A4

Panel: Toxic Products in the Public Sphere: Narratives, Spaces and Controversies

X. Guillem, José R. Bertomeu (organisers)
X. Guillem (chair)

- C. Florensa; C. Sans Ponseti, „Radiation, Scientists and Publics in Spain"
- A. Nieto-Galan, „Chemical Pollution the Public Sphere"
- J. Gil-Farrero, „Nobody Wants Landfills".
- J. M. Galech, „Negative sculptures of toxicity"
- J. R. Bertomeu, comment

Historical studies on toxic products have flourished during the last decade. The studies have been inspired in part by the growing social concern over the thousands of new products deposited every year into the atmosphere, rivers, sea, ground, our food, and our bodies. These substances have been employed for many different purposes: medical therapies, colorants, food additives, war weapons, fertilizers, pesticides, or even as part of everyday commodities. Historians have followed these products in different cultures and societies from different perspectives: history of chemistry, environmental history, history of public health, food history, or history of crime. A review of recent trends on these topics can be found in edited volumes (Le Roux and Letté (2013), Boudia and Jas (2013; 2014), etc.) and the essay reviews by Jas (2014) and Guillem (2015) in the journal Ambix.

The purpose of this session is to provide a multidisciplinary forum for current historical research on toxic products during the two last centuries (1800-2000). Papers will cover issues related to risk control, public and academic controversies, public and occupational health, national and international regulations, environmental justice, local and global circulation. Papers are organised around particular spaces (rivers, mines, landfills, fertilising farms, industries, etc. but also athenaeums and museums), historical actors (victims, polluters, experts, deniers, activists, artists, lawyers, professors, popularisers, politicians, industrial managers, etc.) or products (oil, tobacco, endocrine disruptors, aluminium, fumes, arsenic, radioactive products, fertilizers, food adulterants, chemical weapons, etc.). Participants are expected to present a particular case while addressing general historiographical issues and providing points for comparative analysis.

Radiation, scientists and publics in Spain under Franco's dictatorship: The simultaneous construction of visibility and invisibility of radioactive contamination

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At the closing session of the Second International Conference on Human Genetics, held in Rome in 1961 the attendants approved a motion to warn the responsible Governments about the dangers of atomic explosions for the descendants of individuals exposed to atmospheric radiation. Among the attendants there were five Spanish scientists. The motion was reported in a Spanish scientific journal by geneticist Antoni Prevosti, member of the Spanish delegation to the Conference. The message was clear: even though invisible, there was a real thread associated with atmospheric radiation.

Five years later, four nuclear US bombs fell onto a little town on the Spanish coast, Palomares, due to an accidental crash between two US Air Force planes during a refuelling manoeuvre. Three of the bombs leaked their content on earth and one remained intact, sunken into the sea. The official response to the incident was a public media campaign that showed the Minister for Information and Tourism, Manuel Fraga Iribarne, taking a bath into Palomares beach, together with the US Ambassador Angier Bilde Duke. The message was clear: as the images made visible, there was no risk for Palomares inhabitants due to radioactive contamination.

Under Franco's dictatorship (1939-1975), Spanish government fiercely controlled the media and developed a communication model that followed the logic of different truths at different levels: while scientists were visualising the nuclear risk among their limited elitist forums, the nuclear radiation thread was invisibilised to the general public. Following Olga Kuchinskaya's analysis on Chernobyl accident (Kuchinskaya, 2014), this paper will reflect on the production and propagation of visibility vs. invisibility of nuclear radiation's risk in the Franco's dictatorship context

Chemical Pollution in the Public Sphere: Expertise, Politics and Industry in Spain in the 1970s

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In 1974, the prestigious Spanish chemist and science populariser, Miquel Masriera, edited a book, La lucha contra la contaminación (Fight against pollution), under the auspices of UNESCO. The book included chapters written by politicians, professional scientists, and relevant members of international organisations, and presented the main 10 pollution agents of the time: CO2, CO, SO2, NOx, Phosphates, Hg, Pb, Oil, DDT, and nuclear radiation. Just two years earlier, in 1972, in a convention for industrial chemistry held in Madrid, engineer Jaime Blasco discussed the way to define „pollution" in a context of considerable growth of the chemical industry. Equally, resonances of international conferences on environment and pollution (Stockholm,

1972) reached the Spanish public sphere at the end of Franco's dictatorship, in a context in which international chemical corporations benefited from low wages and free taxation for their establishment in Spain. A detailed analysis of several contemporary national and international conferences, and a careful dissection of Massiera's book, will help us to sketch the main aspects of a seminal environmental debate, which progressively emerged in Spain, in the late years of Franco's dictatorship.

Nobody Wants Landfills: Controversies around solid urban waste disposal in Catalonia (1970s-1990s)

Judit Gil-Farrero
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During the most part of 20th Century, in Spain, there was very little control over pollution resulting from industrial activities and none at all from non-industrial ones. Until 1975, at the end of General Franco's dictatorship (1939-1975), there was no legislation on solid urban waste disposal. Illegal landfills or controlled ones spread everywhere in no adequate places. In this talk, we focus on two case studies in Catalonia, in the 1970s, which steered great controversy: one of them placed in a karstic mountain range, near Barcelona, and the other one located in the slope north of an iconic volcano, near the city of Olot. Both cases have many things in common: top-down decision making, local inhabitants' opposition, a scientific community alerting about geologically non-adequate features, extensive press coverage, and a long term use of both landfills for decades. These two environmental conflicts allow us to analyse the role of the different historical actors involved and their interactions, as well as to reflect on the reaction of public authorities when assessing the risk of groundwater pollution and the production of methane in the landfills.

Negative sculptures of toxicity: Artistic research by Eva Lootz and the mines of Riotinto and Almadén in Spain (1980-2014)

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The study of public controversies around toxic products and their manufacturing constitute a well-known trend in historical research on toxics. This paper aims to add the visual arts to the usual analysis of written sources, television programmes, films and documentaries, and hence to open new possibilities for comparative research on these issues. It is the study of a particular case, the artistic works by Eva Lootz inspired by the mines of Riotinto and Almaden in Spain, which can be seen as an example of how the recent conceptualization and practice of what is called artistic research might be of interest for historians of the sciences.

Artist Eva Lootz (Vienna, 1940) lives in Spain since 1967. She began to take an interest in mining around 1980 and developed the concept of „theatre of matter" for the site where minerals and raw materials are extracted. After visiting then the mines of

Riotinto and Almadén, still in operation, she created several art works about them, mainly sculptures, drawings and photographs. Some 30 years later she has returned to those mines, where the mining activities have ceased and which have fallen into an increasing state of neglect while tons of toxic wastes have clandestinely been dumped in the site. Environmental, health and social problems persist in those areas. She has developed new art works that, together with the earlier ones, show that mines become cultural territories in which have to be mapped, by following the trail of absence, the technological and metallic legacy that supposedly represents us in our great public spaces and devices. Pointing out the gaps and wastes left by the extraction of minerals is for her a means to indicate the complementarity between what is culturally signified and what is treated as insignificant.

THURSDAY, 31 AUG, 10:45-12:45, SESSION B4

Science teaching: Historical perspectives

G. Boeck (chair)

- P. Grapí, „Fourcroy and chemistry education”
- K.Kiprijanov, „Learning with sausages”
- I. Malaquias, 19th-C Portuguese education”
- J.A. Pariente Silván, „Science in the Classroom”
- V. Milanovic; D. D. Trivic, „Chemistry Textbooks in Serbia”
- F.León Olivares, „Material culture of chemistry lecture”

Antoine-François Fourcroy: organising chemistry and chemistry education in post-revolutionary France

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The French chemist Antoine-François Fourcroy (1755-1809) was a relevant member of the „community of opinions” constituted around Lavoisier, along with Berthollet, Laplace, Monge and Guyton de Morveau, among others. Fourcroy exerted control in many teaching institutions, proved to be a prolific chemistry textbook writer, as well as an active and influent protagonist in the field of educational politics. The subject of this presentation is about Fourcroy’s project for the teaching of chemistry in the context of the construction of national system of education in post-revolutionary France. This project was intimately linked to the theoretical body of chemical affinities and its evolution can be followed through his net of chemistry textbooks.

