5th

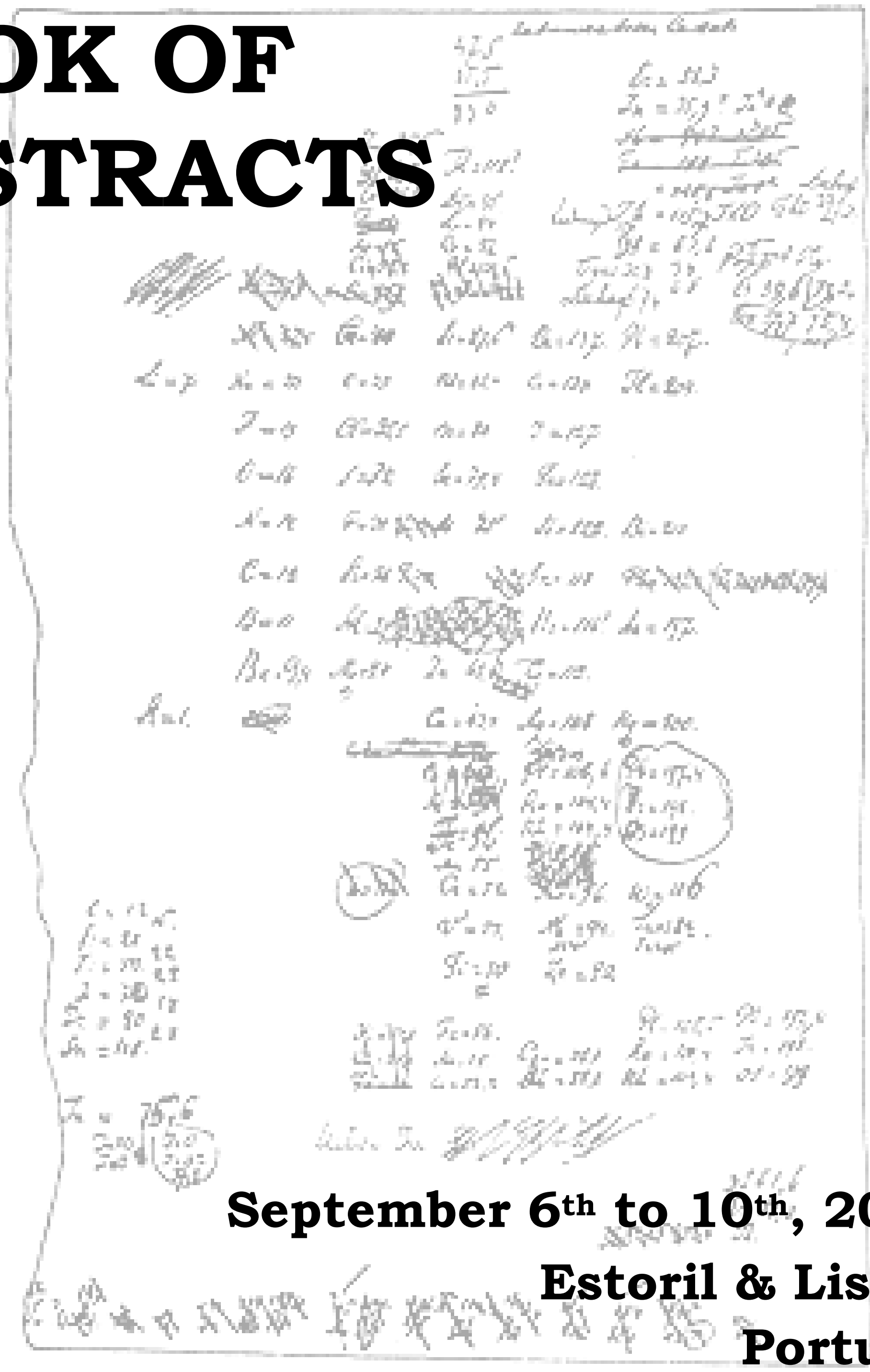
INTERNATIONAL CONFERENCE ON THE HISTORY OF CHEMISTRY

Chemistry, Technology and Society

Editors

Maria Elvira Callapez, Isabel Malaquias , Ricardo Santos and Hugo Rosa

BOOK OF ABSTRACTS



September 6th to 10th, 2005

Estoril & Lisbon

Portugal

Book of Abstracts

Editors

Maria Elvira Callapez, Isabel Malaquias, Ricardo Santos and Hugo Rosa

Secretariat

5th International Conference on History of Chemistry
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WELCOME

By Maria Elvira Callapez, Chair of the Local Organizing Committee

Dear Colleagues

Portugal is often referred as a welcoming country, rich in both sun and friendliness.

At Lisbon, the nation's capital, you will find marks and milestones of the city's rich historical background merged with the twenty-first century architecture. Estoril on the other hand, is well known for its marvellous beaches and fresh air, which benefits the local tourism.

In our role as hosts, we have prepared a schedule which we hope can provide learning opportunities and also encourage a friendly discussion amongst everyone. But there will also be a social component to the event in which we wish to bring everyone closer to each other and the Portuguese culture as well.

In conclusion, our goal is to provide a good scientific dialogue that hopefully will go beyond the schedule and reach a more personal level allowing bonds to be made.

It is our most sincere wish that this Conference becomes more than a meeting between old acquaintances, and provides a starting point for challenges ahead.

Enjoy your stay!

ACKNOWLEDGEMENTS

The Committee is deeply thankful to the following Institutions for their support and help without which the meeting could not be held:

ACADEMIA DAS CIÊNCIAS DE LISBOA
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CÂMARA MUNICIPAL DE RIO MAIOR
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CIRES – COMPANHIA INDUSTRIAL DE RESINAS SINTÉTICAS
CTCV – CENTRO TECNOLÓGICO DE CERÂMICA E VIDRO
EMBAIXADA DE ESPANHA
EuCheMS – European Association of Chemical and Molecular Sciences
FCT – Fundação para a Ciência e Tecnologia
FLAD – Fundação Luso-Americana para o Desenvolvimento
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CONTENTS

CONTENTS

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CONFERENCE PROGRAMME

Tuesday 6 Sept	
15.00-19.00	**Arrivals of those who don't take part in the Workshop, and registration for the Conference at the Hotel Estoril Eden**
20.00-22.30	**Dinner buffet at the Hotel Estoril Eden (for participants in the Conference)**
Wednesday 7 Sept	**Opening session (at Academia de Ciências de Lisboa)** *Chair: José Manuel Toscano Rico / Maria Elvira Callapez*
9.30-10.00	Prof. José Manuel Toscano Rico and Prof. José Vitorino Pina Martins, President and Vice-President of the Academia das Ciências de Lisboa Prof. José Manuel Martinho, President of the Sociedade Portuguesa de Química Prof. Fernando Pina, General Secretary of the Sociedade Portuguesa de Química Prof. Fernando Ramôa Ribeiro, President of Fundação para a Ciência e Tecnologia Prof. Ernst Homburg, Chairman of the Working Party on History of Chemistry
10.00-10.45	Plenary lecture on 'The History of chemistry in Portugal' by Prof. José Ferreira da Silva, Universidade do Porto, Portugal
10.45-11.05	**Coffee/tea break**
11.05-11.50	Plenary lecture on 'Popularising chemistry: Hands-on or hands-off?' by Prof. David Knight, University of Durham, UK
11.50-12.35	Plenary lecture on 'No more miracles: The unfortunate decline in catalyst innovation' by Prof. John K. Smith, Lehigh University, Bethlehem, PA, USA
12.35-12.55	*Walk from the Academy of Science to the Museu da Farmácia*
12.55-13.25	**Visit to the Museu da Farmácia**
13.25-14.55	**Lunch at *Restaurante A Ver Navios* in Museu da Farmácia**
	(Afternoon sessions are held at Museu da Farmácia)

Wednesday 7 Sept	*Session 1A: Portuguese chemistry, 1640-1910* *Chair: Elisa Maia*
15.15-15.40	Luís Miguel Carolino (Brazil), 'Aristotelian theory of mixtures and corpuscular matter conception among Jesuit philosophers in mid-seventeenth century Portugal'
15.40-16.05	M. Serrano Pinto, Isabel Malaquias, M.A.G. Cecchini, L.M. Moreira-Nordemann, and J. Rui Pita (Portugal/Brazil), 'José Pinto de Azeredo's chemical analysis of the air of Rio de Janeiro in late 18th century'
16.05-16.30	Cristina Maria Campos Ramalho (Portugal), 'The teaching of chemistry in Portuguese universities between 1836 and 1910'
16.30-16.55	A.M. Amorim da Costa (Portugal), 'The atomic theory in Simões-Carvalhó's "Lessons of Chemical Philosophy" (University of Coimbra, 1851, 1859)'
16.55-17.15	**General discussion**
Wednesday 7 Sept	*Session 1B: Theory and practice in twentieth century chemistry* *Chair: Colin Russel*
15.15-15.40	Pierre Laszlo (France), 'The sucrose inversion experiment and its epistemic significance'
15.40-16.05	W. Gerhard Pohl (Austria), 'Microchemistry was an "Austrian science" for many years'
16.05-16.30	Marco Fontani and Mariagrazia Costa (Italy), 'The twilight of the naturally-occurring elements: Moldavium (Ml), Sequanium (Sq) and Dor (Do)'
16.30-16.55	Stephen J. Weininger (USA), 'Theoretical ambitions, empirical constraints, and chemists' intuitions: the saga of the reactivity-selectivity principle'
16.55-17.15	**General discussion**
20.00-23.00	**Welcome drink and dinner at Hotel Estoril Eden**
	(All sessions are held at Hotel Estoril Eden)
Thursday 8 Sept	*Session 2A: Applied chemistry through the ages* *Chair: Marco Beretta*
9.00-9.25	Evangelia A. Varella (Greece), 'Purple and indigo dyes in the Greco-Roman world'
9.25-9.50	Halina Lichocka (Poland), 'Chemical analysis as a method of discovery in pharmacy in the age of Enlightenment in Europe'
9.50-10.15	Hjalmar Fors (Sweden), 'Chemistry at the Swedish Board of Mines, 1700-1750'
10.15-10.40	Mary Archer (UK), 'Applied chemistry at the University of Cambridge, 1702-2002'
10.40-11.00	**General discussion**
Thursday 8 Sept	*Session 2B: Contexts of popularisation* *Chair: Brigitte Van Tiggelen*
9.00-9.25	Joachim Schummer (Germany/USA), 'Providing metaphysical sense and orientation: nature-chemistry relations in the popular historiography of chemistry'
9.25-9.50	Andrew Ede (Canada), 'Persuasion and iconography in A. Cressy Morrison's "Man in a Chemical World" '

9.50-10.15	Ana Simões (Portugal), 'C.A. Coulson and the popularization of theoretical chemistry in the twentieth-century'
10.15-10.40	Peter J. T. Morris (UK), 'Presenting chemistry at the Science Museum: its history and current practice'
10.40-11.00	**General discussion**
11.00-19.00	**Poster session I at Hotel Estoril Eden**
11.00-11.20	**Coffee/tea break**
Thursday 8 Sept	*Session 3A: (Applied) chemistry in the nineteenth century* *Chair: Soňa Štrbáňová*
11.20-11.45	Jan Trofast (Sweden), 'Jacob Berzelius and the chemical laboratory'
11.45-12.10	Miroslav Novák (Czech Republic), 'Polarimetry and sugar industry'
12.10-12.35	Anita Kildebæk Nielsen (Denmark), 'Nutrition theories in Denmark in the nineteenth-century: before and after Liebig'
12.35-13.00	Anders Lundgren (Sweden), 'Knowledge in early pulp and paper industry'
13.00-13.20	**General discussion**
Thursday 8 Sept	*Session 3B: Instrumental practices 1910-1960* *Chair: José R. Bertomeu Sánchez*
11.20-11.45	Annette Lykknes and Lise Kvittingen (Norway), 'The founding of a chemical laboratory at Norway's first Institute of Technology: laboratory practices 1910-1936'
11.45-12.10	Francisco Javier Calvó-Monreal (Spain), 'Molecular biology in Catalonia and the development of X-ray diffraction technology: the structuralist school of Joan Antoni Subirana and Jaume Palau'
12.10-12.35	Keith A. Nier (USA), 'The transformation of atomic weights: new instrumentation and objective progress'
12.35-13.00	Carsten Reinhardt (Germany), 'Electronics meets chemistry: Herbert S. Gutowsky and the beginning of chemical NMR'
13.00-13.20	**General discussion**
13.20-14.50	**Lunch at Hotel Estoril Eden**
Thursday 8 Sept	*Session 4A: Between industry and academia, 1900-2000* *Chair: Isabel Malaquias*
14.50-15.15	José Claro Gomes (France), 'Between science and industry: the rare earths' school of Georges Urbain (1872-1938)'
15.15-15.40	Elena Zaitseva (Russia), 'A.E. Chichibabin (1871-1945) and the development of chemical and chemical-pharmaceutical industry in Russia'
15.40-16.05	Kenneth Bertrams (Belgium/USA), 'Converting academic knowledge into industrial innovation: strategies of appropriation of university-based research at Solvay & Co. and Gevaert N.V.'
16.05-16.30	Muriel Le Roux (France), 'Between university and industry. The Institute for Chemistry of Natural Substances, the story of an unusual CNRS laboratory: the ICNS, 1960-2000'
16.30-16.50	**General discussion**

Thursday 8 Sept	*Session 4B: Nineteenth-century laboratory practices* *Chair: Ursula Klein*
14.50-15.15	Alan Rocke (USA), 'Material culture and professionalization of European science: the role of Liebig and German laboratory practice'
15.15-15.40	José R. Bertomeu Sánchez (Spain), 'Sense and sensitivity : Marsh's test for arsenic in European toxicology (1836-1845)'
15.40-16.05	Fernanda Madalena Costa and Isabel Marília Peres (Portugal), 'Historical note on optical methods and related scientific instruments for chemistry use by Lisbon Polytechnic School in the end of the nineteenth and the early twentieth centuries'
16.05-16.30	Soňa Štrbáňová (Czech Republic), 'The Prague Wenzel Batka company: business, science, invention, and politics'
16.30-16.50	**General discussion**
16.50-17.10	**Coffee/tea break**
Thursday 8 Sept	*Session 5A: From fertilisers to nerve gases, 1830-1945* *Chair: Eva Vamos*
17.10-17.35	Laurence Lestel (France), 'Fertiliser producers in France in the nineteenth-century: their links with chemists (1830-1870)'
17.35-18.00	Frank Ruhnau (Germany), 'Combustion research in the Third Reich (1937-1945): reflections on a border arena of chemistry, physics and technology'
18.00-18.25	Heinrich Kahlert (Switzerland), 'Why Hitler did not deploy nerve gas agent in World War II?'
18.25-18.40	**General discussion**
Thursday 8 Sept	*Session 5B: Communication between Britain and the Continent, 1650-1850* *Chair: António M. Amorim da Costa*
17.10-17.35	D. Thorburn Burns (Northern Ireland), 'The continental editions of the works of Robert Boyle'
17.35-18.00	Fernando Egídio Reis (Portugal), 'Bringing scientific knowledge to Portuguese readers: chemistry in periodicals of Portuguese liberal emigrés (1808-1822)'
18.00-18.25	C.A. Russell (UK), 'The Marreco story'
18.25-18.40	**General discussion**
20.00-23.00	**Dinner at Restaurante Sr. Vinho (Fados), Lisboa**
Friday 9 Sept	
9.00-10.20	*Business meeting of the EuCheMS Working Party on History of Chemistry (at Hotel Estoril Eden)*

8.00	*Transport to Universidade Lusófona (for those who have Posters to*
10.20	*Transport to Universidade Lusófona*
	(All sessions are held at Universidade Lusófona)
11.00-16.00	**Poster session II at Universidade Lusófona**
Friday 9 Sept	*Session 6A: Chemical technology and biotechnology after World War II* *Chair: Ernst Homburg*
11.00-11.25	J. M. Leal da Silva, Gilberto Gomes and Isabel Cruz (Portugal), 'The roasting of pyrites containing arsenic: a case study (Barreiro 1950-1972)'
11.25-11.50	Arjan van Rooij (The Netherlands), 'Re-evaluating the role of industrial research in the 1950s and '60s. DSM's caprolactam research and the development of the HPO-process, 1956-1977'
11.50-12.15	Viviane Quirke (UK), 'From chemistry to pharmaceuticals, and from pharmaceuticals to biotechnology: the many transformations of Imperial Chemical Industries in the twentieth century'
12.15-12.40	Ton van Helvoort (The Netherlands), 'The government is here to stay: recombinant-DNA technology and the autonomy of science in the Netherlands'
12.40-13.00	**General discussion**
Friday 9 Sept	*Session 6B: Public and private faces of chemistry, 1770-1900* *Chair: Anita Kildebaek Nielsen*
11.00-11.25	Núria Pérez-Pérez (Spain), 'The instrumental use of chemistry in biomedicine at the end of the eighteenth century'
11.25-11.50	Anna Simmons (UK), 'Laboratories, liniments and learning: the place of chemistry at the London Society of Apothecaries in the nineteenth century'
11.50-12.15	Marika Blondel-Mégrelis (France), 'Popularisation in chemistry: Liebig, the pre-eminent example'
12.15-12.40	Geert Vanpaemel (Belgium), 'Science, honour and commerce. The public face of chemistry in nineteenth-century Belgium'
12.40-13.00	**General discussion**
13.00-14.30	**Lunch (with wine tasting) at Universidade Lusófona, Lisboa**
Friday 9 Sept	*Session 7A: The chemical industry during the interwar period* *Chair: Marika Blondel-Mégrelis*
14.30-14.55	Erik Langlinay (France), 'Technology, territories and capitalism: the First World War and the reshaping of the French chemical industry (1914-1928)'
14.55-15.20	Nathan M. Brooks (USA), '"Chemization" and the chemical industry in the Soviet Union, 1917-1941'
15.20-15.45	Declan O'Reilly (UK/USA), 'Black gold: Standard Oil of New Jersey, I.G. Farbenindustrie A.G. and the politics of synthetic oil 1925-1945'
15.45-16.00	**General discussion**