Learning with Sausages, Lines, and Letters: The Didactic Origins of Structural Formulae in Germany

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Ubiquitous in chemistry today, structural formulae constitute one of the cornerstones of modern chemistry. The received narrative depicts the emergence and adaptation of these 'line-and-letter formulae' as a rapid and linear process which occurred almost simultaneously in Britain, Germany, and France during the late 1860s. Yet evidence from printed sources strongly suggests that the dissemination, appropriation, and consolidation of structural formulae was a gradual and non-uniform process which spanned more than two decades, and which was strongly determined by the way in which chemical knowledge was communicated.

My paper investigates the emergence and early use of structural formulae in Germany. I argue that structural formulae must be seen as part of a didactic tradition which was developed by August Kekulé in 1857. The first part of my paper demonstrates that Kekulé's use of 'sausage formulae' had a direct impact on the teaching practice of Emil Erlenmeyer, who was one of the first German chemists to apply the new 'line-and-letter formulae' as representations of valency and structure in the mid-1860s. The second part of my paper explains how the use of periodical literature for didactic purposes had promoted the rapid dissemination of structural formulae among a wider scientific audience in the German lands during the late 1860s and early 1870s. In doing so, my paper provides an innovative case study of the hitherto neglected function of periodicals in science education. Furthermore, my paper emphasises the essential contribution of communication practices to the formation of chemistry as a modern scientific discipline.

Towards a place for chemistry in the 19th century Portuguese middle education

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During 19th century the channels linking the public to scientific knowledge were more deeply developed. Following a positivist trend, science was perceived as a fundamental tool for developing citizenship. Scientific subjects were included in the secondary school curricula and this also contributed in a larger sense towards popularising of science. After 1855, science took a more definite place in the Portuguese secondary school system, following the efforts of previous decades to establish both a national public secondary school system and the science studies (1836). Chemistry was introduced together with Physics and Natural History as a course that should be taken in the last three-four years of the upper secondary school. The legislation reinforced the experimental practice and the need for equipped laboratories. In this presentation we will bring together the emergence of chemical studies at secondary schools, the physical spaces created to practice and learn chemistry, focusing on two or three case studies in which it will be possible to better

follow the spaces, the teaching, the textbooks and other written material used as well as the objects that still remain from that period of study. We hope to make more visible the tenuous dynamics of a network of influences we can identify, in some cases trying to reinforce an Iberian connection and in others a Belgium, French or German influence, both on the methodology and spaces.

Science in the Classrooms during the 19th Century: Professor Mariano Santisteban (1821-1886)

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This communication is part of a doctoral thesis project whose beginnings were presented at the 10th International Conference on the History of Chemistry. The time elapsed and the work done allows us to respond with this paper to some of the issues that were raised at that time.

The first laws that led to the establishment of secondary education in Spain were published during the first half of the nineteenth century. At the same time, „physics and chemistry" was defined as a single subject. This discipline had no equivalent outside of the Spanish educational context. It was the use of laboratory practices undertaken by teachers, together with the new teaching tools created by them what joined the two disciplines. We are going to know, thanks to the training and teaching career of Mariano Santisteban, the relationships among his practical demonstrations in the laboratory, the progress of the manual that he wrote and the appearance of new teaching tools like paper and pencil problems. It was in this period that science became decisive in the secondary education. This incorporation produced debates related with the role of science in the general education of citizens, which are still ringing in our ears.

Mita Petrović's chemistry textbook as a framework for learning chemistry in secondary schools in Serbia in the 19th century

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The first secondary-school chemistry textbooks in Serbia date from the second half of the 19th century. With aim to gain insight into chemistry knowledge that was presented to secondary school students in Serbia in the second half of the 19th century, and didactic organisation of the textbooks from that period, we analysed secondary-school chemistry textbook written by Mita Petrović. The first edition of this textbook was printed in 1883.

Mita Petrović (1848–1891) worked at the Serbian Teacher training School in Sombor, where he taught mathematics and natural sciences. His textbook Chemistry for

Secondary Schools, based on Prokop Prohaszka and Others, was used more than 20 years and shaped the way of thinking in chemistry among the generations of students. In order to achieve the set goal, we needed to develop a methodology for analysing and evaluating the quality of this textbook within the context of the period when it was created.

The contents of Mita Petrović's textbook are organised into two sections: inorganic chemistry and organic chemistry. The material related to inorganic chemistry is interspersed with segments of material in which general chemical principles and laws are reviewed. The organic compounds are systematised in accordance with homologous series.

Numerous structural and organisational components are identified in the textbook. Also, the indicators of didactic organisation of a textbook, such as explanations of scientific terms, a functional use of illustrative means of expression and variety of the examples used are present in the analysed textbook.

The material culture in the chemistry lecture and cabinet of the National Preparatory School at the end of the 19th century

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The aim of this paper is to analyse the Chemistry lecture and cabinet in the Escuela Nacional Preparatoria at the end of the 19th century. Nowadays, the institution is part of the Universidad Nacional Autónoma de México's high school subsystem. This paper will analyse, on one hand, the study to show the material culture of the ENP's Chemistry cabinet, as part of the Chemistry lecture and the lecturer's academic formation; on the other hand, the books that were used during the lectures between the years 1867 and 1900. Finally, the work is based on archive work, such as the Universidad Nacional Autónoma de México's Historic Archive through the Fondo Escuela Nacional Preparatoria, furthermore, the UNAM's Archivo Histórico de la Antigua Escuela Nacional de Medicina, particularly the Student's Files.

THURSDAY, 31 AUG, 14:00-15:20, SESSION A5

Panel: Toxic Products / Toxic Risks [contd.]

X. Guillem, José R. Bertomeu (organisers)
J. R. Bertomeu (chair)

- R. Lutz, „Petroleum Progress"
- P. Punter-Chiva, „Climate Change Spanish Deniers"
- C. Teixeira, M. C. Lourenço, „Toxic Substances in Scientific Collections"
- X. Guillem, comment

Petroleum Progress: Oil Refining Technologies and the Making of the Modern World

Raechel Lutz
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In this paper, I analyse the role of oil refining technology and the development of the petrochemical industry in shaping America's toxic relationship to oil. Here, the petroleum refinery is the specific site of transformation of a crude oil into the materials of modern life. While the industry first relied on small horizontal stills that distilled crude into different fractions in the 1860s, contemporary oil refineries dwarf those operations in their scale and complexity. I argue that oil become integral to the functioning of American society because of how technological change drove the creation of the petrochemical industry. I assert that Standard Oil's initial success was due not only to John D. Rockefeller's innovative and incisive business practices, but also to the technical skill of his business partner, Samuel Andrews, who helped to establish early refining practices within the first Standard Oil refineries in the 1860s. Further technological change at the refinery enabled petroleum refiners to dramatically increase the amounts of products made from hydrocarbons and the ways in which American society has incorporated petroleum into daily life. Between 1910 and 1930, the development of high- quality gasoline proved to Standard Oil the potential for petroleum to act as a feedstock of raw materials for the chemical industry. Fuelled by demands for 100 octane gasoline, toluene, and synthetic rubber during World War II, refiners became convinced that the „oil-chemical" industry could exist as a new entity, and Standard Oil led the way in developing petrochemical research.1 By 1970, a fully formed petrochemical industry became an anchor mooring the production and refinement of petroleum into American society and the world economy.

This paper is a draft of the third chapter of my dissertation, „Oil State: An Environmental History of Petroleum Refining in New Jersey, 1860-2015," where I argue that oil refineries created environmental, social, and economic change in New Jersey and helped to shape America's modern relationship to fossil fuels.

Climate change Spanish deniers: a pluralistic approach

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The study of scientific controversies has been a privileged territory for science historians. In the last decades, the historians have focused on the study of controversies related to science, medicine or technology which were developed beyond academic environment.

Some controversies in the public sphere can be produced by political or economic powers. They have the ability, through their influence on media, to exaggerate differences between experts or undervalue the agreement existing in knowledge areas which are sensitive to their interests. Examples of these type of controversies can be found in the famous book Merchants of doubt, written by the historians Naomi Oreskes

and Erick Conway. In their study, American characters, some of them with scientific academic careers, are described perfectly. They produced controversies and denied scientific evidences which could be harmful to business sector. To achieve it, they used uncertain arguments.

This research wants to study the deniers of climate change existence in Spain. The period chosen comprises the years of the four first IPCC report publications. The study will adopt a pluralistic approach. The main goal of this research is to show a collective portrait from Spanish climate change deniers. To achieve it, it will be analysed arguments, spaces and means to do it.

In addition, it will be checked if arguments, spaces or means have been changing through the different periods studied. This research treats to show the hypothesis that has been proved in other contexts like for example Naomi Oreskes and Erick Conway studied. Furthermore, it pretends to be an approach to the development of scientific controversy controlled by political and economic pressures.

Toxic substances in scientific collections: A study-case in the University of Lisbon cultural heritage

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Museums, universities, research institutes and schools use and preserve collections of historical instruments, equipment and specimens. Many are contaminated with toxic substances from chemicals to pesticides residues and radioactive materials. These collections may represent a public health and safety issue, especially for curators, preparators, students, conservators and, ultimately, the general public. Since the 1990's and particularly the 2000's, museum and conservation literature, including leaflets, papers, studies and museum policies, have been addressing the history, practices and risk assessments of toxics and contaminant agents in collections, from inherent and acquired hazards to indoor air quality.

In this paper, we will present a general overview of the problematic of toxics and contaminant agents in scientific collections from a historical perspective. We will also explain the need to know the history of toxics and their use to preserve scientific collections today. Finally, we will present and discuss the results of a preliminary survey of toxics and contaminants in scientific collections of the University of Lisbon. The preliminary survey is part of a larger study aimed at producing preventive conservation protocols and resources for the preservation of scientific heritage.

THURSDAY, 31 AUG, 14:00-15:20, SESSION B5

Chemistry teaching: new approaches

G. Pallo (chair)

- L. Moreno-Martinez, „Modesto Bargallo”
- T. Hagendijk, „Learning from recipes”
- A.Marchal Ingrain, „History of Periodic Table”
- U. Eikeseth, „Asbestos and chemistry teaching”

Modesto Bargalló (1894-1981): Using the history of science in classrooms at the beginning of the 20th century

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Modesto Bargalló Ardévol (1894-1981) was one of the most important reformers of science education in earl twentieth-century in Spain. He published many papers on pedagogical issues and developed a fruitful activity as science educator. After the Spanish Civil War, he fled Spain in 1939 and started a new life in Mexico, where he kept teaching chemistry while developing a successful career in history of chemistry. He obtained the Dexter Award of the American Chemical Society Division of History of Chemistry in 1977. Although some aspects of his biography have been analysed, his pedagogical proposals are far less known. In this communication, I analyse his ideas about the pedagogical uses of history of science and science teaching practices. Bargalló argued that the history of science provides the most appropriate method for science teaching in primary education. His ideas were based on a broad range of historical, epistemological and psycho-pedagogical conceptions, which will be analysed in this paper. The analysis relies on the historical studies on science education published during the last two decades and the fresh perspectives in scientific biographies. The purpose of this paper is to explore how the history of science was used as a pedagogical method to teach „science for the general public” at the beginning of the 20th century. I claim that this analysis could provide new opportunities for revising the role of the history of science in classrooms, particularly in primary schools.

Learning from sixteenth-century recipes: The value of pedagogical reconstructions for chemistry education

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What can chemistry students learn from reading and performing centuries-old recipes? How can historical reconstructions contribute to chemistry education in general? With these questions in mind, I started a pilot lab course in January 2017. Students performed reconstructions of inks, pigments and fake-pearl recipes found in an English translation of Alessio Piemontese's De'secreti (1595). This book of secrets proved immensely popular in the sixteenth century and contained recipes ranging from alchemy to the decorative arts.

In this paper I will argue that the pedagogical use of historical reconstructions can contribute to chemistry education in at least two different ways. First, while the historically-oriented science student is a rare species, reconstructions prove to be a natural way to involve science students with history and to create historical awareness of their discipline. For example, they learn about alchemy while figuring out how to reconstruct a recipe using lutum sapientiae (clay) and develop an understanding of the raw materials used in early modern workshops and laboratories.

Second, historical reconstructions activate a set of epistemic attitudes that complement the skills taught in traditional lab courses. Whereas the importance of the senses has been downplayed in modern chemistry, historical reconstructions allow students to gain material literacy through experiencing the brittleness of Arabic gum or smelling the peculiar sweetness of iron gall ink. Moreover, students have to deal with the ambiguities of early modern recipes and consequently learn to be creative and to improvise in the lab.

Educational material to introduce the history of the Periodic Table of the elements using theatre as a vehicle

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Disseminating science to bring it closer to an audience of non-scientists is not an easy task so, based on some previous successful theatrical experiences which have demonstrated that theatre can be a valuable tool to teach chemistry while motivating students, I decided to write an entertaining play as a vehicle for disclosing science and highlighting the contributions of some researchers to the development of chemistry.

All students study the Periodic Table in school. However, in general this topic is rejected because it is traditionally learned through memorization. In this context, herein we present the book-script of the play „You are made up of elements" which has been written as a useful and motivating educational tool to bring science and its characters into the classroom by using theatre as a vehicle.

The story begins with a dream in which a girl falls asleep during the study of the elements and the periodic table. The girl sees a great and colourful periodic table in her dream. The image of a bearded gentleman calls her attention and she reads: „Dmitri Ivanovich Mendeléiev: Tobolks 1834-Saint Petersburg 1906" When his name is heard, Mendeléiev appears on stage and, since he disagrees with the colourful table, he starts telling the origin of the elements from ancient times, their discovery and applications.

The rise and fall of asbestos and implications for chemistry teaching

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„People who suffer from hay fever should greet this new invention with joy," With these words a Norwegian newspaper in 1898 reported the invention of asbestos handkerchiefs that could be cleaned by simply putting the cloth in the fire.

The above example illustrates how our current knowledge of toxicity and environmental impact of chemicals and materials might be limited and could change with time. It has been argued that some of the central responsibilities of science teachers is to make students aware of the limits of science and the tentative nature of science. Asbestos is a good example to illustrate this topic in chemistry teaching. This family of natural silicate minerals has been known and used by man for thousands of years, which is documented through findings of pottery with asbestos. The minerals' fibrous and flame-resistant properties made asbestos popular in textiles and as a construction material in the 1950s and 1960s, before growing health concerns put an end to its use in the 80s.

In this paper I examine how asbestos is presented in science textbooks and other written Norwegian historical sources in the period from 1898-1998. From being portrayed as a wondrous isolating and flame resistant material that could protect fire fighters from fire, the sources gradually tell a different and darker story about the material.