Friday 9 Sept	*Session 7B: Practice and theory before Lavoisier* *Chair: Halina Lichocka*
14.30-14.55	Mi Gyung Kim, ‘Experimental systems and theory domains in pre-Lavoisian chemistry’
14.55-15.20	Maria Helena Roxo Beltran (Brazil), ‘The art of distillation in manu-scripts and early printed books: transmission of practical knowledge’
15.20-15.45	Roman Mierzecki (Poland), ‘Error in chemical manuals: the priority of Lavoisier unjustly questioned’
15.45-16.00	**General discussion**
16.00-19.00	**Visit to the Aqueduto das Águas Livres, Lisboa**
19.00-21.00	**Closing session & cocktail at Museu da Água - Reservatório da Mãe d’Água das Amoreiras, Lisboa**

(I) Poster Session I on Thursday 8 September, 11.00-19.00, at Hotel Estoril Eden	
Willem J. Hornix (The Netherlands)	The role of the history of science in science education
Isabel Amaral and C. Barreira (Portugal)	Chemistry applied to medicine: the School of Tropical Medicine of Lisbon (1902-1942)
António Costa Canas and Carlos Valentim (Portugal)	Portuguese pharmacopoeia in the Renaissance: Tradition and innovation
Sara Carvalho (Portugal)	Experimental work in the chemistry courses of the Polytechnic School of Lisbon: 19th century and beginning of the 20th century
Pedro Casaleiro, Catarina Pires (Portugal)	Laboratorio Chimico of Coimbra University: A Museum space
Heinrich Kahlert (Switzerland)	Walther Bothe`s error in World War II
Robert D. Hicks and Rob Lukens (USA)	The Chemical Heritage Foundation Institute: An innovation in promoting chemical history
Raul Vital (Portugal)	Águas Livres aqueduct. Science and Technology in 18th Century in Portugal in Water Supply.
Glen E. Rodgers (USA)	Scientific/historical travel seminars in Europe
Susana Santos (Portugal)	The Revista de Chimica Pura e Applicada and the foundation of the Portuguese Chemical Society
Leal da Silva, J.M. (Portugal)	Do you know Mr. Stinville?
Emília Vaz Gomes and Isabel Malaquias (Portugal)	The development of physics and chemistry teaching at the University of Coimbra and the emergence of spectroscopy (1860-1880)
Bernardo Jerosch Herold (Portugal)	Two centuries of Portuguese chemical nomenclature
George N. Vlahakis (Greece)	Alchemy survived? An alchemical manuscript, Anastasios Christomanos and the status of chemistry in late 19th century Greece

(II) Poster Session II on Friday 9 September, 11.00-16.00, at Universidade Lusófona	
Maria Elvira Callapez (USA/Portugal)	The challenge of PVC and regulation - must we abandon this important useful material?
Elisa Maia and Natacha Quádrio (Portugal)	Safety regulations in chemistry laboratories in schools and universities - past and present
Maria Filomena Camões (Portugal)	Golden pages of the history of chemistry in Portugal
Isabel Cruz (Portugal)	From the "Instituto Industrial e Comercial de Lisboa" to the "Instituto Superior Técnico" - What Transition? (1892-1922)
Sandra Lopes, Maria Teresa Carreira (Portugal)	Bernardino António Gomes and the Isolation of Chinchonine in the early 19th century - a polemic work
Elisa Maia, Ricardo Pestana (Portugal)	A data base of ancient laboratory material of chemistry and physics existing in old schools and in the Science Museum of the University of Lisbon
Sandra Lopes (Portugal)	Ferreira da Silva and toxicology in Portugal by the end of the 19th century: The legal case of Urbino de Freitas
Isabel Serra and Nuno Peiriço (Portugal)	Portuguese chemists and radioactive minerals
Vanda de Carvalho Vitorino and Maria do Carmo Elvas (Portugal)	Retorts - mythic pieces of chemical equipment
Lurdes Cardoso and Maria Adelaide Salvado (Portugal)	China Root In Connection To The Cure Of The Syphilis
Alexandra Silva (Portugal)	The importance of Analytical Chemistry in Industry
Ana Leonor Pereira and Rui Pita (Portugal)	Chemistry Applied To Medicine And Public Health - The Work Carried Out By Charles Lepierre (1867-1945) In Portugal
Stefano Zambelli (Italy)	Kramers - Christiansen contribution to chemical kinetics

PLENARY LECTURES

Chair: José Manuel Toscano Rico
Maria Elvira Callapez

THE HISTORY OF CHEMISTRY IN PORTUGAL

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The history of Chemistry can be divided into five periods that James Campbell Browne(1), professor of Chemistry at the University of Liverpool, has designated and dated as follows:

I – Prehistorical (<1500 B.C.)

II – Alchemical (1500 B.C. – 1650 A.C.)

III – Iatro-chemical (1500 – 1700)

IV – Phlogistical (1650 – 1750)

V – Quantitative (>1775)

In Portugal the beginning of Chemical Studies took place in the last period of this chronology. It seems that, unless rare references, the iatro and phlogistic chemistry do not had great repercussions in the Portuguese scientific milieu. Anyway, as early as the middle of the XVII^th^ century (1648) "Tratado das virtudes dos óleos de enxofre, vitríolo, philosoforum, alecrim, salva e agoa ardente " by Duarte Madeira Araes was published in Lisbon(2). It is also worth mentioning the names of two Portuguese, that at earliest stages of Chemistry development, maintained contacts with famous foreign scientists: João Jacinto de Magalhães, contemporary and friend of Priestley and Ribeiro Sanches, disciple of Boerhaave (Leiden). The perspectives that Lavoisier opened in the chemical science fits into the enlightenment period which reached Portugal in the middle of the XVIII^th^ century and found a resonance in the policy of the portuguese statesman and minister of king José the 1st – Marquês de Pombal. Pombal was the promotor of the 1772 reformation of Coimbra University (the only one existing at the time in the country), instituting, among other innovations, the teaching of chemistry at both theoretical and experimental levels in the "Laboratório Chímico". It was there that several generations of notable professors and researchers were taught.

For the sake of systematisation the evolution of Chemistry in Portugal can be divided into five periods(3), which we can characterise as follows:

1st – Origins- (1772 – 1780) - Characterised by the inclusion of chemistry studies in higher education (Ensino Superior) at Coimbra University – Pombalian Reformation. In this period the most significant names in the field were Rodrigues Sobral and Andrada e Silva.

2nd - Extension – (1780 – 1837) – Creation of " Laboratório da Casa Pia" (later "Casa da Moeda") to which we associate the names of Bernardino Gomes and Mousinho de Albuquerque.

3d - Dissemination – (1837 – 1885) – Inclusion of Chemistry studies in the Polythecnic School (Lisbon) and Polythecnic Academy (Porto) and Industrial and Agronomic Institute (Lisbon) meanwhile created. It is in this period that come across the names of chemists such as Vicente Lourenço, Oliveira Pimentel, António de Aguiar, Ferreira Lapa and Duarte Silva.

4th – Perfectioning and zenith – (1885 – 1911)- This was a period of great development in chemistry in this country regarding both its study and its applications. In this period we can find such distinguished names as José Júlio Rodrigues Simões de Carvalho, Santos e Silva, Sousa Gomes, Álvaro Basto and with special enphasis on that of António Joaquim Ferreira da Silva(4), the glory of portuguese chemistry. Due to this fertile activity much of scientific and technical accomplishments in the field of chemistry in Portugal was, at that time, centred in Porto. Ferreira da Silva who was a teacher of exceptional scientific merit was based at the Polytechnic Academy and its successor, the Faculty of Sciences (Porto University). He was author of textbooks for his chemistry courses and published dozens of papers on his scientific and technical works, some of which are famous and recognized abroad as importants. Ferreira da Silva was also director of " Laboratório Chímico Municipal do Porto" dealing with matters of urban hygiene. To his credit we should also mention the foundation in 1905 of the monthly Portuguese Review of Pure and Applied Chemistry, together with Alberto de Aguiar and José Pereira Salgado and the collaboration of most of the famous names in Portuguese Chemistry of the time. It was in this period that secondary schools –"liceus"– (Passos

Manuel's reformation, 1836) were created, whose curricula included the teaching of chemistry and its experimental study was instituted.

In 1907 a chemical – industrial complex (C.U.F. – "Companhia União Fabril", later Quimigal) was implimented at Barreiro, in front of Lisboa on the left bank of the river Tejo, whose production was growing steadily in the course of time, ranging from sulphuric, chloridric and nitric acids, sodium, copper and aluminium sulphates, ammonium, aniline and fertilizers to systems for polyurethane, polyoil, etoxylate, polyester, resins and many other products with great economic value. It was also in this period (1910) that the "Ensino Técnico Agrícola" was reformed with the creation of " Instituto Superior de Agronomia" and " Escola de Medicina Veterinária" by the splitting of the former "Instituto de Agronomia e Veterinária" . Studies of chemistry were included in these new institutes.

5th – Modern Chemistry or Chemical Specialization (≥1911). This period correspond to the creation of two new universities (Lisboa and Porto, 1911) [(5)] whose faculties of sciences were the successors of their respective Polytechnics.

The technical-industrial-commerce teaching was also the subject of reform in 1911, with the creation of the "Instituto superior Técnico" and the "Instituto Superior de Comércio" by the splitting of the former "Instituto Industrial e Comercial "(Lisbon). At the University of Porto the Faculty of Engineering was created including, as at the "Instituto Superior Técnico", a course in chemical engineering.

The teaching of chemistry was considerably extended in the curricula of the various courses of institutes and faculties either as teacher training or as a specialisation in chemical engineering.

Relevant details of the evolution of teaching and applications of chemistry in Portugal will be covered during the presentation of this topic, with particular emphasis on Medicine, Pharmacy, Agriculture, Industry, Hygiene, Public Health and Biochemistry.

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POPULARISING CHEMISTRY: HANDS-ON OR HANDS-OFF?

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Linus Pauling: 'Chemistry is wonderful. I feel sorry for people who don't know anything about chemistry. They are missing an important source of happiness'. Most people don't feel that.

I happen to sit on the Royal Society's of Chemistry's Committee for promoting Chemistry to the Public (CPCP for short) – facing the current crisis in confidence. Chemistry departments are being closed, and 'chemical' goes with weapons (of mass destruction), pollution, and poisoning. Let us contrast, making people **interested**, supporters – and making people **active**, chemists.

Contrariwise, 200 years ago, Fourcroy, Davy, Dalton, and then Liebig were important, respected public figures, expected to solve the world's problems rather than contribute to them; and lectures were thronged. Even 100 years ago, Lord Salisbury, lugubrious aristocrat and Prime Minister was an enthusiast: and in the mid twentieth century, young Oliver Sacks found real delight in chemistry, the structure of DNA was worked out, and Harold Wilson won an election invoking the 'white heat of new technology'. Chemistry did not yet attract odium: it was a top science.

What was the secret of these earlier days? I suggest that chemistry appealed to body, mind and spirit. It was essentially experimental (see Faraday's *Chemical Manipulation)*, calling upon hands-on skills akin to craftsmanship; it was done in a laboratory (maybe a 'portable' one, set up for the occasion). Physicists like John Herschel classed it below natural philosophy partly for this reason, and partly for its lack of elegant mathematics: it was closer to crafts than to scholarship, but thus more accessible. Many people relished doing experiments at home, defying danger.

It had theory, in some turmoil as phlogiston disappeared in favour of oxygen, as electricity was brought into it, and as organic chemistry was opened up. Moreover, chemistry promised a dynamical account of things, rather than a mechanical one, making it more fundamental: Priestley expected Newton to be eclipsed by a chemist. Chemistry appealed to the mind.

Then it also had a spiritual dimension, as we see in the effusive notes to the Unitarian Samuel Parkes' *Chemical Catechism.* Chemists set out to improve the creation, purifying and making things: but might nevertheless marvel and be awestruck by what they were finding and doing.

It is helpful to look at the nexus of the chemist, the entrepreneur, and the public to see how in the past chemistry was got across both to those who just wanted to attend lectures or read popular writings, but as consumers and taxpayers would pay for chemistry; and to those who aspired to become chemists – at the 'reading nation' recently described by William St Clair.

It will be helpful to examine making chemistry human: through obituaries, J.F.W.Johnston on 'common life', Faraday, on the candle, and Liebig's 'familiar letters': and to contrast this with making chemistry dogmatic, W.T.Brande, syllabuses for [bored?] students with an exam to pass.

Maybe in Britain the 1870s, with the Devonshire Report and the beginning of formal scientific education in the wake of Prussian victory over France, mark the beginning of 2 cultures, and about the time when chemistry becomes forbidding, and alarming: its potential shown in the chemists' war, 1914-18. And by 1900, chemistry had yielded its place as the elite science – ever since it has been the essential service science, seeming less and less attractive on its own.

Chemists will wonder like King Canute whether this tide can be turned, and chemistry again become bask in the glow of popularity as in its youthful days two hundred years ago.

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NO MORE MIRACLES: THE UNFORTUNATE DECLINE IN CATALYST INNOVATION

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Imagine a chemical industry that produces sophisticated products under ambient conditions and with no waste products. It could come true according to a 1992 National Academy of Sciences report. However, the rate of catalyst innovation in the petrochemical industry has declined significantly in recent decades. One reason for this is probably cut backs in research funding in a mature industry. Another factor has been the failure to firmly establish catalyst research in universities supported by public funds. The development of new catalysts has usually been a path-dependent process tied closely to prior work. Of course, this also describes much of chemistry. Catalysis is more complex than chemistry because it includes important material science components. There is very little useful theory to guide catalysis research, which is perhaps a major reason that it had not been very attractive to academics and funding agencies. The golden age of catalysis appears to have been between 1940 and the mid-1980s, when a remarkable number of new systems were developed. It is also interesting the extent to which these innovations were the product of central European (Germany, Czech Republic, Russia, and Hungary) chemists, many of whom were trained before World War II. Now that his generation has retired it is unclear if their legacy has been passed on to younger chemists.

PAPER ABSTRACTS

Session 1A: Portuguese chemistry: 1640-1910

Chair: Elisa Maia

ARISTOTELIAN THEORY OF MIXTURES AND CORPUSCULAR MATTER CONCEPTION AMONG JESUIT PHILOSOPHERS IN MID-SEVENTEENTH CENTURY PORTUGAL

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This paper will discuss the use of corpuscular conceptions within the context of Scholastic discussion on the theory of mixtures. Corpuscularism has generally been taken as a key touchstone to distinguish between the seventeenth century *nova scientia* and that of the scholastic Aristotelians. Descartes' or Gassendi's different corpuscular matter theories are emblematic examples which are usually cited. Though closely attached to the Aristotelian setting of elements and qualities, Jesuit natural philosophers drew on the theory of corpuscles in order to explain natural phenomena as cases of mixtures of elements. In this paper, attention will be given to mid-seventeenth century Portuguese Jesuit commentaries on Aristotle's *De Generatione et Corruptione* Special emphasis will also be given to the influential Francisco Soares Lusitano (1605-1659). Two case studies will be highlighted. The first is the explanation of the origin of coldness on earth which was thought to be caused by very small, subtle particles that filled the atmosphere. These cold particles were supposed to be stimulated by Saturn by way of sympathy, thereby producing cold on Earth. The second example concerns rarefaction, and particularly the theory which stated that rarefaction was brought about by air corpuscles penetrating the porous parts of solid bodies. In doing so, this paper generally seeks to contribute to a reappraisal of early-modern Aristotelianism, and particularly that promoted in Portuguese universities and Jesuit colleges.

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JOSÉ PINTO DE AZEREDO'S CHEMICAL ANALYSIS OF THE AIR OF RIO DE JANEIRO IN LATE 18TH CENTURY

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In the present work it is intended to analyse and put in context an article on the exam of the air of Rio de Janeiro that was published in 1790 in *Jornal Encyclopedico*, a periodical whose main objective was the spreading of general knowledge, namely the principal scientific achievements. The author was the physician José Pinto de Azeredo (1763/6?-1810) whose experimental works made him an author of particular interest among historians of science in Portugal and Brazil. There are few references to his life and work, although he is the author of several other memoirs on medicine in Brazil, Angola and Portugal that should give him a more prominent place in the Luso-Brazilian-Angolan and Portuguese medical history. Azeredo was born in Rio de Janeiro and there he made secondary studies. For some unknown reasons, he went to study medicine in Edinburgh with his brother, in 1786/87 and 1787/88. In 1787, he wrote a dissertation about *An experimental enquiry concerning the chemical and medical properties of those substances called Lithontriptics, and particularly their effects on the human calculus* (Wemyss, 1933). Andrew Duncan, president of the Harveian Society, made a 3-pages summary on it that was published in the *Medical Com-*

mentaries of December 2, 1788 and ends saying: "*Uppon the whole, all his experiments, to a number of 106, are conducted with great judgement; and the inferences which he draws from them, are highly important, both in a chemical and medical view*" (Duncan, 1788, 398). In the same year he presented a memoir about the effects of "fixed air" on the nervous system and got the medical degree in the cosmopolite university of Leiden (May) after having defended a thesis on Podagra. In the second half of 18th century five Portuguese and five Brazilian born students took their graduation there (Rieu, 1875). He returned to Lisbon and stayed there for one year after being recognised as a physician by the Crown. That gave him permission to work in Portugal and all other colonial dominions. In April 1789, the Queen nominated Azeredo as "fisico-Mor" (Chief of Medicine) in Luanda (Angola) and among his duties he should open there a "School of Medicine". In June 1789, he arrived in Rio de Janeiro and stayed for one and a half year (he sailed to Angola in Sept. 1790). There he began his medical practice. He presented some experiments on air composition before the Literary Society of Rio de Janeiro. His experimental measurements led to the publication of the above-mentioned article in 1790. This publication begins with an introductory part where he explains its aim and historical context as well as the knowledge of the works of Black, Priestley and Lavoisier. In the following, he refers to his experiments on "pure air" and "fixed air". In the last part, "mophete" is mentioned but without experiments. In each section, Azeredo refers several physical, chemical and biological properties and takes some conclusions.

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THE TEACHING OF CHEMISTRY IN THE PORTUGUESE UNIVERSITY BETWEEN 1836 AND 1910

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This paper aims to analyse the transmission of scientific knowledge in the domain of Chemistry, performed at the College of Natural Philosophy of the University of Coimbra, under the rule of a liberal power. The Portuguese university, at that time, was based in Coimbra, and the College of Natural Philosophy lectured exact and natural science, within which chemistry was included.

The political and social instability which characterised the liberal period that mediated the transition from a monarchical regime to a republican regime reflected itself in the education system in Portugal, particularly in the higher education, thus influencing an intellectual elite which began a set of reforms necessary for the progress of the country.

As a methodology, we will analyse the data respecting the teachers who have lectured the subjects of Chemistry, from the degree of Natural Philosophy, and the data relating to the choices they have made concerning the curriculum they have taught and the course-books they have adopted. This information will be counter-crossed with the objectives preconised by each of the reforms performed in the teaching of Chemistry in Portugal during the period we are studying.

This way we intend to know whether the College of Natural Philosophy was, or not, an institution innovative and modern enough, able to replace the bookish study for an experimental teaching, more directed at its practical application in science, propitiating the development of Chemistry applied to industry, the same way it happened in the rest of Europe in the XIX century.

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THE ATOMIC THEORY IN SIMÕES-CARVALHO´S "LESSONS OF CHEMICAL PHILOSOPHY" (UNIVERSITY OF COIMBRA, 1851, 1859)

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With John Dalton´s atomic theory, which gave a theoretical background to the ideas of definite proportions, and J. J. Berzelius who put atomism on a much more secure footing, using it to explain how different chemical compounds may contain the same elements in the same proportions, the research on the real nature of the acting forces responsible for the mutual combinations of the simple and indivisible atomic particles and the experimental determination of their equivalent weights, heat capacities and isomorphism in different compounds, became one of the most important part of elementary chemistry during the whole nineteenth century [1]. Although many chemists felt that an atomic theory was merely a distraction assuming that chemists ought to stick at the equivalent weights which gave accurate recipes and not bother with attempts at explanation, among the most distinguished chemists there were great debates about the status of atoms, and some of them were quite sceptical on the subject.

As a matter of fact, this has been the situation of chemistry teaching in the University of Coimbra, Portugal, in the middles of the century, where, since 1844, Chemistry was taught in the Faculty of Natural Philosophy, along four distinct disciplines, Chemical Philosophy, Inorganic Chemistry, Analytical Chemistry and Organic Chemistry. From 1844 to 1870 the most responsible Professors of these disciplines were António Sanches Goulão (1805-1857), Miguel Leite Ferreira Leitão (1815-1880) and Joaquim Augusto Simões de Carvalho (1822-1902). From the three, only Simões-Carvalho has written a Manual with the content of his twenty six lectures in Chemical Philosophy and Inorganic Chemistry. The book with the title *Lessons of Chemical Philosophy*, was edited in Coimbra, by the University Press, with a first edition in 1851 and a widely revised second edition in 1859 [2].

The title of the book follows a general trend for academic titles, at the time, such as some years early, J. Dalton´s *New System of Chemical Philosophy* [3] and J.B.A. Dumas´ *Leçons sur la Philosophie Chimique* [4], or some years later, A. Wurtz´s *Leçons de Philosophie Chimique*[5].

Quoting among others, Wenzel, Richler, Proust, Berthollet, Gay-Lussac, Pelouze Baudrimont, Dulong, Petit, Raspail, Dumas, Laurent, Dalton and Berzelius, it is clear that Simões-Carvalho knew very well all the great debates and controversies about the status of atoms at that time. In the book he makes his own criticism of those debates and controversies. It is our purpose in this work to analyse historically that criticism.

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[3] - J. Dalton, *New System of Chemical Philosophy*, 1807.
[4] - J.B.A. Dumas, *Leçons sur la Philosophie Chimique*, Collège de France, 1836.
[5] - A. Wurtz, *Leçons de Philosophie Chimique*, Paris, 1864.

Session 1B: Theory and practice in twentieth century chemistry

Chair: Colin Russell

THE SUCROSE INVERSION EXPERIMENT AND ITS EPISTEMIC SIGNIFICANCE

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To anthropologists, a material systems approach concerns itself with full contextualization of an item. Their studies center on the context of use of an object by focusing on the context of its exchange. I shall follow their precepts about how information should be gleaned from the material culture of a people with an example from our own tribal practice.

Many a student of chemistry has performed the sucrose inversion experiment, as part of laboratory training throughout the period from the 1860s to the present. In this talk I report on the multiple meanings of a practice that amounts to an exchange in which the elders share their experience with the novices. It can be seen as an initiation into adulthood, as part of the certification as a professional chemist.

In part a ritual, putting organic chemistry under the seal of chirality, such a monitoring of a chemical reaction in real time is also a celebration of sweetness in foods, an allusion to the continuity from field work (beet cultivation) to industry (sugar manufacturing), and to the close link between chemistry as a science and chemistry as an industry. That the inversion is catalyzed either by an enzyme or by Bronsted acids is also an essential element of the background of this particular experiment. Such a bridging of the chemical and the biological perpetuates the ideas of Louis Pasteur, who was so instrumental in setting it up.

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MICROCHEMISTRY WAS AN „AUSTRIAN SCIENCE“ FOR MANY YEARS

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Between 1900 and 1940 Austrian chemists made leading contributions to microchemistry. This branch of chemistry is not clearly defined, but is mainly used for analytical methods. In this paper the name is used for methods adapted from classical chemistry for very small amounts of substances (about a few milligramms).

There are several advantages of the micro-approach compared to the macro-approach:

1. it can be done even when very small amounts of a substance are available.
2. the time for manipulating small amounts is much shorter compared with that necessary for larger amounts.
3. the micro-approach is cheaper concerning reagents and less detrimental to the environment.

the apparatus is usually cheaper compared to apparatus for macro-amounts.

Microchemistry began very early and was mainly used for the analysis of minerals. The systematic description of microchemical methods began around 1895 with the book by T.H. Behrens. It was extended by Friedrich Emich around 1900, who was the founder of quantitative inorganic microanalysis. He established a school of microchemistry in Graz. The most famous representative of this school was Fritz Pregl who received the Nobelprize of Chemistry in 1923 for his quantitative elemental analysis of organic compounds.

Emich and Pregl were followed by a number of capable microchemists, among them Hans Lieb and Julius Donau in Graz, Hans Molisch, Robert Strebinger and Fritz Feigl in Vienna and Ludwig Kofler In Innsbruck. These are only the bestknown of a larger number of microchemists working in Austria between the two world wars.

Why became Austria leading in the field of microchemistry and not other countries which were famous for their chemists and large chemical industries? There may be the following reasons to explain this fact:

1. Austrian chemists had a long tradition of isolating and characterising natural substances from plants and other organisms, even when they were present only in minute amounts.
2. Austrian universities were more involved in very delicate experimental work (and less theory)
3. The lack of expensive physical apparatus in these years forced the researchers to concentrate on extending classical chemical methods.

The microchemical school of Austria continued after World War II, but continually lost its importance because physical methods of analysis exceeded by far the sensitivity of the microchemical methods. Today microchemical methods get back some importance in medical analysis, forensic methods and in the new field of combinatorial chemistry.

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THE TWILIGHT OF THE NATURALLY-OCCURRING ELEMENTS: MOLDAVIUM (ML), SEQUANIUM (SQ) AND DOR (DO)

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The more the vacant boxes in the periodic table diminished, the more scientists increased their efforts in the attempt to identify the missing elements. Although the techniques they used were more and more sophisticated, the elements seemed more elusive and difficult to find. Despite the risk of reporting false discoveries, the number of announcements increased and scientific journals received many papers that endowed many fanciful names for elements 85, 87 and 93 [1].

In the years in which physicists were successfully re-assessing the great number of new discoveries that would have led to the synthesis of artificial elements, in Paris a couple of spectroscopists was looking for the presence, in nature, of the elements of atomic number 85, 87 and 93.

In 1934 Mlle. Yvette Cauchois (1908-1999) created a curved crystal focusing X-ray spectrograph. Three years later, with the aid of this highly sensitive, high-resolution instrument, the Romanian physicist Horia Hulubei (1896-1972) and his French colleague, Cauchois, reported weak lines which they assumed were a doublet of element 87. In 1939 the two physicists found evidence for the existence of eka-rhenium in the mineral betafite from Madagascar. Although they were supported by their patron, Jean Perrin (1870-1942), the "discoveries" did not receive experimental confirmation outside of France. Finally, in 1939, Hulubei and Cauchois observed unknown lines in the emission spectrum of radon, some of which could indicate the presence of eka-iodine among the disintegration products of this noble gas. They prematurely announced these discoveries and prematurely named these elements: moldavium (symbol Ml) [2], sequanium (symbol Sq) [3] and dor (symbol Do) [4]. Just a year later a new claimant for element 85, the Swiss physicist Walter Minder (1905-1992), came into the limelight. A question of priority arose between him and Hulubei, but their arguments soon became trifling and the proposed symbol, Ml, became an illegal squatter in the Periodic Table. By the end of the 1940s, solid confirmations of their existence by other workers bestowed on them their final names: francium, neptunium and astatine.

It is possible that minute amounts of element 87 exist in nature, but definitely not in the mineral samples analysed by Cauchois and Hulubei. Naturally-occurring traces of element 93 do not exist at all. And it might be hypothesised that the discovery of moldavium, like the presumptive discovery of the first "transuranic" harmoniously named sequanium, was the consequence of incorrect interpretation of experimental data. A different conclusion is possible for dor. Since it is now known that an isotope of element 85 is found as an occasional branch product among the decay products of radon, it is quite possible that some lines of its X-ray emission spectrum may be found in the radiation from radon sources. Nevertheless, it is very doubtful if such weak radiation could be detected by Hulubei and Cauchois, even with the focusing spectrograph they used.

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THEORETICAL AMBITIONS, EMPIRICAL CONSTRAINTS, AND CHEMISTS' INTUITIONS: THE SAGA OF THE REACTIVITY-SELECTIVITY PRINCIPLE

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The reactivity-selectivity principle (RSP) holds that "highly reactive species are unselective in their choice of reactants compared to stable and therefore unreactive species", a hypothesis that "has long been part of the chemist's intuition".[1] For almost a half century the RSP has been used to predict relative reaction rates, gain insight into reaction mechanisms, and provide guidance to the perplexed undergraduate. Yet it is founded on the premise that necessary connections could be established between the thermodynamic and kinetic parameters of a reaction, which classical thermodynamics denies. This talk explores the role of theoretical aspirations, empirical practices and anthropomorphic "intuitions" in establishing the RSP and in making it vulnerable to criticism.

By the 1930s a combination of thermodynamic and kinetic studies was found indispensable for understanding reaction mechanisms, which physical organic chemists were using to refashion organic chemistry "as a science rather than an art".[2] They began to examine the possibility that thermodynamic and kinetic characteristics of series of related reactions could actually be connected, using the many practical and theoretical studies of aromatic substitution. The Hammett equation, dating from the late 1930s, was the first so-called extrathermodynamic relationship between reaction thermodynamics and kinetics.[3] In the 1950s J. E. Leffler and G. S. Hammond established a theoretical rationale for these relationships, while H. Brown arrived at an empirical measure of reactant selectivity. The stage was set for the institution of the RSP as a major generalization about chemical reactions.

Although there had been caveats from the beginning about the RSP's scope of applicability[4] most initial investigations supported its validity. However, further extensions began uncovering an increasing number of exceptions. In 1977 one reviewer concluded that "in spite of many apparent failures the reactivity-selectivity principle is fundamentally valid",[5] while a later pair of reviewers asserted that "it is time [the RSP] was dropped from textbooks as a tool for prediction or interpretation of reactions in solution in spite of its theoretical appeal".[6] The argument has continued to the present; its persistence tells us much about both chemical practice and chemical culture, especially with regard to the discovery of general "principles".

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Session 2A: Applied chemistry through the ages

Chair: Marco Beretta

PURPLE AND INDIGO DYES IN THE GRECO-ROMAN WORLD

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The Greco-roman world is acquiring purple from the waters of the Mediterranean, and in a lesser extent from the Atlantic depths. Huge loads of molluscs offer evidence of substantial manufacturing in early second millennium Crete. Later on, production will flourish in Cypriot Larnaca, and nowadays Lebanon and Israel; while in the seventh century innovative conservation techniques will permit the imperial Byzantine palace to establish a rigorous monopoly. Careful observers of a society familiar with the multiple meanings of this most glorified dye of all ages, Pliny the Elder and Vitruve are meticulously describing the way of collecting the yellowish precursor of the colouring principles. The actual dyes – dibromo indigo, dibromo indirubin, indigo and indirubin – are the result of a complicated reaction chain, based on their equilibrium with the leuco monomers.

Rare, valuable and exquisite, purple was consciously imitated – or desperately adulterated – by extremely elaborate procedures, including a sequence of dark red and violet baths. Rather dull and fading, the outcomes are due to a large series of colorants, while minerals are documenting on an ingenious technical knowledge or are attempting to influence the hue, along with various flower extracts. By far more widespread are recipes proposing the use of kermes, madder or orcanet. Addition of indigo dyes or treatment with oak gall and mineral mordants is creating a violet shift. Primary purple substitute is however dyer's bugloss, carefully combined or ingeniously complexed. Even as late as about the turn of the first millennium a.D., the relative success of the fraud is causing serious penalties.

Indigenous in the Mediterranean area, woad provides Europe with a conventional organic blue, bearing its rare and precious Oriental counterpart in the extract of *Indigofera tinctoria* L., highly valued by antique and medieval open sea traders. In both cases the actual colouring principles are indigo and indirubin. Hellenistic and Roman technical manuals are meticulously describing the procedure yielding a highly standardized woad pulp. Mastering the laborious process since earliest times, European cultures are using this versatile violet blue for both dyeing and painting; while Pliny the Elder and Dioscurides are correlating indigo paste – a mysterious powder of almost mineral origin – to several volatile by-products of purple.

Woad acts as an alternate to indigo, and both are well known for contributing in many recipes concerning purple imitations, instinctively relying on the chemical correlation of the colouring principles. Although inexpensive and widespread, woad is still at times replaced by metal oxides. By far more precious, indigo will be substituted by its Mediterranean relative, or even by unstable flower extracts and weight increasing material. Cautious empirical approaches – including sublimation – allow a series of proposals yielding unsteady, bur nonetheless aesthetically acceptable results.

E.A. Varella, *Experimental Techniques And Laboratory Apparatus In Ancient Greece*, Medicina Nei Secoli 8 (1996) 191

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CHEMICAL ANALYSIS AS A METHOD OF DISCOVERY IN PHARMACY IN THE AGE OF ENLIGHTENMENT IN EUROPE

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Enlightenment philosophy posited that nature and laws governing it embrace the totality of knowledge about the world and should thus constitute the fundamental sphere of scientific research. With analysis believed to be the most important tool of cognition, the issue of composition of bodies became more relevant than ever before. The perception of nature as a reservoir of goods available to benefit man was consistent with Paracelsus's earlier view that nature is also an immense pharmacy. The only problem was how to find one's way about that pharmacy. From time immemorial, plants had served as the most abundant source of medications. Many species of medicinal plants were known and effectively utilised. At the turn of the 19^{th} century, efforts to find new medicines led pharmacists to look at the dangerous realms of poisonous and narcotic plants. Chemical studies of their composition yielded increasingly substantial results as analytical methods and techniques were more and more sophisticated.

The new approach to the examination of plants involved dismissing distillation in favour of the analysis of plant juices, extracts and other liquid material obtained from plants. As plant juices tended to be more or less acidic, the discovery of an alkaline substance in the concentrated juice from immature opium poppies *Papaver somniferum* was a remarkable surprise. The compound was morphine and that discovery channeled scientists' efforts towards finding alkaline substances in other plants. The analytical method they used was simple. It involved alkalising concentrated juices or extracts to detect any organic bases, called alkaloids by W. Meissner, in the resulting solution. The findings were almost invariably positive if the material came from poisonous plants. There would be a fine sediment of nitrogen-containing substances possessing strong pharmacological effects.

The appeal of this line of research and its apparent simplicity made it popular not only across university laboratories but also in pharmacies. European scientific journals were soon brimming with reports on the discovery of various natural substances exerting potent effects on the human body. The newly-discovered substances were put to medicinal use very quickly. However, another problem arose: the discoveries, so numerously reported by the press, would often turn out to be illusory as the substances were actually mixtures of a number of chemical compounds, a fact of which their discoverers were usually not aware. Arguments over attribution of discoveries ensued inevitably, and many of them have persisted until today.

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CHEMISTRY AT THE SWEDISH BOARD OF MINES, 1700-1750

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The paper sets out to cast new light on the relationship between mining and chemistry in Sweden during the first part of the eighteenth century.

During the period, chemistry was mainly pursued by officials at the Board of Mines, the government agency for control of the mining industry. There, chemistry was to a large extent considered an auxiliary science to the industry, and was used to improve and control mining practices.

The paper studies chemistry's dependence on the Board of Mines as a support structure, and as a nurturing matrix in which it could evolve theoretically and define itself as a cluster of theories and methods independent from alchemy. For example, it was in their capacities as employees of the Swedish Board of Mines that Georg Brandt and Axel Fredrik Cronstedt conducted the mineralogical investigations that would lead to their discoveries of cobalt (discovered by Brandt in 1730) and nickel (discovered by Cronstedt in 1751).