THURSDAY, 31 AUG, 16:00-18:00, SESSION A6

Panel: Toxic Products (contd.)

X. Guillem, José R. Bertomeu (organisers)
C. Florensa (chair)

- J. R. Bertomeu-Sánchez, „Arsenic in Spain (1840-1940)"
- F. Hachez-Leroy, „Aluminium in Food: the Forgotten's Controversies"
- X. Guillem-Llobat, „Fighting pests with hydrogen cyanide"
- S. Arapostathis, „Fertilising Farms and Institutional Authorities"
- E. Aucouturier, „French Chemical Weapons Trials in the Algerian Sahara"
- A. Nieto-Galán, comment

Arsenic in Spain (1840-1940): From criminal tool to public health hazard

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The paper follows arsenic compounds in Spanish society during the 19th and early 20th centuries. I review the production, trade, uses and methods for detecting arsenic, as well as the changing historical actors involved in these processes. My purpose is to connect different narratives related to poisons in crime, public health and environmental history. Arsenic compounds were massively used massively for a broad range of purposes: medical drugs, pesticides, dyes, criminal poison, etc. The first part of the paper is focused on several poisoning crimes by the middle of the 19th century, when new methods for detecting arsenic (particularly, the new Marsh test) were introduced and discussed by the emerging community of Spanish toxicologists. Criminal poisoning created social alarm and famous trials were commented in academic and legal publications as well as in the general press. These trials encourage the exchanges across different popular, medical and legal cultures. While new medical research was produced by toxicologists, several regulations concerning arsenic trade were introduced. At the end of the nineteenth-century, the cases of arsenic poisoning continued, but increasingly associated with food poisoning, particularly with drinks such as wine. During the early twentieth century, the new uses of arsenic in industry, medicine and agriculture introduced additional public health problems. In the second part of the paper, I review several cases of arsenic poisoning, in which new victims, experts, standards of evidence and legal regulations were involved. My focus will be on a case of collective intoxication in 1946 in a rural area, which was attributed to common practices of wine adulteration and the extended use in agriculture of lead arsenate compounds as pesticides. By comparing the different cases, I will discuss the changing „modes of government of risks" (Jas-Boudia) concerning arsenic in Spain, that is, the ways in which experts, public authorities and stakeholders conceived and managed the hazards related to arsenic poisoning during the 19th and 20th century.

Aluminium in Food: the Forgotten's Controversies

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In 1855, a new metal was born: the aluminium. Henri Sainte-Claire Deville, who discovered the first successful process to obtain aluminium, established too its chemical and physical characteristics, and its total safety, as he wrote. This paper proposes to examine three different controversies that took place from the 1890's to the 1930's, both in Europe and the United States. First, we will explain how was built a community of researcher, in Europe, that promoted the aluminium and defended it against suspicion from 1855 to the 1890's. Second, we will examine the alum baking powder controversy in the United States, and its actors, from the end of the 1890's to the First World War Third, we will analyse the British controversy, which concerned the aluminium utensils during the interwar period. In the three cases, we will compare the

role of the actors: public and private researchers, companies, state. But we also will take into consideration how the controversies got into the public field to create suspicion.

Fighting pests with hydrogen cyanide in the Valencian countryside at the turn of the twentieth century

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At the turn of the twentieth century, chemical pest controls were introduced in agriculture as a prerequisite rather than as an ad-hoc treatment. Although pests had been a problem in agriculture for centuries, the important changes that the food chain underwent by the 1870s were responsible of an unprecedented intensification of these problems. The spread of intensive export agriculture and monoculture led to the emergence of pests of unknown devastating capacity and to the search of new controls which were meant to substitute the physical methods that had been more common in previous periods. Authors such as James Whorton or Nathalie Jas have referred to these changes and have raised interesting points on the use of arsenical pesticides in this period. This bibliography will constitute and interesting starting point for my research. However, I shall focus on another highly toxic substance used in pest controls in the first decades of the twentieth century, prussic acid or hydrogen cyanide.

Hydrogen cyanide was extensively used from the late-nineteenth century in citrus in California and this experience was soon very influential in other citrus-growing regions. I shall analysed the introduction of this pesticide in the Valencian Country and focus on the way in which workers and consumers safety was considered in regulations as well as in the teaching and implementation of this treatment at the main Valencian agricultural research station. Although the paper will focus on the use and regulation of prussic acid in agriculture, I shall nevertheless consider the influence that the discussions concerning other uses (in chemical warfare or the fumigation of urban spaces) exerted on it agricultural use.

Fertilising Farms and Institutional Authorities: Experts, Regime-Making and Agricultural Politics in Greece, 1940-2000

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On 24 April 2015 the daily press reported the condemnation of Greece by the European High Court. This condemnation was due to the partial, fragmented and thus incomplete implementation of the European legislation and directives in relation to the use of fertilisation and the overconsumption of nitrogen (N) fertilisers in Greece. Despite the initial goodwill of the Greek state, which exercised policies to reduce the extensive use of N fertilisers and their harmful effects in water and soil, the European Union and its institutions believed these measures to be incomplete and fragmented.

The situation was deemed severe enough to force the European High Court to ask for an increase in the number of regions characterised as 'vulnerable zones'. In 2010 the European Union had asked the Greek government to include, in the list of 'vulnerable zones', more regions than were in the national list. While Greece understood the importance of the call and the importance of the issue, the official Greek state moved with bureaucratic ambivalence, even neglect, towards the Union's suggestions. This resulted in the court case and the country's condemnation. In this context agronomists and agriculture scientists have started to promote an emphasis on securing precision in the management of fertilisers, water and propagation material. It has been argued that through the appropriate use of mechanical and information devices, farming could be transformed into a practice where fertilisation would be conducted through 'variable rate inputs' that were formed by taking into account soil and plant conditions, as well as the geographies of the fields and the geomorphology that necessitate a more flexible strategy in fertilisation and plant and soil nutrition. In the early years of the 21st century, other engineers and agronomists promoted a holistic approach to agriculture as an effective public policy to increase productivity and quality and to forge a different developmental pathway that would introduce a different approach to agriculture.

In the early 21st century the central issue of concern for experts and policy makers was the reduction of agrochemicals and most importantly the 'rational' use of N fertilisers due to the environmental pollution and concerns about public health of rural communities and consumers too. In this setting the present paper aims to address the following research questions:

1. What was the role of experts and knowledge communities in shaping the Greek agriculture regime in relation to the use of fertilisers in post-War Greece?

2. What was the framing constructed by experts in relation to the use of fertilisers, and how did this function epistemologically and politically in policy-making arenas of the period?

3. What were the conceptual transformations changes in vision, and how were those linked to institutional authorities, professional identities and the political aspirations of experts seeking to participate in regime-making in the field of agriculture?

By addressing these questions, this paper aims to study the politics of expertise and the co-production of sociotechnical imaginaries, expertise identities and public policies in agriculture and the use of fertilisers in post-World War II Greece to 2000. Through the co-productionist idiom, the processes of appropriation would be studied and unravelled as dynamic processes in the case of post-war Greece. The study argues that experts functioned not only as mediators but as promoters and shapers of sociotechnical imaginaries and directed specific policies in promoting or controlling the use of fertilisers, particularly N fertilisers, in Greece. The aim is not to provide a comprehensive study of the roles and performativity of all the stakeholders and industrial interests. Its modest aim is to provide a preliminary study of the role of experts, mostly agronomists and soil scientists, in shaping sociotechnical imaginaries, directing policies and contributing to the making of sociotechnical regimes.