A central argument is that chemistry fulfilled not only scientific, but also social functions at the Board. It served to preserve the social status of the often high born officials. In order to advance at the Board, they had to learn and practice the skills of craftsmen such as assayers. While an eighteenth-century nobleman could be a learned man, he could not be a craftsman (or at least not admit that he was one). By making craft procedures a subordinated part of chemistry, an intellectual pursuit, an imagined or factual decline of social status could be avoided. Thus the hand was not elevated above the head, or rather the "heads" of the Board of Mines were not brought down to the level of the miners and other craftsmen they were meant to control.

It is furthermore argued that chemistry became surprisingly "modern" in this context, and that important concepts that were later to be taken up by such chemists as Torbern Bergman and Antoine Laurent Lavoisier were originally developed in this setting.

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THE USES OF CHEMISTRY
APPLIED CHEMISTRY AT THE UNIVERSITY OF CAMBRIDGE, 1702–2002

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'The uses of chemistry, not only in the medicinal but in every economical art are too extensive to be enumerated, and too notorious to want illustrating.' So wrote Richard Watson, the fourth holder of the 1702 Chair of Chemistry in the University of Cambridge, in the 1780s. And so it has proved throughout the history of this venerable chair, the oldest continuously occupied chair of chemistry in Britain. From the first holder of the chair, the Veronese apothecary Giovanni Francesco Vigani, through Richard Watson, who nearly doubled the firepower of British gunpowder, Smithson Tennant, who made a fortune from the production of malleable platinum, and down to the present day, chairholders have professed the applications of their science to medicine, manufactures and industrial processes as much as they have the 'pure' subject. This paper draws on a book recently published to celebrate the tercentenary of the 1702 Chair of Chemistry at Cambridge, and explores the evolution of applied chemistry over the past three centuries through the unusual lens of the careers and avocations of the fifteen chairholders.

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Session 2B: Contexts of popularisation

Chair: Brigitte Van Tiggelen

PROVIDING METAPHYSICAL SENSE AND ORIENTATION: NATURE-CHEMISTRY RELATIONS IN THE POPULAR HISTORIOGRAPHY OF CHEMISTRY

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From early Latin alchemy to modern day "biomimetic" chemistry and nanotechnology, "learning from nature" has been a popular concept to place chemical research into a metaphysical context that provides both orientation for chemists and a convenient public image of chemistry. Underlying this concept is a teleological notion of nature that, in popular contexts, equips nature with all kinds of anthropomorphic capacities, including agency and intention. Since medieval times this anthropomorphism has unleashed a series of metaphors of quasi-personal relationships between Nature and Chemistry, such as "Chemistry learns from Nature", "Chemistry rivals Nature", "Chemistry surpasses Nature", and "Chemistry masters Nature".

Following-up earlier work (Schummer 2003), this paper analyses the uses of such metaphors in the popular historiography of chemistry with emphasis on Paul Walden's history of organic chemistry from 1941. By arranging the metaphors in a historical order – from "learning from Nature" to "mastering Nature" – Walden created a notion of progress that provided metaphysical sense and orientation to the work of ordinary chemists. Not only could they embed their work in the universal relationship between Man and Nature; Walden's notion of progress also provided metaphysical direction and goals for chemists and allowed them to locate their particular work in the universal history.

Such popular history, although embraced by many chemists for obvious reasons, has a prize, however. As with all ideas of progress, it smuggles in normative implications which one need not share. This paper will finish by arguing that the prize for metaphysical orientation has been public hostility towards chemistry.

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PERSUASION AND ICONOGRAPHY IN A. CRESSY MORRISON'S MAN IN A CHEMICAL WORLD

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In 1935, the American Chemical Association annual meeting chose as its theme the tercentenary of chemical industries in America. The theme was part of a larger effort to improve the image of chemistry (and science more generally), by portraying chemistry as an industry and study with a long, and American, history. The organizing committee selected A. Cressy Morrison to write a companion book, and in 1937, Morrison published *Man in a Chemical World*, with illustrations by Leon Soderston.

Morrison's text and Soderston's illustrations work together as a grand apologia for chemistry aimed at the man in the street. As such, it represents a powerful attempt to transform the public image of chemistry. The illustrations were full of religious motifs, and portray the chemist as a modern-day priest, while at the same time emphasizing a new, and Americanized, image. While this was not the first instance of scientists being portrayed as "men in white lab coats," it was one of the most overt uses of the metonym that would become the visual icon of modern science.

This paper looks at the text and images and the context of their creation, within the growing literature regarding the creation of images in science (both the scientific object and the scientists as object[1]). It argues that the modern image of chemistry was a success iconographically, and but failed to truly persuade the public of the benevolence of chemists.

[1] See, for example, Lorraine Daston and Peter Galison, "The Image of Objectivity," Representation, v.40, 2001, pp. 81-128.

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C.A. COULSON AND THE POPULARIZATION OF THEORETICAL CHEMISTRY IN THE TWENTIETH-CENTURY

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Chemistry has been presented as an essentially experimental science within the community of chemical practitioners as well as to outsiders. What were the implications of theoretical (quantum) chemistry in reshaping this image, especially in what concerns the ways chemists introduced their science to non-expert audiences? In this talk, the contributions of C.A. Coulson are used as a probe to answer this question. Coulson played a key role in the emergence of theoretical (quantum) chemistry in the UK, in the development and popularization of the molecular-orbital approach, and in the internationalization of theoretical (quantum) chemistry. He allied research and teaching with activities as a textbook writer, popular science lecturer and lay preacher of the Methodist Church, whose sermons often dealt with science. Especially through the delivery of popular science lectures, Coulson pushed forward the view that theoretical chemistry was an integral component of chemistry. The analysis of his popular lectures enables one to look at the ways in which Coulson articulated his views about the role and status of theoretical (quantum) chemistry, and specifically the character of theory, in its relationship to chemical notions, experimental results, numerical data, and the role of visualization. I also characterize audiences and settings used to reach ever wider audiences and, finally, rhetorical strategies deployed to build an effective discourse.

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PRESENTING CHEMISTRY AT THE SCIENCE MUSEUM: ITS HISTORY AND CURRENT PRATICE

Peter J. T. Morris

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Chemistry occupied a large segment of the Science Museum's exhibition space between the rehousing of the collections in the East Block in 1925 and the closure of the main chemistry galleries in 1999. For most of this period,, chemistry was the basis of one of the museum's departments headed by a Keeper. While none of the Keepers of Chemistry ever became Director, the famous historian of chemistry (and editor of *Ambix*) Frank Sherwood Taylor was Director between 1950 and his premature death in 1956. Many children first became aware of the excitement of chemistry through the chemistry displays at the Science Museum, most notably Oliver Sacks (*Uncle Tungsten*) and John Stock. Thus the portrayal of chemistry at the Science Museum was a major element of the popularisation of chemistry in Britain in the twentieth century.

How chemistry has been presented in this time and the rationale of this presentation will be the focus of my paper. What was displayed was also largely what was collected – whether it was collected to be displayed or displayed because it had been acquired – and hence any discussion of the presentation of chemistry also shed light on the museum's acquisition policy. Throughout the period under discussion, chemistry was divided into applied (industrial) chemistry and pure (experimental) chemistry. Latterly biochemistry became a separate subject (both in terms of collections and displays). I will examine the background of the chemistry staff, their outlook on chemistry and the external influences on their views, and how they sought to communicate with their audience through their presentation of chemistry. Moving from the history to current practice, I will trace the movement away from a strict disciplinary division between galleries and curators during the 1990s towards a new way of presenting chemistry as part of science as a whole. The culmination of this process will be the opening of a major science gallery around 2009.

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Session 3A: (Applied) chemistry in the nineteenth century

Chair: Soňa Štrbáňová

JACOB BERZELIUS AND THE CHEMICAL LABORATORY

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Before the mid-18th century Sweden made its scientific contributions mainly due to its mining tradition and the variety of minerals. Swedish chemistry lost its leading position when Torbern Bergman (1735-1784) and Carl Wilhelm Scheele (1742-1786) died in the 1780s. However, Jacob Berzelius (1779-1848) was soon to take their place in the world of chemical science and continued the Swedish tradition. There was in fact an important link between these periods: Johan Gottlieb Gahn (1745-1818) - discoverer of manganese, inventor and chemist – a forgotten celebrity.

The fundamental interests of Berzelius encompassed the whole of chemistry, although his professional life can be divided into different periods. The grand creative genius of Berzelius and the joy he had in his work are not only apparent in his experimental research, but are evident also in his activity as a teacher and in his writing. The style of his writing exhibits great freedom, force and beauty.

Berzelius was very careful when planning and performing his experiments. He formed his opinions on the basis of his own experience. In analysis he tried to select or develop methods that depended as little as possible on the manipulative skill of the chemist.

The laboratory was the central place in Berzelius' life, a place where he passed a considerable portion of his time. It is therefore natural that its arrangement and furniture claimed much of his attention when he was setting it up.

Historians have had a pronounced tendency to ignore the details of the practical work of the chemists, not least the small pieces of equipment. In the early 19th century no given rules existed for how a chemical laboratory should be constructed or equipped. If the time in the laboratory was to be as pleasant and profitable as possible, a number of technical problems had to be solved e.g. moisture, water supply, ventilation, light and heating. The work surface was usually a large central table.

We have only small fragments of how Berzelius laboratory was furnished, although the remaining 3000 items including chemicals will provide us with a sense of how it could be at the time. The knowledge has recently increased since a chemical laboratory of the time has been found in the southern part of Sweden. This laboratory has not been in use since 1866 and belonged to the count H.G. Trolle Wachtmeister – a very close friend of Berzelius. The enormous correspondence of more than 700 letters written from 1818 to 1848 has recently been published and gives us tremendous information on scientific matters as well as social, political and personal matters in an open-hearted atmosphere. After a few months in the Berzelius laboratory in Stockholm, Trolle-Wachtmeister moved to his home Årup, where he built a well-equipped chemical laboratory where he performed his mineralogical analysis under the guidance of Berzelius. Later on, analysis of agricultural products was to be on his schedule. In the laboratory journals found, together with the original equipment used in each of the described experiments, we are able to see how chemists of the time performed their chemical experiments, what equipment they used and all the problems that occurred during their work. Let us visit this remarkable laboratory!

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POLARIMETRY AND SUGAR INDUSTRY

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There are not many industrial branches that influenced society in the European countries in such a complex manner as sugar industry did in the 19th and at the beginning of the 20th centuries. Pronounced influence of this industrial branch can be tracked especially in the Czech Lands, where the prosperous beet sugar manufacture was immediately followed by increase in agricultural production, growing manufacture of fertilisers, development of specialized farm and industrial machinery and, last but not least, changes in laboratory practices.

Many local sugar manufacture specialists, both Czechs and Germans, were excellent professional chemists and their inventions and technology improvements influenced technology of sugar production throughout the world. Sugar industry contrary to "classical" food industries like brewing was not constrained by rigid traditions and its technological progress represented an impetus of this industrial branch. Beet juice purification – carbonatation, and an entirely new diffusion process invented in the Czech Lands have been used all over the world up to these days.

The unprecedented development of sugar industry in the Czech Lands associated with technology improvement and sugar yield increase was conditioned by careful and exact control of the manufacture process. Sugar concentration in the main production flow, as well in different by-products and wastes, was the basic parameter of this control that required fast and adequately exact analytical methods. Both these aspects - speed and accuracy - were eminently important owing to the continuous character of manufacture and necessity of permanent monitoring of sugar yield. Polarimetry, a sensitive, non-destructive technique for measuring optical activity exhibited by inorganic and organic compounds, has played such important role in this field that it can be without exaggeration considered pillar of sugar industry development. Before introduction of polarimetry to control laboratories of sugar factories, no simple analytical method or physico-chemical equipment for such purpose had existed since sucrose is rather difficult to determine, especially in complex mixtures of sugar manufacture intermediates. We also should take into account that in the 19th century possibilities of analytical methods were very limited comparing to the present state.

For all these reasons, considerable attention was paid to polarimeters by chemists as well as manufacturers of polarimeters so that during decades of their use in the laboratories of sugar industry many modifications of these apparatuses were developed. Among polarimeters of well-known European manufacturers (Soleil, Duboscq, Haensch and Schmidt, Pfister and Streit, etc.) also the device of a Czech firm Frič Brothers achieved international recognition. A Bates - type polarimeter, improved by Fričs, was adopted as a standard device by the American Bureau of Standards in Washington.

The paper will compare the utilisation and principles of different types of polarimeters employed in sugar industry of that time.

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NUTRITIONAL THEORIES IN DENMARK IN THE NINETEENTH CENTURY – BEFORE AND AFTER LIEBIG

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Liebig's chemical theories played important roles as generators of new research not only in organic chemistry, but also in fields of applied chemistry such as agricultural chemistry and nutrition science. Biochemistry (physiological chemistry) gained (much) impetus by the publication in 1842 of Liebig's *Die Thier-*

Chemie (in English *Animal Chemistry*, published the same year), in spite of (or because of) the fact that many of Liebig's ideas were repudiated in the following decades. As Larry Holmes has pointed out in his introduction to the 1964 reprint of Liebig's book "[s]eldom has a book written with so little regard to scientific standards of objectivity and caution wielded such demonstrably important scientific influences"[1]. The impact of Liebig's theories took place on a scientific level as inspiration for new physiological research, but also at a common level in so far as the concepts were used as theoretical background in the composition of popular dietary and nutritional guides.

This paper explores the development of a science of nutrition in Denmark in the nineteenth century and the way scientific theories were presented in scientific and popular publications. Particular focus is given to the interplay between medical and chemical approaches to solving the new science's main problems. The paper will review the reception of Liebig's ideas in Denmark and will attempt to evaluate the impact of the ideas on the practical dietary advices given to the ordinary Dane.

The paper results form ongoing research that is a part of a larger research project (located at the Department of History at the University of Copenhagen) on cultures of and discourses on food, drinks, and tobacco in Denmark in the nineteenth century.

[1] Frederic L. Holmes, "Introduction", in Justus Liebig, *Animal Chemistry or Organic Chemistry in its Applications to Physiology and Pathology*, a facsimile of the Cambridge edition of 1842 (New York/London: Johnson Preprint Corporation, 1964), pp. vii-cxvi, on cxiv-cxv.

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KNOWLEDGE IN EARLY PULP AND PAPER INDUSTRY

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The process of making paper can, since its origin, be described as a mechanical treatment of raw products, mostly linen, in order to free the cellulose. During the 19th century the need for more paper drastically increased, and the classical sources, especially linen, could not satisfy the demand. Other sources were actively searched for and wood was a natural choice. When first using wood it was treated mechanically the same way as other raw products had been treated, but such a paper became a rather weak paper, and mechanical methods were gradually replaced by chemical ones. This paper is about how such new chemical methods were introduced into the pulp and paper industry. I will focus on the meeting between the new technology and the existing mechanical methods, and the questions will be asked on what points the two methods differed, and not the least what united them. I will make an attempt to answer such questions by following the careers of some of the leading persons in the pulp industry during this time, but also by using the concepts locality, continuity and mobility. Finally some general conclusions will be drawn.

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Session 3B: Instrumental practices 1910-1960

Chair: José R. Bertomeu Sánchez

THE FOUNDING OF A CHEMISTRY LABORATORY AT NORWAY'S FIRST INSTITUTE OF TECHNOLOGY: LABORATORY PRACTICES 1910-1936

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In August 2004 a project on the collection and preservation of scientific instruments, chemicals and glassware from the previous Department of Organic Chemistry at the Norwegian Institute of Technology (NTH, now NTNU) was initiated. The original aim of the project was to preserve and register objects from the *organic chemistry* laboratory, and has now been extended to other sections of the previous Faculty of Chemistry. The work has also included archive studies of outgoing letters from the organic chemistry laboratory, which shed light on what it was like to establish a laboratory of organic chemistry at Norway's first Institute of Technology.

The role of instruments and experiments in the history of science has been given increasing attention from the 1970s and onwards, and as a consequence the Scientific Instrument Commission (of the International Union of the History and Philosophy of Science) was founded in 1977. Of the many papers presented and published the last 30 years, few are devoted to the role of objects in chemistry. Especially chemicals are important in chemistry, along with instruments and glassware. In the ongoing project at NTNU all three types of objects are well represented. In this presentation it is our aim to illustrate the role of chemicals, glassware and instruments in the establishment of a research and teaching laboratory and show how such objects can be exploited in the writing of a history of an institution or field.

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MOLECULAR BIOLOGY IN CATALONIA AND THE DEVELOPMENT OF X-RAY DIFFRACTION TECHNOLOGY: THE STRUCTURALIST SCHOOL OF JOAN ANTONI SUBIRANA AND JAUME PALAU

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Recent studies in the history of molecular biology have stressed the importance that must be attributed to the instruments in the development of the discipline. This communication presents the case study of a research group which emerged in Barcelona, Spain, in the mid sixties, within a general process which also took place in other european countries: the Macromolecular Chemistry Department. The distinctive feature of this research group lies in their physical location within an Engineer's School and in the academic training as chemists of their founders. Their postdoctoral training in The United States, United Kingdom and Israel, sets their research towards structural molecular biology, towards the adoption of the X-Ray techniques and to the development of their own instruments to be applied in the structural analysis of biological macromolecules (DNA and histones). The engineer's School workshop made possible the design, construction and modification of some X-Ray diffraction cameras. This communication deals with the so called catalonian structuralist school, led by Joan Antoni Subirana and Jaume Palau.

THE TRANSFORMATION OF ATOMIC WEIGHT: NEW INSTRUMENTATION AND OBJECTIVE PROGRESS

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Atomic weight has been a matter of fundamental importance in chemistry and other science for well over a century. Available knowledge about atomic weights gets more precise and more extensive as time goes on. During the first half of the twentieth century the development of new instrumentalities led to realization that atomic weight is a different sort of property than had previously been thought. Atomic weight had been understood as a constant, a direct characteristic of each element's atoms, and much successful chemistry and physics was done on that basis. From the 1910s through 1920s however, it was recognized that this was the case only for mono-isotopic substances. For elements with multiple isotopes, atomic weight was still a distinct characteristic but it was seen to be an average based on the abundances of the isotopes and the masses of each. From the 1930s on it was established that the abundances of the isotopes of some elements vary not only in particular samples but over time and space in the world at large. Atomic weight in such cases is thus a variable, not a constant. Atomic weight now is known to be a different sort of thing for different materials. These discoveries depended on the introduction, improvement, and spread of new capabilities, especially that of separating and manipulating atomic and isotopic ions with mass spectrometers. The development of mass spectrometry also led to two distinct, discipline-centered measurement systems, and ultimately to a third scale reached through international negotiations and votes. The development of the laboratory instruments and techniques directly linked to the issue of atomic weights also produced extremely important breakthroughs in the other fields in chemistry as well as in other areas of science and technology. This story of the transformation of atomic weight can illuminate the inadequacies of many widespread views of the nature of science, while recognizing the crucial role of the development of laboratory instruments and techniques helps point the way to a far clearer and more comprehensive account of how scientific knowledge grows in chemistry and beyond.

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ELECTRONICS MEETS CHEMISTRY: HERBERT S. GUTOWSKY AND THE BEGINNINGS OF CHEMICAL NMR

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In the late 1940s and early 1950s, chemists, physicists, and electronic engineers developed Nuclear Magnetic Resonance Spectroscopy (NMR) from a high-precision physical method to a routine chemical technique. Important contributions to this development came from the research group of the physical chemist Herbert S. Gutowsky at the University of Illinois in Urbana-Champaign, USA. In Gutowsky's laboratory, students of chemistry and engineering worked together to unravel effects that became the basis for the uses of NMR in structural analysis. In doing so, they designed and constructed several NMR spectrometers on their own. The talk will present a detailed analysis of the design and construction process of their first spectrometer, and will focus on its teamwork character. It will be argued that Gutowsky and his group needed the understanding of electronic, physical, and chemical phenomena in order to obtain control of the spectrometer. This multi-faceted control was the decisive step in the recognition, characterization, and subsequent standardization of fundamental effects in the chemical applications of NMR.

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Session 4A: Between industry and academia, 1900-2000

Chair: Isabel Malaquias

BETWEEN SCIENCE AND INDUSTRY: THE RARE EARTHS' SCHOOL OF GEORGES URBAIN (1872-1938)

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By the end of the 19th Century and the early 20th Century, France lived one of its richest periods of chemical industrialization. This paper focuses on one of the less known branches of chemical industry, the rare earths industry. Normally, readers are more acquainted with the work developed by chemists such as Georges Urbain (1872-1938), Auer von Welsbach (1858-1929), Lecoq de Boisbaudran (1838-1912) in this field, than with the process and the reasons underlying the emergence of this industry. Considered in generally as chemical curiosities, only Auer von Welsbach, an Austrian chemist was employing a mixture of Thorium and rare earths in order to produce incandescent mantles, improving gas lighting. At the turn of the century, Auer von Welsbach came to France and established a rare earths' elements factory whose production was interrupted by the First World War, upon request from the French Army. After the war, Georges Urbain, a French chemistry professor whose reputation derived from his contributions to this field, founded in 1919 the *Société des Terres Rares*. A factory was established and its direction was given to the *Société* by the Army. By establishing close links between research and industry, Georges Urbain gathered around him a group of researchers and created in this way the French research school of rare earths. His research programme focussed on the isolation of these elements was directly influenced by the French academic culture in a similar way to that of Marie Curie regarding radium industry. The foundation of factories in France increased the production of rare earths, and gave France industrial autonomy in rare earth related alloys. Rhodia, one of the biggest chemical groups in France, can be considered today as a product of Urbain's school know-how of purifying mixtures of several rare earths elements. Ferro-cerium's production, for instance, allowed for the formation of a large monopoly in lighter flints for nearly 80 years, which closed down in 1998 due to environmental problems caused by rare earths production, notably soil and water contamination by radioactivity. This situation was even worsened by China's low cost production and better technology for purging radiation from rare earths mixtures.

Georges Urbain is also known to have been one of the staunch supporters of fundamental chemistry playing a role in French chemical theory. His research programme focussed on pure chemistry, and his chemistry courses at La Sorbonne advocated the beauty of the scientific discoveries to the detriment of applied chemistry. That was why a controversy opposing Urbain and Le Châtelier occurred because of their contradictory views concerning the teaching of pure and applied chemistry in their courses. Contrary to Curie's works on radioactive substances whose social utility was perceived as being of paramount importance, rare earths' elements seemed not be as interesting to the needs of mankind, despites the tests made to evaluate their medical applications. Urbain's positions regarding pure and applied chemistry seem contradictory: if on the one hand Urbain joined his friend Jean Perrin during the 30s in a campaign for the promotion of "pure" science, and created la *Caisse nationale de la Recherche scientifique* and the *Laboratoire des gros traitements chimiques*, on the other, he established the *Société des terres rares*, a company devoted to the production and trade of rare earths salts. By then chemists realized that they needed industry to pursue their research programmes in fundamental chemistry; in turn, industrialists were aiming to earn money from their research. Changing boundaries between pure and applied chemistry or becoming an adept of one field or the other was more concerned with getting funds to use in the industrialization efforts than with rational or moral practice of science.

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A.E.CHICHIBABIN (1871-1945) AND THE DEVELOPMENT OF CHEMICAL AND CHEMICAL - PHARMACEUTICAL INDUSTRY IN RUSSIA

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In history of science there exist names of scientists at the mention of which in our memory appear associations with the development of entire areas of knowledge. Prominent organic chemist academician A.E.Chichibabin is one of such scientists. His creative evolution is inseparably linked with the history of chemistry of heterocyclic compounds, pyridine, in particular. His way in science is an example of entwinement of theory and practice.

In the work, basing on new archive materials (Russian and French) there is shown contribution of scientist in the elaboration of a number of known technological processes and his important managerial role in the establishment and development of certain industrial productions in Russia.

Reaction of cyclocondensation of aldehyde with ammonia, discovered by Chichibabin (Chichibabin's name reaction) in 1906 became the basis of contemporary industrial synthesis of alkylpyridines. It is also used for synthesis of raw feedstock for production of artificial rubber. Amination of pyridines, discovered by him (1914) led to creation of new ways of producing azodyes.

Being a professor of Moscow university, over 20 years heading chemical faculty of Moscow High Technical School (MVTU), Chichibabin made a lot for preparation of qualified personnel of chemists for chemical and defense industry, who made direct contribution in creation of potential of Soviet industry. In MVTU he founded military-chemical department with chairs of explosives, toxic gases etc.

In 1914-1918 being the chairman of chemical departments of Moscow Military-industrial Committee and Zemgor, the scientist participated in solving pressing problems of extending capacities of chemical productions, of improving their technology because of a necessity to change over to new sources of raw materials in war-time conditions (organization of production of sulfuric acid in village Rastiapino, Nizhegorodskii region etc.).

A.E. Chichibabin is also an organizer of Russian chemical-pharmaceutical industry. During World War I years he established Moscow Committee Assisting to the Development of Chemical Pharmaceutical Industry. In MVTU together with scholars he organized medical supplies workshop and also, for the first time in Russia, chair of chemistry and chemical technology of pharmaceutical industry. Together with scholars (V.M.Rodionov, N.G.Patsukov, etc.) Chichibabin developed industrial methods of preparing a number of alkaloids. In 1917 he organized construction and startup of first alkaloid plant in Russia. Due to the scientist's research there were also created methods of producing salicylic acid and its salts, aspirin, phenacetin etc.

In Soviet Russia (1920-s) Chichibabin worked as a chairman of Board of State Chemical-Pharmaceutical Plants of VSNKh (Supreme Council of the National Economy), that controlled all chemical-pharmaceutical industry of the USSR. A.E.Chichibabin continued his research in this direction in emigration, in 1930-s, cooperating with largest pharmaceutical companies of the world (e.g., "Éstablissements Kuhlmann", "Schering", "Roosevelt & C^0").

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CONVERTING ACADEMIC KNOWLEDGE INTO INDUSTRIAL INNOVATION: STRATEGIES OF APPROPRIATION OF UNIVERSITY-BASED RESEARCH AT SOLVAY & CO. AND GEVAERT N.V.

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The social making and dissemination of knowledge in the chemical sector has become a classical topic in the treatment of the history of that discipline. Business historians, on the other hand, have been eager to focus on the stages of integration of exogenous R&D in the chemical industry. With the emergence of the so-called "science-based industry" in the last quarter of the nineteenth century onwards, the German experience of interactions between science and industry has undoubtedly paved the way to the framing of complementary models – "industrialization of invention", on the one hand, "scientification of industry", on the other (Meyer-Thurow, 1982; Weingart, 1978). While such theoretical conception rationalizes our understanding of a rather complex picture, it implicitly legitimates the surfacing of a "one-best-way" model and tends to overlook the unexpected mechanisms of fruitful misunderstandings that abound in the coming together of scientific and industrial – or entrepreneurial – environments.

The question this paper seeks to address relates to the strategies deployed by the firms Solvay & Co. and Gevaert N.V. – two multinationals operating in a highly innovative sector and depending on a low national system of innovation (Devos, 1993; Schröter and Travis, 1998) – in taking advantage from the research capabilities located in the surrounding academic landscape. It will be argued that, instead of conforming themselves to any previous blueprint for innovation, both industrialists and academics sought to overcome their conflicting interests and cultural divergence by bringing out mutual opportunities that eventually led to an unexpected form of utilitarian cooperation. Paradoxically, these ups and downs proved to be decisive in the long run as they contributed to shape the patterns of increasingly coordinated and elaborated industry-university relationships in the Belgian chemical industry.

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BETWEEN UNIVERSITY AND INDUSTRY: THE INSTITUTE FOR NATURAL SUBSTANCES CHEMISTRY, THE STORY OF AN UNUSUAL CNRS LABORATORY: THE ICSN, 1960-2000

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In a previous study, I emphasize that links between university and industries were old and regular in the French chemistry[1]. Even though today the French government supports those connections, from the thirties until today, it's uncommon to meet scientists really able to admit that the academic research has many contracts with industries for a long time.

It's why the Institute for Natural Substances Chemistry (hereafter ICNS) history is so interesting. The ICSN researchers have always worked with several firms. The ICSN is one of the main National Centre For Scientific Research (hereafter CNRS) laboratory. The ICSN was founded in the late 50s, because France couldn't compete with Great Britain, Switzerland and USA to carry out research on natural products.

The ICSN is famous because Pierre Potier's team has patented two major molecules and has dealt with two firms to turn them into drugs named Navelbine and Taxotère. In one way, Pierre Potier's team has won the competition against the American scientists despite the National Cancer Institute program[2]. The French drugs are very used everywhere around the world for the cancer therapy.

The Pierre Potier's ability to manage the contracts with Pierre Fabre Pharmaceutical firm for the Nabelbine and Aventis for the Taxotère is noteworthy. Whereas oncology drugs were not seen as the most desirable area in which firms might compete.

What I would like to do with this presentation is to explain how was-it possible? The CNRS (public sector) doesn't fund cancer research in the strict sense of the term. However, many researchers are working on this point. One aspect of this story is the degree of autonomy and freedom of action that the French researchers enjoyed.

The rich collection of archival material is required here. Pierre Potier (the inventor) has thrown nothing away and I have access to notes about all the steps of a research project and direction to take when not pursued and preliminary drafts of publications since corrected as well as officials letters, personals letters, memo, minutes and laboratory notebooks. Pierre Potier has given me more than 30 hours of interviews.

So I am able to explain how P. Potier has managed his team, his laboratory and then the Institute firstly to discover the two news molecules, secondly to turn them into drugs. Furthermore, I will present his personal strategy to preserve the public science interest, the researchers' interest and how has he kept under control the intellectual and industrial properties of their discoveries even today as he is retired. The licences fees pay by the two firms are huge and are still now the major patents income for the CNRS.

I would argue that the relationship between individual and collective is the key of the success whatever the role of the state, of structures and of organisation and I would present one path to make chemistry in France since the 60s until today.

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Session 4B: Nineteenth-century laboratory practices

Chair: Ursula Klein

MATERIAL CULTURE AND PROFESSIONALIZATION OF EUROPEAN SCIENCE: THE ROLE OF LIEBIG AND GERMAN LABORATORY PRACTICE

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In 1830, Justus Liebig invented an improved apparatus for the easy and accurate determination of the carbon content of organic compounds. Liebig's timing was superb, for the science of organic chemistry was just then beginning to explode both in volume and importance. A recently published historical/chemical investigation in which some of Liebig's early analyses were repeated with a replicated apparatus has provided evidence that suggests that Liebig's technique was indeed as simple and reliable as he claimed. But what may have been some of the wider effects of this innovation? It is well known that the half-century from 1830 to 1880 saw a great movement toward professionalization of European science. In this paper we explore the role that Liebig's new laboratory practice may have played in that process.

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SENSE AND SENSITIVITY: MARSH'S TEST FOR ARSENIC IN EUROPEAN TOXICOLOGY (1836-1845)

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In October 1836, James Marsh (1794-1846) communicated to the Royal Society of Arts of London his "new method of separating small quantities of arsenic". The method was based on an already known property of arsenic: it combined with hydrogen in nascent state and yielded arsine. Arsine could be easily decomposed in hydrogen and arsenic, which formed a thin metallic film on the surface of a cold glass. The new test was soon employed in many European countries. It was favourably reported by Mohr and Liebig in the pages of the *Annalen der Pharmacie*. Liebig affirmed that its high sensitivity was "beyond any imagination". Jacob Berzelius also published a positive review of Marsh's method and suggested some improvements. Marsh's paper was soon translated into French in the *Journal de Pharmacie* during November 1837 and employed during a poisoning trial in France as early as in May 1838.

In spite of these promising beginnings, the spread of Marsh test was surrounded by a great controversy. Its high sensitivity was a constant source of problems. In France, the polemic reached his apex during 1841, when special sessions were held at the Academy of Science and the Academy of Medicine. Due to the political resonance of some poisoning trials, the debate was not confined to the French scientific and medical community. Medical, scientific and popular journals dealt at length with the problem and they published detailed accounts of experimental toxicological practices and contrasted opinions concerning the use and abuse of Marsh's test. The polemic faded away during the subsequent years and Marh's test became a common method in analytical chemistry during the nineteenth and twentieth-century. As a result, Marsh's test is an excellent historical case to study how a chemical apparatus was transformed from an object of controversy to a reliable and unquestioned method for toxicological research. First, I shall analyse the old methods employed by the first experts in arsenic toxicological analysis. Then, I shall discuss how Marsh's test was introduced in France and Germany and the advantages and drawbacks that were reported by toxicologists.

Marsh's test was largely transformed during this process and several alternative devices were suggested by different physicians and pharmacists. Its high sensitivity produced some puzzling and unforeseen problems, which will be analysed in the paper. I shall finally describe the scientific controversy which took place and explore the consequences of the Marsh's test controversy in European toxicology.

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HISTORICAL NOTE ON OPTICAL METHODS AND RELATED SCIENTIFIC INSTRUMENTS FOR CHEMISTRY USE BY LISBON POLYTECHNICAL SCHOOL ON THE FINAL XIX AND EARLIER XX CENTURIES

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The optical methods, namely spectroscopy are usual techniques present in any analytical research or education laboratory, its study and its history are always associated with the Chemistry history.

It isn't possible to understand a technique's contributes in science development without being aware of the setting and the people who interacted with it. So, we followed an evolutive path in Polytechnic School and in the Faculty of Sciences of Lisbon until 1917, in what concerns the emergence and development of spectroscopy and other optical methods and its inevitable consequences. How and when did spectroscopy arrive at Polytechnic School, namely in Chemistry area? What other methods are associated? How did it contributed to scientific research? Which are the consequents to the teaching of Chemistry?

Agostinho Vicente Lourenço, Achilles Machado, and later, in the Faculty of Sciences of the University of Lisbon, António Pereira Forjaz are landmarks in Chemistry science progress in Portugal and they are also responsible for the development and teaching of spectroscopy.

Our study permits to give the answers to the questions made and found a track through the analysis for the Chemistry chairs' curricula, the adopted books for the Professors, the publications, the communications introduced, the catalogues and also documents archives and the pieces the instruments in existence at the Science Museum reserve.

In the evolution of an instrument, like a spectroscope, we can find the evolution of some concepts of Chemistry itself.

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THE PRAGUE WENZEL BATKA COMPANY; BUSINESS, SCIENCE, INVENTION, AND POLITICS

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The family firm founded in Prague by Wenzel Batka in 1759, traded mainly in chemicals and chemical glass. Stepwise, pharmaceutical products, chemical apparatuses, laboratory and pharmacy furnishings and agricultural products enriched the assortment of the merchandise, especially in the next generation when Wenzel's sons Paul and Wenzel Jr. became the owners. After 1820, when Wenzel Batka's grandson Johann Baptist Batka directed the company, it became renowned all over Europe; it supplied many important chemical laboratories, not only in the Czech Lands, but also other countries. Among the customers were, among others, J. J. Berzelius, J. von Liebig, J. E. Purkinje, most probably also F. Wöhler and D. I. Mendeelev, and even the Greek Queen. The Batkas had demonstrable contacts with J. B. Trommsdorff, J. A. Buchner, J.- L. Gay-Lussac, and many other prominent European chemists.