French chemical weapons trials in the Algerian Sahara (1960-1980)

Etienne Aucouturier
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The French biological and chemical weapons program is among the earliest and benefited from significant scientific resources. From the turn of the 20th century to the beginning of the 1970's, scientific and military endeavours in the domains of chemistry and biology applied to making weapons that would specifically target physiology, were closely intertwined and done in cooperation with eminent scientists or scientific French institutions. With the international prohibition of biological weapons at the beginning of the 1970's, the French military focused on improving their chemical warfare arsenal. On the basis of first hand archival materials from Institut Pasteur and from the French Ministry of Defence, we shall focus on a period of intense trials of chemical weapons, that took place in the Algerian Sahara, between the beginning of the 1960's to the middle of the 1970's. Through a private company operating under the hierarchy of the French Ministry of Defence, after the France-Algeria independence agreement (1962) and in accordance with secret provisions, the French military were able to intensively test gas dispersion (such as the neurotoxic sarin). We shall present this episode of French military history and address the role of this testing structure in the French chemical weapons program and strategy.

THURSDAY, 31 AUG, 16:00-17:20, SESSION B6

Chemistry teaching: new approaches (contd.)

I. Malaquias (chair)

- E. Maia; R. Pestana, „Influence of TV series"
- A. Gosh; C. Wamser, „Arrow Pushing"
- K de Berg, „A view of the iron(III) thiocyanate"
- J. Chamizo, „Fifth Chemical Revolution"

The influence of TV series in the change of the public image of chemistry

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Chemistry laboratories are one of the most visible faces of chemistry. Alchemical laboratories, much similar to kitchens or forges, were slowly modernized becoming scientific spaces where, notwithstanding, some of the old magic of alchemy remained,

visible in paintings and engravings. In the 19th century, the development of chemistry together with the introduction of practical teaching of a large number of students forced universities to have large chemistry laboratories built in many European countries. The images of the alchemical laboratories as well as those of great laboratories with impressive equipment, reinforced by some early movies showing laboratories with big glassware producing fumes, contributed to a negative public image of chemistry, often associated with danger.

In the 20th century, a change in chemical practices which reduced the scale of experiments and the development and implementation of instrumental methods of analysis, allowed the labs to be smaller and many of the great laboratories were destroyed or transformed. By the beginning of the 21st century a new change of the image of chemistry laboratories occurred, mainly influenced by television series, particularly those of the so called CSI (Crime Scene Investigation) cluster that show very attractive computerized laboratories dedicated to forensic science (in great part chemical science) with „miraculous" instruments, that give „almost instantaneous results" for the more sophisticated chemical analyse.

In this communication we will present pictures illustrating chemistry laboratories of different periods and discuss the changes in the image of chemistry associated with them, and also some misconceptions eventually introduced by TV programs.

A History of Arrow Pushing

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Since their introduction by Sir Robert Robinson almost a century ago, curly arrows have become an essential part of the language of organic chemistry. This talk will trace the history of English-language textbooks of organic chemistry, focusing on their adoption of a mechanistic approach to the subject. We will also discuss recent progress in the application of arrow pushing to inorganic reactions, as well as to the outstanding challenges in that area. We will conclude with a discussion of recent quantum chemical studies indicative of a rigorous theoretical foundation for this popular pedagogical tool.

A view of the iron (III) thiocyanate reaction through the lens of history: Contributions to nature of chemistry studies, analysis, and chemistry education

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Every student of chemistry is likely to have studied the iron(III) thiocyanate reaction as part of a study of equilibrium chemistry and many pathology laboratories will have used the reaction to determine the total iron content in lysated blood during the 1960's and 1970's. A study of the reaction from an historical point of view sheds some light on why the reaction became popular in chemistry education and gives clarity to the conditions under which the reaction could be used for iron analysis. In addition, a study of the way chemists have understood the reaction over a period from 1855 to 2016 reveals important information about the nature of chemistry as a discipline. By approaching nature through a chemical abstraction, chemists began to seek standards of chemical nomenclature and ways of quantifying matter and its reactions with varying success. The development of the field of coordination chemistry, increasingly sophisticated instrumentation, mathematical modelling, and computerized data analysis programs played an important role in determining the composition of the resulting red compound and relevant formation constants. However, the path to discovery was not a simple one. It involved controversy, the use of approximations, and a reaction that was difficult to tame given its instability. Yet the reaction continues to fascinate chemists and chemistry educators. Possible reasons for this fascination will be discussed.

The Fifth and Final Chemical Revolution

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A new chronology is introduced to address the history of chemistry, with educational purposes particularly for the end of the twentieth century and here identified as the Fifth Chemical Revolution (1973-1999). This paper attempts to show one of the ways history of chemistry can be teachable for chemistry teachers, being something more than an undifferentiated mass of names and dates, and establishing a temporal framework based on chemical entities that all students use. The paper tries to keep equilibrium between over-simplification and over-elaboration. Each revolution is considered in terms of the Kuhnian notion of 'exemplar' rather than 'paradigm.' This approach enables the incorporation of instruments, as well as concepts and the rise of new sub disciplines into the revolutionary process and provides a more adequate representation of such periods of development and consolidation. In the period of the Fifth Chemical Revolution mainly three new instruments: electron capture detector; flash photolysis with Ti-sapphire laser beam and the scanning tunnelling microscope, changed the way of seeing and understanding chemistry, and the concepts that were developed with them as the new sub disciplines that emerged: Green, Organometallic, Supra-molecular, Nano and Femto Chemistry. Characterized by nanoparticles, its iconic

entity, this revolution showed a deep transformation in the very heart of chemistry. That is to say, the size and type of objects (substances), the way in which they must be done and the time in which they are transformed. In one-way or another, chemistry' limits had been set out.

FRIDAY, 1 SEPT, 10:45-12:45, SESSION A7

Boundary work: Chemistry and Economy

E. Homburg (chair)

- K. Schranz, „Carmichael Smyths's Nitrous Acid"
- C. Halm, „Agricultural Chemistry"
- I. Suay-Matallana, „Customs Laboratory of Lisbon"
- L. Zwisler, „Flow injection analysis"
- K. A. Nier, „Military industrial tool"

Dr. Carmichael Smyth's Nitrous Acid Fumigation: The Chemical Testimony of James Keir

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In the spring of 1802, Dr. James Carmichael Smyth petitioned British parliament for recognition of his nitrous acid fumigation process that countered airborne contagions. William Wilberforce championed Smyth's case by organising a committee to compile testimony for the efficacy and priority of Smyth's discovery.

The committee proceedings were fraught with controversy though as surgeons and physicians presented conflicting evidence about the procedure. Alongside key medical figures, several chemists were invited to share facts based on chemical principles and experiments. Adding his voice to Humphry Davy, the Scottish-born chemist and industrialist James Keir wrote to parliament to support both the precedence and effectiveness of Smyth's work. The committee eventually awarded Smyth 5000 pounds for his discovery.

After his parliamentary award Smyth still fought critics and ended up reprinting his previous text A Description of the Jail Distemper (1803, 2nd ed.), which included an appendix with two more letters from the chemist James Keir.

In this paper I argue that Smyth's discovery provides an excellent case study of boundary work between physicians, surgeons, and chemists at the turn of the eighteenth century. Although Keir was primarily a manufacturer, his position as a respected chemist had been established through his role as a chemical writer and his fellowship in the Royal Society. Though this talk I also examine how chemists fashioned themselves as trustworthy truth-tellers, including witnessing and communicating experiments from a distance, and how chemistry, once a field intricately connected with medicine, began to be viewed as a separate area of expertise.