The owners of the firm were not ordinary merchants. Wenzel Batka Jr. and his son Johann Baptist Batka published a number of scholarly publications. J. B. Batka regularly visited the Congresses of the German Naturalists and Physicians, not only to advertise there his commodities, but also read papers. Some of the traded equipment had been improved by J. B. Batka's own practical innovations; he also invented new recipes for making chemicals; this way he personally contributed to the progress of laboratory techniques and facilities. In 1835, J. B. Batka founded in the outskirts of Prague a well-equipped chemical laboratory where he and his collaborators prepared chemicals including various very pure elements that served in European laboratories as standards. In this lab he also trained young chemists some of whom became recognized scientists. J.B. Batka was also known for his activities in several scientific and professional societies and his political involvement in the revolutionary year 1848, when he stood up on the side of the Czech intellectuals demanding more autonomy for the Czech nation within the Habsburg monarchy.

The Batka case may demonstrate that studies into the history of laboratory practices and instruments should also include dealers who used to supply laboratories with glassware, apparatuses, chemicals and other necessary equipment, and whose role has often been neglected in historical studies. This paper attempts to show that deeper insight into the activities of some businesses may unearth their unexpectedly versatile and active role in the scientific enterprise and society in general

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Session 5A: From fertilisers to nerve gases, 1830-1945

Chair: Éva Vámos

FERTILIZER PRODUCERS IN FRANCE IN THE 19TH CENTURY: THEIR LINKS WITH CHEMISTS (1830-1870)

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The importance – and shortage – of fertilizers, and especially nitrogen, in agriculture in the nineteenth century France led to an intense activity for the identification of nitrogen sources and flows in the city, the use of urban and industrial wastes as nitrogen fertilizers for agriculture, and the development of the organic and mineral fertilizer industry in Paris.

We would like to show how the fertilizer producers used the knowledge of chemists to produce new fertilizers or fertilizers of controlled quality, through the example of factories such as Lainé, or Houzeau-Muiron. This paper also deals with the arguments used to promote urban and industrial fertilizers, i.e. the transformation of all kinds of urban refuse into low-cost fertilizers, the recovery of until then useless industrial waste, and the transformation of a dangerous and unhealthy nitrogen containing excremental material, when discharged into rivers, into a valuable and useful product for plant nutrition and the human diet. This could be illustrated by the increase of the number of new fertilizer factories around Paris in the 1870s.

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COMBUSTION RESEARCH IN THE ´THIRD REICH´ (1937-1945): REFLECTIONS ON A BORDER ARENA OF CHEMISTRY, PHYSICS AND TECHNOLOGY

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This paper explores combustion research in the ´Third Reich´: a field of science located in the borderland of chemistry, physics and engineering. It focuses on a transdisciplinary ´twilight zone´, in which ´peers of science´, acting as science managers or 'intermediaries´, strove to yoke domains of ´basic science´ - analytical chemistry, chemical kinetics, fluid mechanics, instrumentation - into research projects dealing with technological problems as the ´knock´. As pivotal scenery of the story, I consider the ´Institute for Motor Science´ at the Center for Aviation Research near Braunschweig, which was built in the 1930s in the course of German rearmament policy.

For convenience, the figure of the director of this institute, a professor named Ernst Schmidt, serves as crossing point in outlining three spheres of description, which may constitute a narrative of German combustion research. From a micro-perspective, the account sheds light on the experimental setting and the generation of knowledge at Braunschweig. By taking up a meso-perspective, it is reasonable to call attention on research communities (´Arbeitsgemein-schaften´), who were established to ensure the circulation of knowledge across institutional barriers and between different power blocs, and special emissaries (´Bevollmächtigte´) like Schmidt, who were nominated to bundle research activities at different sites and to allocate resources with regards to technological ends. And the view from a macro-perspective suggests to ask, how events and actions on the micro- and meso-level correspond with short- and long-term transformations of involved disciplines and with general trends in science, technology and policy.

Such a multi-level approach is a starting point to unfold a landscape of combustion research as heterogeneous field of discourses and practices and to trace patterns of interaction against a background of sociocultural configurations.In addition, the paper echoes some suspense-creating factors or ´oppositions´ arising from historiographic reflections of that kind: short-term programmes versus ´longue durée´, the ´fluidity´of careers versus the ´inertia´ of institutional settings, a horizontal of ´claims´ and demarcations versus a vertical of ´collective expectations´ and decomposing/composing activities from engines to test tubes.

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WHY HITLER DID NOT DEPLOY NERVE GAS AGENT IN THE WORLD WAR II

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TABUN, the first known nerve agent, was discovered accidentally in 12/23/1936 by the Bayer devision of the IG-Farben researcher Gerhard Schrader (1903-1990). Official called an insecticide this agent was patented (No. 15/399) in March 1937. Because of the law of 4/24/1934 which required all inventions of possible military significance to be reported to the Ministry of War, Schrader has informed the Army Ordnance Office ("Heereswaffenamt") (HWA) about the military implication of this stuff. The code name of this agent was called *Präparat 9/91*, later called *Le100*, *Gelan*, *Stoff83* lastly known as TABUN. From 1937 to 1939 the semi-technical production of TA-BUN were proofed and tested, so that a pilot plant was implemented in Munsterlager under the commando of the HWA. In this peace time period the I.G.-Farben didn't want to have any military implication in directly related war material production. In January 1940 however, the Germans be-gan construction of the full scale plant, code named *Hochwerk*, at Dyhernfurth. An I.G.-Farben sub-sidiary, Anorgana headed by the I.G. board member Otto Ambros, operated the TABUN plant [1].

The May 1943 meeting of Ambros with Hitler is often mentioned in literature, but lastly the content –Ambros didn't recommend the beginning of chemical warfare (CW) - are based on affidavit of Ambros in the Nurnberg trial (1947) which is historically spoken should take with care [1-5]. Nevertheless, the Germans have had their weapon of mass distinction: In this time the Ger-man TABUN stock was about 1858 tons in shells and bombs. This means the German war machine have had the power to destroy all higher animals within 4000 km^2 area within in few minutes [1, 6]!

On 1 March 1944 Ambros (1901-1984) gave a lecture on the situation of the German CW pro-gram in the "Führerhauptquartier" together with Hitler and others. He explained that the decided amounts of 1000 ton per month (moto) TABUN of the meeting of 15 May 1943 were fulfilled to 70%. In the next month it was indented to fulfil the production target to 100 %. After this lecture Hitler enhanced the production quota to 2000 moto without considering that the amount of Phosphor did not exist in Germany [1, 7]. Almost 40 % of phosphor stock (50000 t/a P_2O_5 year production) was already used by the TABUN production [8]! In this lecture mentioned, Ambros referred to Hitler "about the demoralise impact, which were occurred by application of these types TABUN and SARIN, and the use of these stuffs was characterized as a means of very last decision. It was referred to the *possibility* [italics author], that the opponent [=allies] had drifted the develop-ment in a *similar* [italics author] direction. In literature is has been known, that – especially in America [=USA] - scientific investigations were carried out with matter related constitution ["*Kör-per verwandter Konstitution*"]" [1, 8]! What did Hitler understand presumably with the formulation "matter related constitution"? Or otherwise asked, what kind of rhetoric effect of this chemical ex-pert (Ambros made his PhD. by the Nobel prize winner Richard Willstätter) will be happened by such a chemical layman like Hitler as a listener? To my opinion, there might be only one answer: Hitler might or more probably have to get the impression that the opponent have had the same quality of chemical weapons with nearly the same amount, but the allies did not have nerve agents as well known historical matter of fact and the allies noticed lately it, despite of ENIGMA, not until since May 1943 [3]! So Hitler might be deterred and this is the reason for not starting the chemical war machine with nerve agents. What a kind of big difference on the degree of enthusiasm of Am-bros compared with Fritz Haber's exertion of influence in starting the CW in the World War I [1].

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Session 5B: Communication between Britain and the Continent, 1650-1850

Chair: António Amorim da Costa

THE CONTINENTAL EDITIONS OF THE WORKS OF ROBERT BOYLE

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Up to the late eighteenth century Latin was the language held in common by all serious Scholars in Europe. In addition it was the language of University instruction in some subjects and countries as late as the first years of the twentieth century.

Hence, the translation of books from the language of an authors' country into Latin was a major factor in the wide dissemination of an author's work across Europe in the seventeenth and eighteenth centuries. This factor will be illustrated by consideration of the continental editions of Boyle's individual works and collected sets in Latin and other languages. Twenty four out of the thirty of Boyle's scientific and five out of the twelve of his religious and utopian works appeared in continental editions. Information will be given of a rare Swedish edition of "Style of the Scriptures" (1767), not noted by Fulton.

In the days before authors-copyright there was little or no protection for authors and publishers against editions printed in another country, without reference to, or indeed an author's permission. Boyle had particular problems with the Dutch bookseller/printers "pirate editions". His quite extensive correspondence with, and advice from Henry Oldenburg, the Secretary of the Royal Society and also Boyle's literary agent, on this topic will be outlined.

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BRINGING SCIENTIFIC KNOWLEDGE TO PORTUGUESE READERS – CHEMISTRY IN PERIODICALS OF PORTUGUESE LIBERAL EMIGRÉS (1808-1822)

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In the first two decades of the nineteenth century, various Portuguese periodicals were published in Paris and London, and sent to both mainland Portugal and overseas. They were published by Portuguese émigrés, the majority of which fled the country either to escape political persecution, or simply to foster their scientific education. These periodicals had an encyclopaedic matrix and scope. They aimed at bringing science to a wide audience and contributing in this way to the transformation of a country, which their editors perceived as being remote and far from the centres of production of scientific and technical knowledge.

From 1808 to 1822, these periodicals drew the attention of Portuguese readers to the importance of being in touch with the most recent developments in science and technology. They published abridged versions of articles and texts taken from books, dictionaries and other European periodicals, which were translated into Portuguese. Among the sciences they disseminated, chemistry was considered of paramount importance, due to its applications, notably to agriculture and industry.

Between the late eighteenth century and the early nineteenth century, Portuguese editors and writers of periodicals followed closely the changes and major developments in chemistry and tried to bring them to the knowledge of a diverse, though restrict group of readers of scientific periodicals in Portugal. This paper focuses on the role of these disseminators of science and their views on chemistry, as well as on the participation of editors and readers in this process.

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THE MARRECO STORY

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This is an account of two remarkable Portuguese men, father and son, who played an important part in the popularisation of chemistry in 19th century Britain. It reveals little known facts about the dissemination of chemistry in Victorian England and also offers an insight into scientific relations between Portugal and Britain.

The older man was Antonio Freire Marreco who in his youth had been involved in the struggle for Brazilian independence, and came to England in the 1820s as a wine importer. He soon helped to set up the world’s first association for chemistry: the London Chemical Society. Although short-lived this society published a journal, in which chemistry and politics are intertwined. Later he moved north and became associated with the Stephensons in development of railways in Durham. He married the daughter of a local entrepreneur but after some years moved with his family to his native Portugal, advising industry on railway and mining technology.

A son of this marriage, Algernon, received some early education in Portugal but on his father’s death returned to northeast Britain. Here he too became fascinated by chemistry, and eventually became the first professor of chemistry at what is now the University of Newcastle-upon-Tyne. However he chiefly to be remembered, not for the research he carried out, but for his part in another chemical institution. He was deeply involved in the foundation and subsequent fortunes of the Newcastle Chemical Society. His was another “first”, being the earliest example of a provincial chemical society anywhere. The significance of this society, very different from the London Chemical Society, will be explored in detail.

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Session 6A: Chemical technology and biotechnology after World War II

Chair: Ernst Homburg

THE ROASTING OF PYRITES CONTAINING ARSENIC: A case study (Barreiro 1950-1972)

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The roasting of pyrites started, in Barreiro (Portugal) chemical complex, with the first plants for the production of sulfuric acid (by the lead chambers process) that the chemical corporation CUF- Companhia União Fabril, S.A.R.L. established there, in the first years of the 20th century. The specificity of the mechanical multiple-earth furnaces (initially of the type Herreshoff - Stinville) allowed, as also happens in the rotary furnaces, to an quite satisfactory elimination of the arsenic contained in the Portuguese pyrites that, as common to all the pyrites of the "Iberian pyrite belt", present it in an amount such that, if fixed in the cinders, would be unacceptable for the requisites set forth by the iron & steel industry for the purified leached cinders ("purple ore"). Cumulatively, in this period previous to the II World War, the sizing of the industrial units, the low requirements in relation to the quality of the acid, almost totally dedicated to the production of phosphate fertilizers, and some important modifications in the equipment of the lead-chamber ("box-chambers"), had not only helped to keep the technological *status* in the sulfuric acid production of that company as exclusively dependent of the mentioned process, but extended their useful life far beyond what would be expected under the rhythm of modernity.

However, since the end of the World War II, the domestic demand for an acid with low contents in arsenic and iron, moved the company to choose the technological alternative required to give a suitable response to this new growing market. It was in this context that appeared first (simultaneously in the company and the country) sulfuric acid plant by the contact process. However this first move was not enough to bring the production of the "contact acid" above the amount of the "chamber acid" still being produced in the CUF industrial premises at Barreiro. Only the production of nitrogen fertilizers, that CUF initiated in 1952, would bring a truly important application for this "new acid". Successively, the bigger economic size of the new industrial plants has been reflected in the necessity use of successively bigger furnaces, with greater problems for maintenance of the suitable thermal profile, guaranteeing the same effect of the removal of the arsenic and implying an increasing attention for the recovery of the roasting heat.

This paper analyzes how the technical staff of the company has faced, in an innovative mood, the technological limitations to the date: "flop" of the then modern foreign technologies for the roasting of arsenic-containing pyrites in turbulent beds with keeping the requirements of iron & steel industry for the leached cinders coming out, the successively increasing size of the units of contact acid production of CUF and of their roasting furnaces and the introduction of heat recovery equipment. Using to advantage the domestic know-how when the process intensification was recognized as the solution to increase the "contact acid" production required by the new nitrogenated fertilizers line, and keeping the quality of leached pyrite cinders with at sight its ironmaking application, these technicians have conceived original solutions in the field of the roasting of arsenic-containing pyrites, keeping in Barreiro, at least for plus one decade, the exclusiveness of the use of mechanical furnaces for the roasting of Portuguese pyrites. On the other hand, the acquired knowledge about the mechanism of arsenic removal during the roasting of pyrites allowed them to approach, successfully, the longed for introduction of turbulent bed furnaces – what would come to have place in 1972, with selection and use in a new bigger unit of the two-stage roasting BASF process.

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RE-EVALUATING THE ROLE OF INDUSTRIAL RESEARCH IN THE 1950S AND '60S. DSM'S CAPROLACTAM RESEARCH AND THE DEVELOPMENT OF THE HPO-PROCESS, 1956-1977

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After the Second World War, the practise of industrial research entered a boom period with very generous spending and an emphasis on science and long-term research. The 1950s and '60s were an unique period of spectacular growth, seemingly unlimited technological opportunities and some major technological breakthroughs. Histories of industrial research, however, have shown the isolated position of many research departments in the 1950s and '60s. Science and a long-term orientation combined to technology push research, which became a problem when growth started to slow down and technological opportunity seemed to decline. From the late 1960s onward companies tried to turn form technology- to market-driven R&D: companies emphasised that research should have a commercial payoff and directed their research to care more for business interests.

This paper will re-evaluate this turn from technology- to market-driven industrial research with the example of DSM, and specifically with caprolactam, an intermediate for nylon.. As a medium-sized Dutch chemical company, DSM is of a category that has not received much attention from historians of R&D, who typically focus on large German and American companies. I will focus on an important process improvement, the so-called HPO-process, to show that research did not have an isolated but an independent position. This position enabled research to develop its own view of the interest of the company and start research projects regardless of the opinion of the production and marketing functions. The example of the HPO-process shows the problems attached to such a position, DSM's production function showed no interest in the process at first and it was commercialised in Japan, but also the potency of this position as DSM later did build an HPO-plant and as the process strengthened the company's market position.

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FROM CHEMISTRY TO PHARMACEUTICALS, AND FROM PHARMACEUTICALS TO BIOTECHNOLOGY: THE MANY TRANSFORMATIONS OF IMPERIAL CHEMICAL INDUSTRIES IN THE TWENTIETH CENTURY

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It is quite well known that the 1980 Spinks Report helped to launch the British biotech industry. However, what is not so well known, is that Alfred Spinks, a chemist and the author of the report, had spent all of his career at ICI, during which he saw the group become fully committed to pharmaceutical R&D, and then expand into biotechnology, one of the first companies in Britain to do so.

This paper charts this progress by looking at the changing material culture and organisation of ICI's Pharmaceutical Division, from one that was dominated by the research tools and practices of synthetic organic chemistry, to another, in which a greater balance between the physical and biological sciences was achieved, leading to the creation of hybrid departments – such as the Biological Chemistry or Physical Chemistry departments. It argues that these transformations placed ICI, and Spinks, who had witnessed them at first hand, in a privileged position when it came to advising the British government, which had become concerned about Britain lagging behind the USA in another high-tech industry, this time the emerging field of biotechnology.

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THE GOVERNMENT IS HERE TO STAY: RECOMBINANT-DNA TECHNOLOGY AND THE AUTONOMY OF SCIENCE IN THE NETHERLANDS

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The practice of post-1980s science differs greatly from that in the 1950s and 1960s. Back then, the emphasis was on basic science; scientists had almost complete freedom to pursue any line of research they felt was promising. This contrasts strongly with the present situation, where scientists are forced to focus their studies on topics that are considered relevant to society. The time horizon for this research is short- to mid-term at best.

To emphasize the qualitative rift between these periods, new terminology has been introduced: basic science is now contrasted with 'Mode 2 science'. Authors like Michael Gibbons argue that Mode 2 science is not just applied or strategic science, because societal influences are intrinsically interwoven with the practice of science. It is obvious that these developments imply a seriously reduced autonomy for the individual scientist. The present paper seeks to analyse the prior history of these developments, recounting how in the 1970s, the Dutch government succeeded in limiting academic freedom so that chemical research at universities was directed at societal problems in general and innovation in particular.