How the soil became a laboratory: One narrative in the early history of Agricultural Chemistry

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„The soil is the laboratory in which the food [of plants] is prepared."
(Humphry Davy, 1813)

Agricultural Chemistry is a science whose foundations lay in the mid-18th century. The first textbooks with agrochemical contents were published in the 1750/60s. At that time agrochemical experiments already found their way into the laboratories and lecture halls of some European reform universities, chiefly in Uppsala (Sweden) and Edinburgh (Scotland). Furthermore, some scholars and enlightened landowners undertook agrochemical trials in their gardens or even on their farmlands.

But in those days Agricultural Chemistry had not yet developed and established its own methodology, neither for experimentation or observation, nor for the implementation into practice.

If the focus of the historical investigation is on experimentation, following questions arise: What experiments, and what kinds of experiments were done until the time of Humphry Davy? What theories and teachings were derived from these experiments? How strong were they connected to agricultural observations and practices? Where and what was the place of experimentation? Finally and with reference to Davy, how did the farmland and the soil become a laboratory of chemistry?

The customs laboratory of Lisbon: chemistry, economy and heritage

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Customs laboratories are a specific site of chemistry created from mid-19th century in different countries in the context of the „age of adulteration". They were mainly concerned with the fight against fraud, trade control, and the analyses of merchandise for taxes and revenue questions. As a result, they had a great economic importance for the governments, and their staff participated in a large number of debates. My paper will be focused on the customs laboratory of Lisbon created in 1887, as a result of the liberal reforms of the Portuguese government. First, I will consider the reason why this laboratory was created, and the chemists and staff working in it. Second, I will explore the main activities and analysis developed in this laboratory, connecting them with its physical context and its urban context. Finally, I will study the main features of the scientific instruments collection that still exists. The old cabinet has been recently catalogued, and provides a group of 217 instruments, which deserve attention, and a complete study in connection with the laboratory itself.

The Life of Flow injection Analysis and Academic Mass Innovation

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The study I will present has taken its offset in a group of artefacts from the historical collection at the Technical University of Denmark. The artefacts stem from the emergence and further development of the flow analysis platform called Flow Injection Analysis or FIA. At the Technical University of Denmark this development started in 1974. A tale of academic innovation between chemical science, industry, engineering academia and political spheres spun from these artefacts. The stories have a number of typical straits of a recent technoscience development in academia and in the talk I will discuss these traits. The people involved had to negotiate their way between the ethos of science, patent systems, the cooperate world and funding systems. A number of coincidences as well as conscious efforts brought FIA onto the international scene. The uneven distribution of wealth in this world opened a path for a technology for mass chemical analysis on the cheap. The fight for resources and enrolments was on. Money was not a goal but a means to sustain continued work. Honour, novelty and opportunity were precious commodities. FIA was not an island; others were on the same trail. I will look into how and why it was perceived as new by some and not by others.

How a Military-Industrial Tool Enabled Analytical Chemistry to Unify Science

Keith A. Nier
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Instrumentation crafted during the Second World War to monitor the production of fissionable material, of aviation fuel, and of synthetic rubber, through separation of ions of different masses, became a major part of the field of analytical chemistry during the post-war decades. Continued diversification and improvement of these tools, mass spectrometers, over the next half century allowed the same mode of analysis to become a significant element of essentially all fields of the natural sciences and of wide areas of governmental and industrial concern. Dramatic additions and modifications have been made in the technologies involved, but the general analytical technique has remained recognizably continuous whether the subjects have been astronomy or zoology, production monitoring or forensic analysis. And while this general type of apparatus may be more widely employed than others, it is hardly the only kind of instrumentation to be used in multiple fields. Thus even as various philosophers and sociologists have extensively questioned the very possibility of a unity to the sciences, the use of such tools of inquiry has been tying more and more of science together in multiple, practical ways.

FRIDAY, 1 SEPT, 10:45-12:45, SESSION B7

Biographical approaches

E. Zaitseva (chair)

- A. Espelund „Sven Rinman”
- L. Saarloos „Edward Frankland”
- C. Bovolo „Ascanio Sobrero”
- S. Štrbáňová „Bohuslaf Raýman”
- E. Campos, „Edwin Cohn”
- M. Shindell, S. Ramasastry, „Toshiko Mayeda”

The discovery of carbon in steel: The contribution by Sven Rinman

Arne Espelund
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Our material culture has since Neolithic times been based upon iron and steel. The metal treated by the blacksmith had to be malleable, low in carbon content. Soft iron and hardenable steel were regarded as separate substances. Successful smelting required a shaft furnace and gave solid iron and a FeO-rich slag, which had to be liquid at some 1100 o C. That steel is iron with less than 1% carbon could not be documented directly. However, around 1780 oxygen as a part of air was disclosed by chemists such as Scheele in Sweden, which meant a defeat for the old phlogiston theory. The volumetric measurement of CO2 evolved when steel burnt in oxygen gave the answer: steel is iron with some 0.7% carbon.

Sven Rinman’s books Försök till Järnets Historia from the year 1782 present the state of the art prior to the new knowledge. He sought the character of soft iron, steel and cast iron by dissolving samples in acid, measuring the evolved gas and characterizing the residue. He made two samples from one smelt of cast iron, the one cooled slowly with carbon present as graphite, the other quickly with metastable Fe3C as white cast iron. Upon solution the grey iron gave a residue reminding of the lead ore PbS used for writing while the other gave siliceous earth. He even mixed the first residue with saltpetre and detonated the mixture, without realizing that his „blyerts” was carbon.

Only a couple of years later the composition of steel as iron containing a small amount of carbon was accepted both by scientists and blacksmiths.

The aim of the presentation is to present not only a milestone in chemistry/metallurgy, but also the approach of a scientist being a member of the renowned Swedish academic world.

It's All about Money: Edward Frankland, Percy Frankland, and Victorian Chemical Education

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This paper will examine the relationship between professionalism, money, and chemical education in late Victorian chemistry. It does so through the case of Edward and Percy Frankland. In 1889, the celebrated London chemist and water-analyst Edward Frankland (1825-1899) exchanged a series of angry letters with his son Percy Frankland (1858-1946), then Professor of Chemistry at Dundee. Their row was ultimately about money; Percy charged his father of failing to pay a debt, while father Frankland accused his son of stealing books, correspondence and even clients from his water-analysis laboratory, where his son had worked as an assistant. The Frankland case offers an insight into the dynamics of a family feud, but it also sheds light on the role of money and the ways in which the personal and the professional overlapped in the practices of Victorian chemistry. In fact, father Frankland explicitly and repeatedly accused his son of acting 'unprofessionally', and actively impeded his son's chances in scientific society by obstructing him in joining the Athenaeum Club. Moreover, Percy was not just Edward's son, but also his former student and assistant, and many of Edward's arguments against Percy's conduct echo a theme that is usually overlooked in the history of chemical education: chemical education was not only a transfer of laboratory skills, but also involved a formation of character. Sensibilities about money and professionalism in Victorian chemical education can therefore be fruitfully examined through the feud between father and son Frankland.

An Explosive Chemist: Ascanio Sobrero from Piedmont to Europe

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The Italian chemist Ascanio Sobrero (1812-1888) synthesized nitro-glycerine in 1847 in Turin (Italy). Born in Casale Monferrato on 1812 during the Napoleonian occupation, Sobrero gained a degree in Medicine at the University of Turin in 1833. After the degree, his interest in chemistry stated. He worked in the laboratory of the University, thanks to his uncle Carlo Raffaele, and then between 1840 and 1843 he improved his studies in chemistry in Paris (with Pelouze and Dumas) and in Giessen with (Liebig). Back in Turin, he became assistant in General Chemistry and on 1844 member of the prestigious Accademia delle Scienze. During the following years, in addition to the activity as teacher, he synthesized the nitro-glycerine (his most important work) on 1847 and, with the chemist Selmi, he discovered the lead tetrachloride. Other Sobrero's discoveries were an oxidation product of terpenes, called Sobrerol, and the guaiacol. After his main discover, on 1866 Alfred Nobel managed to stabilise the nitro-glycerine creating the dynamite. Grateful for the nitro-glycerine, Nobel gave to Sobrero a pension and appointed him as consultant at one of Nobel's biggest Italian factory, in Avigliana, near Turin.

Shedding new light on contacts of organic chemists in the last third of the 19th century: The correspondence of the Czech chemist Bohuslav Raýman

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Correspondence of scientists is an extremely important source in history of science with a many-sided value. Historians of science have mostly studied letters of well-known scientists practicing in the established scientific centres, while correspondence of those at the „periphery" has usually escaped attention. This paper draws on the correspondence of the organic chemist Bohuslav Raýman (1852-1910), one of the key Czech scientific personalities, whose relatively recently discovered heritage contains letters of foremost European organic chemists Wurtz, Friedel, Kekulé and Emil Fischer, and Agornath Chattopadhyaya, a significant Indian chemist. The letters of Wurtz, Friedel and Kekulé to Raýman have already been discussed before; therefore especially the correspondence of Raýman with Fischer (dated 1887-1889) and Chattopadhyaya (dated 1878-1893) will be treated, focusing on two generally unknown cases. The first instance demonstrates an unusual argument between Raýman and Fischer which originated over research into the sugar rhamnose. The second one suggests the influence of the Liebig school on the development of modern Indian chemistry and describes some noteworthy cultural contacts between the Czech Lands and India related to the scientific interactions of Raýman and Chattopadhyaya.

Edwin Cohn (1892-1953): From the plasma fractionation project during World War II to the production of therapeutics from human blood

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When the biochemist Edwin Cohn moved to Harvard in 1920, his studies were devoted to the physical chemistry of proteins. New techniques, notably electrophoresis and ultracentrifugation, were essential to his plasma fractionation project as the USA was then preparing for World War II.

In 1941, the National Research Council enlisted Cohn to direct the purification of bovine albumin as a blood substitute for the war effort. He also worked on the isolation of human serum albumin, a wise decision as bovine albumin never proved safe for humans. This enterprise stressed Cohn's qualities as a leader who, with a multi-disciplinary team, built the Harvard pilot plant for plasma fractionation, running in an industrial style; researchers operated around the clock, this effort allowing the treatment of many Pearl Harbour casualties, with success.

In early 1942, production of human albumin begun on an industrial scale in pharmaceutical laboratories with contracts with the Navy, under Cohn's control until commercial production was underway in 1943.

Cohn's technique allowed the isolation of other human blood components of therapeutic utility, including γ-globulin giving immunity from measles. Critical new therapies for military medicine led to an industry of plasma fractions for civilian use, contributing decisively to the creation of a new specialty: haematology.

Toshiko Mayeda: A „Hidden Figure" of Isotope Geochemistry

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Toshiko Mayeda (1923-2004) was a Japanese American woman, born in Tacoma, Washington, imprisoned during WWII in the Tule Lake internment camp. After her release she and her husband moved to Chicago. Here she studied chemistry at Wilbur Wright College and went to work for the Nobel Prize-winning chemist, Harold C. Urey, who hired her to work as a lab assistant in his University of Chicago laboratory. Urey – a physical chemist credited as one of the „fathers" of isotope geochemistry – had retooled his post-war research program for the use of isotopes to probe questions of earth and solar system history. This included the construction of custom-built mass spectrometers for the precise measurement of isotopic abundances. Mayeda became a crucial part of Urey's team, working alongside his students and collaborators, and learning the science of isotopes in the process. When Urey left Chicago, Mayeda stayed and began collaborating with the cosmo-chemist Robert Clayton, who took over the lab and instruments. Clayton counted on Mayeda to run the laboratory, to help train his graduate students, and to operate the instruments. Mayeda's work did not go unrecognized – she authored and co-authored several papers in the field – and yet she did not reap the professional rewards or the prestige afforded to her male collaborators. In this paper we explore Mayeda's career in the context of work on the history of women in science, and we reflect on the task of recovering the biographies of hidden women and non-white scientists such as Mayeda.

FRIDAY, 1 SEPT, 14:00-15:20, SESSION A8

Panel: Relating Chemistry: Translating Chemistry Across Linguistic, Disciplinary, and Physical Boundaries

C. Berkowitz (organiser and chair)

- C. Berkowitz, „James Woodhouse and Chemistry"
- J. Beckman, „Jöns Jacob Berzelius and Swedish"
- Y. Siderer, „Historical, Cultural and Linguistic Study in Translation"
- H. Chang, „Huaxue Qiushu: The Peak of the Introduction of Western Chemistry"

This panel explores the important work of translation in communicating chemical knowledge and practices in the late-eighteenth and nineteenth centuries. Focusing on an early American chemistry professor and textbook writer, a Swedish researcher's relationship to the Swedish Academy of Sciences, and the Geneva Congress for the Reform of Chemical Nomenclature, these three papers, despite their different sites of inquiry, all shed light in turn on related themes: the ways in which national contexts and languages shaped the modern discipline of chemistry; the relationships among textbooks, print journals, and research; and the connections between formal theory and practices in broader disciplinary and commercial contexts. Berzelius's attempted to render Swedish a scientific language that could be as universal as French or German. The language of organic chemistry at the end of the century was expressed in structural formulas; at the beginning of the century Woodhouse, importing chemical discourse from abroad, attempted to lodge it in practical chemical operations, reflecting the ideology of Lavoisier's chemistry in the idiom of utility. Such translations, whether linguistic, disciplinary, or taking place across cultural and spatial geographies, starkly reveal the imprecision of meanings in scientific domains: the tag „traddutore, traditore" haunts even the most technical of languages, and means that the chemistry practiced by a specific community or in a particular setting can never be entirely replicated in another.

James Woodhouse and Chemistry in the Vernacular

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James Woodhouse, who was born in 1770 in Philadelphia, received his bachelor's and master's degrees, as well as his MD, in his home city. There, he studied under Benjamin Rush and assumed the Chair of Chemistry at the University of Pennsylvania when Joseph Priestley refused the post in 1795, as well as founding the Chemical Society of Philadelphia. His work was proudly local and typically American, drawing equally from French and British traditions, but insisting on the centrality of utilitarian and practical concerns.

Woodhouse wrote what has been described as the first laboratory manual, a book of 100 experiments stripped of an overarching system or framework, and he edited for an American audience both French and English textbooks. His work on medicine and on minerals, metals, coal, and foods reveal a man who bridged what are now regarded as separate disciplines, bringing together the practices and theoretical tools of chemistry and the practical aims of medicine and industry. His was a labour of translation across national and disciplinary boundaries. Such translational work was at its apex in the textbooks. There he stressed the practical character of chemistry and its value to the emerging nation, his willingness to draw piecemeal from different traditions, and also his intentions to make such work accessible to his fellow countrymen. The translational work of a textbook-writer chemist, trained in Philadelphia, working within a medical setting, thus became central to the construction of an American chemistry.

Jöns Jacob Berzelius and Swedish as a scientific language, 1800-1840

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”I doubt … that comprehensive scientific works by Swedish authors will ever be printed in Swedish.” In 1811, the famous chemist Jöns Jacob Berzelius despaired of the future of his native language as a scientific language. On the Swedish book market, only scandals, religious tracts, and textbooks were reliable money-makers, despite the brand-new, liberal press laws.