The case study to be analysed here is the debate over the safety of recombinant-DNA technology in the context of an emerging innovation-oriented science policy. The Dutch government felt that the promotion of public understanding of science was necessary to educate the public at large about the risks as well as promises of rec-DNA techniques. To this end, an agency called Science Information Services (Dienst Wetenschapsvoorlichting, or DWV) was founded by government, which was housed at the offices of the Royal Netherlands Academy of Arts and Sciences (Koninklijke Nederlandse Akademie van Wetenschappen, or KNAW) without being an official branch of this institution. However, it was not long before a controversy developed between DWV and KNAW on the former's activities to promote the 'public understanding of science'. A heated conflict arose about the objectivity of science.

In the early 1980s, DWV was dissolved and the government sought other instruments to educate the public about science. In line with international developments, Dutch safety regulations on recombinant-DNA technology were relaxed. Eventually, however, this meant that the government started to constrain academic freedom as it continued to develop its policy on science. This resulted in plans for strategic research in the domains of biotechnology, materials sciences, catalysis and pharmacology. The paper ends with a discussion of academic freedom in Mode 2 science.

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Session 6B: Public and private faces of chemistry, 1770-1900

Chair: Anita Kildebæk Nielsen

THE INSTRUMENTAL USE OF CHEMISTRY IN BIOMEDICINE AT THE END OF XVIIITH CENTURY

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At the end of XVIIIth century, chemistry achieves a special status as an instrument useful for understanding the mysterious processes concerning life. Within a new academic institution in Barcelona: the Royal College of Surgery, chemical knowledge was applied to, and shaped the world of medicine with one specific purpose: improving the art of surgery, not least, putting into practice the healing art.

The new perspectives opened by modern chemistry as applied to medicine were showed, discussed and spread out thanks to a new academic network raised by specific rules established by the colleges of surgery themselves. These rules gave birth to the setting up of a special kind of periodical scientific sessions: the ones known as "Juntas Literarias". These public sessions were mainly addressed to scholars as well to other audiences. Once a week, a professor of the college gave a lecture which, later, according to the rules of the college had to be censured by one peer in front of the "Junta". The "Junta" was composed by the director and other colleagues all of them professors of the Royal College of Surgery. Most lectures and discussions were written down and had been preserved.

By analyzing information contained in these extremely rich set of sources, and taking the Royal College of Surgery of Barcelona as a case study, this communication aims to do a first approach to the ways through which chemistry contributed to the improving of *biomedical* knowledge regarding anatomy, physiology, pathology and therapeutics at the end of the XVIIIth century.

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LABORATORIES, LINIMENTS AND LEARNING: THE PLACE OF CHEMISTRY AT THE LONDON SOCIETY OF APOTHECARIES IN THE NINETEENTH CENTURY

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Chemistry was always at the centre of the activities of the City of London Livery Company the Society of Apothecaries[1]. It was a specific skill that distinguished apothecaries from other members of the Grocers' Company, thus contributing to their claims for separation in 1617. Furthermore when a laboratory for manufacturing chemical medicines was constructed at Apothecaries' Hall in 1672, this was the key event in delineating a role for chemistry in the apothecaries' activities.

Despite its long history of chemical activity, the Society is most familiar for its role in medical licensing in the nineteenth century[2]. This emphasis has led to the importance of chemistry for the institution being overlooked. Chemistry was essential to the operation of the pharmaceutical trade at Apothecaries' Hall. This had developed out of the 1672 laboratory and at the beginning of the nineteenth century the Society was one of the largest drug manufacturers in Britain, holding valuable monopolies with the Navy and the East India Company[3]. However in addition to chemistry's practical importance in drug manufacturing, through the research and consulting activities of the Hall chemists the subject helped to shape the Society's institutional profile.

Chemistry was also important for the Society's status in medical licensing. In a complex world of medical occupations, it was the Society's objective to make chemical training a criterion of the particular expertise of the apothecary. This was demonstrated when the Apothecaries' Act of 1815 required candidates to take classes in chemistry and from 1835 in practical chemistry[4]. The practice of chemistry also had a rhetorical function for the Society. When faced with criticisms that "a contemptible gang of retail druggists"[5] had the power to license medical practitioners, the Society sought to raise its status as a learned institution by organising lecture courses on chemistry and materia medica, developing a library, arranging scientific conversaziones and using its manufacturing laboratories as a learning resource. In using media compatible with the culture of public science that was prevalent at the time, the Society demonstrated the wide-ranging applications of chemistry to various audiences of its members, medical students and the larger London medical and scientific community. Chemistry was thus crucial to the Society's institutional identity as it sought to raise its status as a learned organization and by understanding the subject's place in the Society's activities a new perspective on the organisation is obtained.

[1] E.A. Underwood (ed.), Cecil Wall and H.C. Cameron, *A History of the Worshipful Society of Apothecaries of London, vol. 1, 1617-1815*, (London, 1963); Penelope Hunting, *A History of the Society of Apothecaries*, (London, 1998).
[2] S.W.F. Holloway, 'The Apothecaries' Act, 1815: A Reinterpretation', *Medical History,* 1966, **10:** 107-29, 221-36; Irvine Loudon, *Medical Care and the General Practitioner, 1750-1850*, (Oxford, 1986).
[3] Anna Simmons, 'The Chemical and Pharmaceutical Activities of the Society of Apothecaries, 1822-1922', PhD Thesis, The Open University, 2004.
[4] R. Bud and G.K. Roberts, *Science versus Practice. Chemistry in Victorian Britain,* (Manchester, 1984), p. 26
[5] *The Lancet*, 1 Nov. 1828, p. 148.

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POPULARISATION IN CHEMISTRY: THE PRE-EMINENT EXEMPLE

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Justus Liebig has been famous, very early, for his fünf Kugel Apparat (1831), for his innumerable organic analysises, for his theory of organic radicals, for his shameful quarrels and for the great activity of his laboratory, swarming with scientists coming from all over the world. He is one of the founders of the new organic chemistry, against Berzelius and in competition with Dumas and Laurent.

Among the many advances this hudge chemist performed in order to make chemistry go forward, one of them has to be taken into account, although being not a proper progress inside the realm of science. On his way back from Great Britain, in 1837, and inextricably linked to the project of writing a book on agriculture, he begun an energic rehabilitation of chemistry that aimed to diffuse all through the world another image of chemistry. An image that contemporary chemists would perhaps take as a guide an inspiror to save chemistry from its polymorphous ill fame.

Through the comparative lecture of texts, memoirs and correspondance, I shall try to detect the reasons of such a change in Liebig's preoccupations, to evaluate the implication of such a crusade, and to determinate the reasons why such a policy did work. The review of the methods used to reach such a success, from advertising, even marketing, to personal interpretations of advances in the science of analysis, the use of his his scientific reputation to impose non-scientific assertions, but also the debates between pure and applied science, teaching and research, between science and industry, science and powers, make Liebig, once more, a very modern personage.

SCIENCE, HONOUR AND COMMERCE. THE PUBLIC FACE OF CHEMISTRY IN NINETEENTH-CENTURY BELGIUM

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The professionalisation of science in the nineteenth century is usually described as the emergence of a distinct social group with a particular professional profile and a corresponding university education, regulating entrance into that profession. But equally, professionalisation may also be seen to depend on the public recognition and appreciation of scientific competence. In addressing public audiences, scientists claim an area of expertise by promoting a public image of their discipline, emphasizing e.g. its utilitarian aspects, its philosophical implications or its relevance for wider social issues. These public strategies not only complement the process of academic professionalisation, but are in their own right to be regarded as dominant factors in shaping the intellectual and cultural authority of the discipline in compliance with local imperatives.

During the nineteenth century, chemistry was a rapidly expanding discipline in Belgian university life. Chemists found academic employment in science, engineering, pharmaceutical and agricultural departments. Yet, throughout the century, chemistry was (compared to mathematics or physics) not an important part of secondary education, distancing the chemical profession from what was generally regarded as basic science. Professional chemists often had to face fierce competition from other professional groups; industrialists were not very interested in the theoretical foundations of the art, while physicians reacted forcefully against the scientific claims of pharmacists. The promotion of chemical fertilizers by chemical companies was criticised by agriculturists favouring organic manure, and the hazards of the chemical industry (and chemical research) put the discipline in a rather unattractive position. A professional society, representing the discipline, was only founded at the end of the nineteenth century[1].

In the face of all this, Belgian chemists developed several strategies to claim scientific competence with the public. Some chemists engaged in philosophical debates on the nature of atoms and forces; others gave public lectures or wrote more or less ‘popular’ textbooks. One chemist, Henri Bergé, attempted to found his own popular journal, *Le Chimiste*, which, however, lasted only a few years. These divergent strategies were probably not very successful. The lack of professional cohesion between Belgian chemists was illustrated by some bitter and widely publicised controversies[2].

This lecture will focus on the popularisation of chemistry in Belgium, evaluating the resulting public image of the discipline and the audiences reached.

[1] H. Deelstra and R. Fuks, “La réorganisation fondamentale de l’Association Belge des Chimistes (1898),” *Chimie Nouvelle* 16 (1998) 1971-1976; R. Fuks, “De la Société Chimique de Belgique à la Société Royale de Chimie. Cent et douze ans de notre association de chimistes : 1887-1999,” *Chimie Nouvelle*, 17 (1999), 2085-3002.

[2] The lack of cohesion and the subsequent construction of a united academic profile has been studied by Geert Vanpamel and Brigitte Van Tiggelen “The profession of chemistry in nineteenth-century Belgium”, in Knight, David en Kragh, Helge (eds.) *The making of the chemist: the social history of chemistry in Europe 1789-1914*, Cambridge University Press: Cambridge, 1998, 191-206.

Session 7A: The chemical industry during the interwar period

Chair: Marika Blondel-Mégrelis

TECHNOLOGY, TERRITORIES AND CAPITALISM: THE FIRST WORLD WAR AND THE RESHAPING OF THE FRENCH CHEMICAL INDUSTRY (1914-1928)

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Axis, regional cartels and local capitalism: the situation of the French chemical industry before WWI

Before the 1st World War, the French chemical industry is strongly linked to territories. This industry is located in only a few valleys (Oise Valley, Rhône Valley, Alpine Valleys) and dominated by cartels and regional bourgeoisies. Only a few factories are located in peripherical areas in order to provide superphosphates for agricultural needs. The link of the chemical industry to the territory is very strong and is doesn't only appears in their names (Compagnie de Saint Gobain, Société Anonyme des Matières Colorantes de Saint-Denis, Manufacture d'Auby, etc…) but combine capitalism to territories by two means: the division of the national territory in regional cartels is due to the high cost of transportations of this raw materials. Moreover, most of the French companies are based on regional capitalism (Kuhlmann, d'Auby…). Only two exceptions tends to minor this point of view : the power of Saint-Gobain which is the only compagny to deserve the title of « national scale company » and the dyestuffs compagnies (Saint-Denis) which depend not mainly on the cost of raw materials but on the proximity of markets (Paris, Lyon). The price to pay for this cartellisation of the chemical markets is a creation of an oligopolistic position and a cut throat competition imposed by major companies to smaller ones who didn't agree to sign cartels agreements.

The1st World War and the birth of a national chemical policy.

The invasion of the northern part of France by the Germans led the French State to develop powder and chlorine plants in the Alps and Pyrénées upper valleys and the Rhône valley. The south/west of the country and the mediterranean shores where developped as well. At the same moment, a reflexion is led by the State on the renewal of a branch dominated by the Germans. Some compagnies, such as Kuhlmann are subsidized in order to create a Compagnie Nationale des Matières Colorantes (National Dyestuffs Company). The opportunity to develop new plants in remote parts of the country is also the occasion for many company to extend their scale and to conquier new territories in order to build superphospahtes plants: Kuhlmann transform itself from a regional to a national company. The war drew a new map of the French chemical industry based and strategic interests and low-cost energy.

The Post-war years: the birth of national chemical capitalism.

The post war years were marked by a nationalisation of the chemical industry and a new occupation of the territory:

- the return to peace means the sales of the German factories based in France (mainly of dyestuffs) to French companies. The return of Alsace to France brought huge potash mines to the State.
- The French state developed a politics in favour of the chemical sector: many powder plants erected during the War were sold to private companies whereas those were protected by a new tariff and refused internationals cartel agreements (Franco-German) until 1927/28 Moreover, the French state created a national company in order to develop the Haber process in Toulouse (ONIA) far from the frontier. This policy led to a self-sufficient mineral and organic chemistry, mainly in the fields of dyestuffs and fertilizers.

· The private companies entered from 1919 in a fierce commercial war: regional cartels exploded whereas many mergers occurred (CNMC and Kuhlmann in 1924, SCUR and Poulenc in 1928..). The regional bourgeoisies based company were replaced by national companies which were nevertheless far from being as powerful as ICI in England or IG Farben in Germany.

The speech will be completed by many maps presenting the location of different companies, maps of different scales (studies of valleys) at different moments of the period studied.

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"CHEMIZATION" AND THE CHEMICAL INDUSTRY IN THE SOVIET UNION: 1917-1941

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Chemistry in Russia and the Soviet Union experienced many changes after the 1917 Bolshevik Revolution. One of the most important of these changes was a growing interaction between academic chemists and the chemical industry. While these contacts were rather unsystematic for most of the years up to the late 1920s, this situation changed in 1928 when Stalin and the Soviet leadership moved the country toward rapid industrialization, the collectivization of agriculture, and the introduction of the First Five-Year Plan. In that year, a group of prominent chemists proposed a plan for the "chemization" of the national economy. This plan met with official approval and it became the basis for the development of chemistry and the chemical industry in the years up to the Nazi invasion of the Soviet Union in 1941. This paper will examine the plans for "chemization," focusing on the years of the First Five-Year Plan (1928-1932). In particular, the paper will investigate the different conceptions of "chemization" as proposed by differing groups in the Soviet Union (for example, chemists and political leaders), as well as changes in the official view of "chemization" over time.

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BLACK GOLD: STANDARD OIL OF NEW JERSEY, I.G FARBEININDUSTRIE A.G AND THE POLITICS OF SYNTHETIC OIL 1925-1945

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In 1926, based on two federal reports suggesting that existing stocks of oil in the US would be exhausted within six to ten years, Standard Oil of New Jersey, the largest oil company in the world, feared that its business was about to implode. In consequence SONJ was willing to countenance a commercial relationship with IG Farben the European chemical giant. Farben, created in December 1925 by a merger of Germany's six leading coal tar dye firms, was interested in an alliance with the American company because it alone could provide the financial resources that Farben needed to develop new chemical processes that would give it market dominance for the next two decades. Chief among these new products was synthetic oil.

In 1925 Frank Howard, head of development at Standard Oil visited BASF's laboratories in Germany. What he saw there astonished him. Farben's hydrogenation technology, developed to make synthetic nitrate during world War One, was also being use to make, acetylene, synthetic rubber and oil-from-coal. American research was infantile compared to the well equipped labs on the Rhine. Howard was quick to see that

hydrogenation technology could provide an answer to the terrifying prospect of rapidly dwindling US oil reserves and he lost no time in getting Walter Teagle, President of Standard Oil, over to Germany to begin negotiations with Farben for access to their hydrogenation technology. Synthetic oil was only part of SONJ's interest, more importantly Farben's hydrogenation technology, which used iron catalysts and high pressure, could be used to improve oil refining, doubling the level of product recovered from a barrel of crude oil.

The result was a limited agreement in 1927 whereby SONJ would be able to use Farben's hydrogenation technology. However both sides saw this as inadequate and Farben proposed a more complete arrangement with SONJ buying the full international rights for a cash sum. SONJ was less happy but seeing that Farben needed the resources to continue to fund its own development of synthetic oil agreed. In 1929 a four party agreement was signed that gave Farben 2% of SONJ's common stock, some to $35, 000, 000. The German company had, in exchange for a protected home market, a large injection of cash at a vital time when the depression was causing its sales to tumble dramatically. At the same time, new oil reserves were discovered in the American Southwest, however SONJ still saw the purchase of Farben's hydrogenation process as the most significant deal of its career, since it enabled SONJ to compete effectively with the new Houdray cracking processes.

What had been a straightforward commercial relationship between two industrial giants was complicated by the rise of the Nazis and Hitler's plans for war. In 1938 SONJ helped Farben obtain vital stocks of tetraethyl lead, necessary to make 100 Octane aviation spirit, for the Luftwaffe. Moreover, it became embroiled in the synthetic rubber controversy, something that proved highly embarrassing to SONJ. Furthermore, in the 1960s the method Farben had used to transfer the proceeds of the hydrogenation sale to Switzerland through its affiliate IG Chemie became the subject of a US tax investigation, which would eventually cost $24, 000,000.

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Session 7B: Practice and theory before Lavoisier

Chair: Halina Lichocka

EXPERIMENTAL SYSTEMS AND THEORY DOMAINS IN PRE-LAVOISIAN CHEMISTRY

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Few historians would dispute that chemistry provided the prototype for modern laboratory sciences. Nevertheless, the formation of chemistry itself as a 'science' has been something of a mystery since many argue that chemistry was no more than a cookery until the Chemical Revolution: it had to acquire physical instruments, methods, and theories to become a 'science.' This characterization of 'chemistry as a branch of physics' severely undermines our ability to understand the historical development of chemistry and to conceptualize that of empirical sciences in general. Recent efforts to anchor such development in 'practice' have not successfully addressed the issue of how various material practices become organized into genres of disciplined knowledge.