Nevertheless, Berzelius published extensively in Swedish. He launched and edited a number of journals, his chemical textbook went through numerous editions, and his Annual Survey of Progress in the Sciences aimed to summarise and evaluate all chemical publications. As Secretary of the Royal Swedish Academy of Sciences, he endeavoured to make the Academy Proceedings the influential journal it had been in the 18th century, despite being published in Swedish. But he wielded his considerable influence through translations.

In this paper, I will talk about the problems with making the publications of the Swedish Academy of Sciences accessible and relevant to a Swedish audience, as well as to a wider scientific public. More specifically, I will look at how the conditions for doing so changed over the first half of the 19th century, and how these changes are reflected in the different reactions to the translation of one of Berzelius’ journals into German, and French.

Historical, Cultural and Linguistic Study in Translation of Science

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This study deals with the historical, cultural and linguistic aspects of translation of science into languages in which the relevant terminologies were not yet invented.

In 1866 professor Henry Enfield Roscoe (1833-1915) wrote a chemistry book for schools. In this book he explained the very basics of matter: Fire-Air-Water-Earth to children, emphasizing the use of experiments as tools to validate physical hypothesis. The book was soon exported from England to the USA.

In 1870 William Elliot Griffis (1843-1928) was invited to teach chemistry to youngsters in remote Fukui in Japan. He asked for Roscoe's book to be sent to him. In 1873 Japan's Ministry of Education published the Japanese translation of Roscoe's chemistry book, titled kogaku kagakusho hyoumoku, „Chemistry Book for Elementary School“.

In 1879 Roscoe's book was translated into Icelandic. In 1929, in the renewed settlings of Jewish people in the Land of Israel, Roscoe's book was translated into Hebrew.

What terminology did the translators use for the new discipline, chemistry? The Japanese translator used old and new terms, some of those survived or modified. Oirbach, the Hebrew translator, added a list of new Hebrew terms facing English and German equivalents. Many of those are in use today. The Japanese and Hebrew translations of Roscoe's text, including historical, cultural and linguistic consideration will be presented.

Huaxue Qiushu: The Peak of the Introduction of Western Chemistry into Qing Dynasty China

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Huaxue Qiushu, long considered to be based on Fresenius' Quantitative Chemical Analysis, was translated into Chinese in 1883 by John Fryer and Shou Xu, This chemistry textbook stands, not only as being representative of the great collaborative work that existed in Fryer and Xu's translation work – combining maturity, experience and understanding to produce a smooth and accurate rendering of the original – but also as one of the best examples to refute the notion that Chinese scientific translations of that period were of poor quality.

Through comparing Qiushu with other translated chemical textbooks of that period, and with the original versions, this paper seeks to demonstrate that, on one hand, Qiushou stands at the peak of the scientific works aimed at the introduction of Western chemistry into late Qing China; and, on the other hand, is also indicative of the many problems faced by translators in their attempts to render scientific (chemical) terminology and nomenclature from English into Chinese.

A further issue to be addressed in this paper is the controversy surrounding which edition Fryer and Xu based their translation on. It has long been held that the original edition of Qiushou was based on the 7th edition (England) of Fresenius' Quantitative Chemical Analysis, published in 1876. However, this paper argues that it was actually based on an earlier work, namely, the 4th edition of Fresenius' A System of Instruction in Quantitative Chemical Analysis (1865).

FRIDAY, 1 SEPT, 14:00-14:45, SESSION B8

Polymers and Plastics

[Sponsor: INEOS/INOVYN]

P. Morris (chair)

- A. Petersen „Early Danish Plastics Industry"
- M.E. Callapez, T. Mota „Plastic, Anthropocene and Time"

The Early Danish Plastics Industry

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For the development of polymers Danish science and industry have not made significant contributions. Up until the time of the Second World War this technology was hardly considered a part of technical chemistry. Danish production of plastic products has been based on import of both materials and know-how. With only a single exception there has not been production of raw plastic in Denmark. Apart from Bakelite and celluloid, production of plastic products in Denmark only began after the Second World War. The delay from international introduction to Danish production was considerable. In contrast to the lack of scientific work in this field there was innovation in using these materials for new products. Some companies beginning to use plastic in the late nineteen fifties have become quite large companies, still producing in the same field.

After the Second World War many German fugitives came to Denmark. One of these possessed knowledge about the use of polymers. This initiated the start of several small plastic industries around the city of Roskilde. One company specialized in making acrylic glass. Due to the lack of proper raw materials it made use of an unusual method. This method formed the base for making specialized products of this material. Always making products for a small volume marked this company has stayed very small. Another Roskilde company had its origin in the local pharmacy. The new owner in the nineteen fifties was not only a pharmacist but also a chemical engineer. His idea was to replace medical equipment of glass with single use products of plastic. The production began in the backroom of the pharmacy but after a few years it was a world company in this field.

Plastics, Anthropocene and Geological Time

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In this presentation we will address the controversial circumstances regarding the definition of the Anthropocene as a geological unit by using plastics as a stratigraphic marker. Worldwide distribution of plastics and some of their particular characteristics led Jan Zalasiewicz et al (2015) to propose this material as an indicator of the basal boundary of the Anthropocene. However, this suggestion was not accepted by the working group on the Anthropocene at the 35th International Geological Congress meeting that took place in August 2016 in Cape Town. Besides plastics, several other stratigraphical markers were proposed, being artificial radionuclides elected.

Plastics are inert, durable, non-biodegradable and easily disposable. They are materials of our modern society that can be found everywhere, in several fields of activity, such as agriculture, medicine, architecture, art and design, engineering, among others. Just like artificial radionuclides, plastics are spread all over the world throughout

land and sea. Why were they not selected as a stratigraphic marker of the Anthropocene?

We will discuss the reasons that support that decision in the context of the procedures to be followed by the international geological community regarding the validation of new geological units. Scepticism among geologists about the possibility of finding a global stratigraphic marker that confirms the Anthropocene as a geological unit of the chronostratigraphic scale will also be considered.

FRIDAY, 1 SEPT, 14:50-15:30, SESSION B8a

„All Things Bakelite"

[Sponsor: INEOS/INOVYN]

Preview of a documentary film by Hugh Karraker (great grandson of Leo Beakeland).

FRIDAY, 1 SEPT, 16:00-17:30, CLOSING SESSION A9

Panel: What future for the history of recent chemistry and molecular sciences? New Challenges in the History of Chemistry and the Molecular Sciences

J.A. Johnson, C. Meinel, B. Van Tiggelen (organisers)
B. Van Tiggelen (moderator)

- Bernadette Bensaude-Vincent
- Lijing Jiang
- Yoshiyuki Kikuchi
- Cyrus Mody
- Carsten Reinhardt

The Commission on the History of Modern Chemistry (CHMC) is in the process of broadening its purview to include not only modern chemistry, but also a variety of related fields under the designation of "molecular sciences" such as material sciences, nanosciences and nanotechnologies, biotechnologies, and the life sciences most directly based on chemistry including molecular biology and synthetic biology. The inclusion of these fields reflects the evolution of chemical methods, techniques and concepts over a wide variety of neighboring fields and has to be reflected in the historiography as much as the integration of new approaches and tools from the recent historiography of science (practical and sociological turn for instance). It is thus timely to reflect on the challenges that lie ahead for the history of recent chemical and

molecular sciences. The panel aims at illuminating some of the most promising current directions of research, as well as some of the difficult challenges in each of these areas including conceptualization of problems in the field, periodization and delimitation of recent developments, as well as access to or preservation of appropriate sources. As an appropriate point of departure for our discussion we suggest using Peter JT Morris' article "The Fall and Rise of the History of Recent Chemistry," Ambix, 58:3 (2011), 238-256.

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