In this paper, I would like to model the historical evolution of pre-Lavoisian chemistry around the two concepts of 'experimental system' and 'theory domain.' The concept of 'experimental system,' originally devised to describe the dynamic complex of materials and techniques that sustained the investigative activity in modern biology can be exploited fruitfully to describe that of chemistry in the early modern era. What organized chemists' ongoing practice in the seventeenth century was the model system – the distillation of plants – that yielded five categories of substances. Chemists stabilized these substances and matched them to the philosophically prescribed 'principles' to organize their didactic discourse. This move constituted the 'theory domain' of composition that became a backbone of the chemical tradition. The introduction of a new analytic method – dissolution in acids and alkalis -- established the new model system of salts, however, and undermined the validity of the principalist approach to chemical composition. The selective actions of salts led to a new 'theory domain' of affinity and the affinity approach to composition, which were embodied in the affinity tables. In other words, stabilized experimental systems and theory domains defined the contour of theoretical chemistry that was neither dominated by idle philosophical questions nor hampered by aimless trial and error.

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THE ART OF DISTILLATION IN MANUSCRIPTS AND EARLY PRINTED BOOKS: TRANSMISSION OF PRACTICAL KNOWLEDGE

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This paper focuses on the Art of Distillation. It analyses some aspects concerning the diffusion of this practical knowledge both in manuscripts and in early printed books, such as books of distillation, treatises on metallurgy and books of secrets, a genre very popular during the Seventeenth Century. Besides, this paper intends to study how recipes and concepts presented in different kinds of books could be interwoven by authors to compose new books, as suggested by the analysis of the Portuguese "Tratado das virtudes dos óleos de enxofre, vitríolo,Philosoforum, alecrim, Salva e agoa ardente"(1648), written by Duarte Madeira Arraes. This author acknowledged in his treatise scholars like Conrad Gesner, who wrote one of the most

important books of distillation, the *Thesaurus Euonymi Philiatri* (1552), Mesue, an Arabic authority on the art of distillation, as well as Johan Jacob Wecker, author of the *De Secretis Liber XVIII* (1559), a collection of recipes.

Medieval and Renaissance texts concerning manipulation of materials bring to our days vestiges of techniques employed by artisans and alchemists long time ago. Distillation is one of the most valuable, among these traditional arts. Powerful "waters", "oils" and other "essences" could be produced by distilling vegetable, animal or even mineral materials.

Books of distillation, printed in early modern Europe, reinforced the idea that distilled "waters" and "oils" were more powerful medicines than the traditional concoctions, since they kept only the purest and subtle parts of the original material. At that time, *aqua vitae*, produced by distillation of wine, was regarded as a celestial medicine.

Authors of Sixteenth Century treatises on metallurgy also described how to prepare sharp "waters" and "oils" by distillation, such as the wonderful *aqua fortis*, employed to part gold from silver. Moreover, *aqua fortis* was also regarded as a very good medicine by authors of Books of distillation.

During the Seventeenth Century, the powerful "waters" and "oils" produced by the art of distillation continued to be used both with medical and metallurgical purposes. Recipes published in books of secrets show it. At that time, practical knowledge concerning "waters" and "oils" prepared by the art of distillation was mainly diffused in. books of secrets. These books gathered lots of recipes concerning several subjects, including medical and metallurgical recipes. However, mineral medicines became especially considered by physicians as long as Paracelsian ideas were discussed.

Duarte Madeira Arraes, *Tratado das virtudes dos óleos de enxofre, vitríolo,Philosoforum, alecrim, Salva e agoa ardente* (1648). Lisbon: Salamandra, 1993.
Conrad Gesner, *The Treasure of Euonymus* (1559). New York/Amsterdan: Da Capo Press/ Theatrvm Orbis Terravm, 1969.
Johan Jacob Wecker, *Eighteen Books of the Secrets of Art & Nature*. London: Simon Miller, 1660.
Vanoccio Biringuccio, *Pirotechnia* (1540). New York: Dover, 1990.

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ERROR IN CHEMICAL MANUALS; THE PRIORITY OF LAVOISIER UNJUSTLY QUESTIONED

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The conceptions concerning the weight increase during calcination of substances from antiquity till the end of the 18th c. are discussed. A special attention is given to the *Essay* of Jean Rey (1630)[1]. The analysis of this *Essay* shows that Rey suggested that air became denser and increased in weight when heated, and this denser air had to be attached to the particles of tin-calx. No explanation, how the tin-calx is formed, is proposed. Nevertheless W. H. Brock in his *The Fontana History of Chemistry* suggests that this author explained the calcination by addition of air particles to the metal.[2] A similar idea as that of Rey is found in Lomonosov's Latin paper (1752) erroneously translated by N. E. Zernov into Russian in 1828.[3] Lomonosov writes: "*nothing else can be the reason for the weight increase except that the acid of sulphur which having been liberated from phlogiston and gathered under a globe and having a tendency to remain at the top, then penetrates into the pores of copper and silver and there thickened, increases the weight"*. The words "there thickened" (in Latin original: " *illisque concretum"*) were replaced by Zernov (probably under influence of Lavoisier's ideas) by: "uniting with them", (in Russian: "*соединяясь с ними")* . This was repeated by a Russian chemist, N. B. Menshutkin in 1905[4] in German. This incorrect Russian text was the basis of errors in Ganzenmüller's reference to Lomonosov's conception in *Gmelin Handbuch der anorganischen Chemie.*[5] The ideas of Rey and Lomonosov are fundamentally different from those of Lavoisier, but these two authors are mentioned in some handbooks as the first authors, who explained the weight increase as a result of combustion during calcinations. It was, however, only Lavoisier, who accurately formulated the theory of combustion having considered simultaneously the increase in the weight of metal, and the decrease in the volume and weight of the air during calcinations in closed vessels.

J. Rey, Sur la recherche de la cause pour laquelle l'Estain et le Plomb augmentent de poisds quand on les calcine, Barras 1630 ; English translation, Essays of Jean Rey, Alambic Club Reprint , No 11. Edinburgh, London , 1895.

[2] W. M. Brock, The Fontana History of Chemistry, 1992; Polish translation Historia chemii, Warszawa, 1999, p. 58.

[3] M. Lomonosov, „*Meditationes de Caloris et Frigoris Causa*" Novi Commentarii Academiae Scientarum Imperialis Petropolitanae, **1**, (1750), pp. 206-229, Russian translation by N. E. Zernov in Новой магазин естественной истории, 1828, part III, No. 1, pp. 29-64; acc. to М.В. Ломоносов, *Полное Собрание Сочинений,* Vol. II, Moskva-Leningrad, 1951, p. 46 (Latin text), 47 (Russian text).

[4] N. B. Menshutkin, Ann. d. Naturphilosophie, 1905, **4**, 219.

[5] R. Ganzenmüller, in *Gmelins Hanbuch der anorganischen Chemie,* Syst. Nr 3, Lieferumg 1, Leipzig 1943, p. 44.

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POSTER ABSTRACTS

Poster session I

THE RÔLE OF THE HISTORY OF SCIENCE IN SCIENCE EDUCATION

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Science education suffers from the complexities of the basic theories of science, which seduces to introduce science dogmatically from ‘first principles’, explaining the structure of the physical world and the fundamental laws regulating the behaviour of its parts. Neither the students, nor their teachers have much understanding of the justification of their scientific convictions, established long ago in history on grounds forgotten. It are the results of the scientific endeavour and the contemporary scientific world picture that counts, not the procedures that justified the hypotheses that became convictions in later times. The scientific method, the close relationships between theory and experiment, the provisional character even of established theories, does not belong, at present, to the core of science education. This applies also to first-degree university education in the sciences. The scientific method is only learned in the research schools and then in a very restricted way: students are trained in the application of theories and experimental methods considered relevant to the special and narrow field of investigation of the research school. The danger is that research training becomes conditioning towards puzzle solving within a very restricted framework.

The close attention of science education for certain problems of modern society and for the technological results of the scientific endeavour is at best the application of current scientific theories to practical problems and, especially in popularized accounts, too often a superficial exposition of practical results embellished with historical or biographical details, more directed towards evoking admiration for, than understanding of science and scientists. Science education, separated from the application of the scientific method, is far away from being an important part of general education directed to prepare the student for an integrated human life in modern society.

The history of science is a reflection on the scientific method in action. It shows the emergence and evolution of fundamental concepts, theories and experimental methods in its human and social context. Although an introduction of science via the history of science is possible, it is not practical: competing alternatives for the solution of scientific problems, the coming to a dead end of many research traditions, and the factual contexts of discovery are a long and dangerous way towards scientific understanding. The contexts of justification are more promising. And a generalist approach in the history of science can give a lead in the recognition of difficulties in understanding the physical world and the characteristics of the solutions proposed and the reasons of the acceptation of particular ones, implicitly demonstrating the scientific method.

As a teacher of science in schools and universities during twenty years and, during another twenty years, teaching the history of chemistry to chemistry students and aspirant chemistry teachers, and the last ten years as chairman of the Working Party on the foundations of thermodynamics of the Royal Dutch Chemical Society, I reflected on the uses of the history of chemistry in science education. My paper will give results of this reflection illustrated by practical proposals for introducing historical aspects in school and university chemistry curricula. The implementation of these proposals asks for concerted action of historians of science, science teachers and educationalists. That will take energy from the historians, not resulting in research papers but only in the presentation of the history of science in the schools and universities and consequently in a deeper understanding of science and in a broader interest for science and science history in and around the schools and universities.

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CHEMISTRY APPLIED TO MEDICINE: THE SCHOOL OF TROPICAL MEDICINE IN LISBON

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This paper aims at reflecting about the role of chemistry used by the School of Tropical Medicine on the fight against tropical diseases on Portuguese colonies. In the context we intend to make some comparisons with other similar institutions as the Schools of Tropical Medicine of Liverpool and London.

The School of Tropical Medicine of Lisbon, founded in 1902, was the result of the process of colonization developed by the Portuguese State. Since 1902 to 1942, the research activity on school was supported by different scientific fields where the chemistry took an important place.

As methodology it was chosen the analysis of the scientific production led by Portuguese doctors of the school and as well as the reports and the scientific missions on the tropics, between 1902 and 1942.

The chemistry seems to be a crucial tool of medicine in the first decades of the twentieth century in Portugal, in the same way that the tropical medicine was the support of the Third Portuguese Empire. The language of colonization also includes the chemistry.

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PORTUGUESE PHARMACOPOEIA IN THE RENAISSANCE: TRADITION AND INNOVATION

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During the Renaissance, Portugal has a leading role in the research and study of medical botany. Authors like Garcia de Orta (c.1500-1568) Amato Lusitano (1511-1568), Cristovão da Costa (XVI century) or Frei Cristovão de Lisboa (?-1652) searched in the new nature, revealed by the Discoveries, the natural products, obtained from the plants, which could serve as efficient medicines against several ilnesses. These savants confronted what had been written in books for centuries against a new reality and refute, based in the direct observation and the study of new plants, the knowledge linked to the Classic Authors. In fact two classic works: *The Natural History* from Pliny, and *Medical Matter* from Discórides, as well as the works of Galeno served for several centuries as important sources of naturalistic medical knowledge, escaping to any criticism or contestation.

The Portuguese pharmacopoeia based in empirical data and revealing the caracteristics, the origins and the terapeutical qualities of new plants contributed without any doubt to an increasing receptivity and knowledge of the use of medicinal drougs originated in diferent countries. This increase in the knowledge of the potenciality of botany reflected in the organization of pharmacopoeia and the therapeutics to administer to the patient. A greater information lead as well to the adoption of new conceptys and to the creatiuon of new cientific terminology.

There seems to be no doubts about the fact that the Portuguese pharmacopoeia was one of the areas which most contributed, through out the Renaissance to the birth of Modern Science. It also generated a long tradition of study and practice of the medical matter with roots in the Arab and Hebraic Knowledge, from the VIII and XII centuries.

That's why we can talk about a long tradition of study of the botanical medicine in Portugal and it's significant contribution to a better and larger knowledge of the flora from several parts of the world with farmaceutical interest. Further more the transference and exchange of vegetable species among several continents, between the XV and the XVII centuries, implicated the reformulation of all the medical knowledge and pharmaceutical which for centuries was confined to a few authorities and their works. From this point of view the role of the Portuguese for the formation of a new area of knowledge, the Chemistry, was to all levels relevant.

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EXPERIMENTAL WORK IN THE CHEMISTRY COURSES OF THE POLYTECHNIC SCHOOL OF LISBON: 19th CENTURY AND BEGINNING OF THE 20th CENTURY

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The research presented in this communication is part of the work undertaken in the stage of the final year of our Chemistry Degree in the Faculty of Sciences of the University of Lisbon. Its aim was to study the experimental practice of students and teachers in the *Labotatorio Chimico* and *Amphitheatro* of the Polytechnic School of Lisbon in the 19th Century until the beginning of the 20th Century.

The work involved an exhaustive study of the Chemistry subjects' programs lectured there, school books currently used and Chemistry treatises recommended by the teachers, as well as several historical documents related to the teaching in this institution.

This research showed how practical experience in Chemistry was introduced in the Polytechnic School of Lisbon and how it developed during the 19th Century.

Several experiments done either in the *Labotatorio Chimico* or in the *Amphitheatro,* as demonstrations, were listed, presenting for each one of them the aim of the work, the experimental procedure and the chemical apparatus scheme. For that purpose, the information obtained from the different sources was crossed.

With this work, we hope to have contributed to a better knowledge of an important part of the History of Chemistry in Portugal, as well as the History of the Polytechnic School of Lisbon.

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LABORATORIO CHIMICO OF COIMBRA UNIVERSITY: A NEW MUSEUM SPACE

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The project of revamping the *Laboratorio Chimico* of the University of Coimbra to become part of the Museum of Sciences includes the adaptation of the building and interpretation of its history.

By the hand of the architect of Pombal university reforms, William Elsden, the *Laboratorio Chimico* was constructed from 1773 to 1777, on the remains of the Jesuits' sixteenth century refectory. Inspired by the Austrian model, "*where such art reaches the degree of major perfection*", to quote the words of the Marquis of Pombal himself in a letter to the rector D. Francisco de Lemos in 1772 (*in* Almeida, 1937-1979). "*Without damaging its architectural beauty*", the space was changed during the nineteenth century, making " *precise modifications adapting to the nature of learning, which is professed in it, and as the current state of science requires*", as written by one of the *Laboratorio* directors, Ferreira Leão (*in* Simões de Carvalho, 1872).

Documental investigation and a large amount of archaeological work made possible to assemble the morphological evolution of the building in its three hundred years at least. From the primitive *Laboratorio* structure to the last decades of the nineteenth century, it witnessed the developments "*that in several periods had the practical studies of chemistry*" in the Faculty of Philosophy of the University of Coimbra (Simões de Carvalho, 1872). This presentation will also cover the various events and characters that influenced the development of Chemistry science in Portugal, alternating between periods of great vigour and times of retraction.

For the museum format, the building is one of the essential objects of exhibitry. The aim is to recover its eighteenth century neoclassic grandeur, keeping the memory of the first construction purposely made only for teaching and research of chemistry in Europe, right before the beginning of the chemistry revolution.

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WALTHER BOTHE`S ERROR IN THE WORLD WAR II

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Since the internment in Farm Hall directly after the world war II, it was claimed among the scientists around Heisenberg, that Bothe's measurements regarding carbon had been wrong, and this would have been one reason for the failing of a German reactor during war-time [1, 2]. But in 1980 some former students of the Nobel prize winner of 1953 Walther Bothe (1891-1957) repeated those measurements and found out, that Bothe and Peter Jensen (1913-1955) had not only been right in 1941, but that Heisenberg had not sufficiently kept to their error analysis [3, 4]. Irving assumed 1967 that other erroneous results decided the race for the atomic bomb [5]. Heisenberg explained 1967 that the experiment of Bothes´s on graphite was not correct. "Bothe had built a pile of graphite pieces but in between the graphite pieces there was always some air and the nitrogen of the air has high neutron absorption" [6]. Leo Szilard (1898-1964), a member of the Manhattan project, had studied chemical engineering before going into physics. He remembered that electrodes of boron carbide were commonly used in the manufacture of graphite. It was known that one atom of boron absorbs about as many slow neutrons as 100 000 atoms of carbon. Very small boron (B) impurities would "poison" the graphite for use as a nuclear reaction moderator [7].

The Physicist Georg Joos (1894-1959) addressed a letter to the Army Ordnance Office ("Heereswaffenamt", HWA, G-46) at 29. March of 1939, that spectroscopic investigation was showing the existence of very stable boron carbide compound. To circumvent this, the compound could be eliminated by a pre-treatment procedure (reducing farina or sugar to get pure carbon resulting less 1 ppm B). Bothe wrote to the HWA at June 1940 (G-12) that his investigations were showing that there were no evidence of B, because "[solely] spectralanalytic investigations of Prof. [Hermann] Schüler [(1894-1964) of the KWIP] were showing that the 0.5% impurities were consisting of Ca, Ti, V, Mg; Ca is the most important." This was the real source of the Bothe`s error: Because in this time Schüler used spectralanalytic carbon which were contaminated by B. So how can you detect traces of B when you have a contamination of B in the agent? Nevertheless, in the summary Bothe mentioned that "as a precaution for producing ultra pure carbon the recipes of Georg Joos should be used". Half year later (01/20/1941) Bothe and his college Peter Jensen wrote to the HWA (G-76) the decision paper in their dissuasion for using carbon as a moderator material. They used a graphite of Siemens-Plania, "this [technical carbon] *might* [italicise author] be the most pure one. The amount of ashes was only 0.092%". These ashes were analyzed with Neutron absorption techniques. So they pointed out: "Because of 1/v-Law we might have 25% absorption instead of 7%". But in their footnote of their paper they explained: "The 1/v law is not valid for high absorbing neu-tron materials like Cd" [8, 9]. This implicit of course that this law was violated also by contamina-tion of B as a very strong neutron absorber and their math-assumption was consequently incorrect!

Technic-historical spoken, there was no consequence of Bothe error to expect because in 1940/41, after conquering Norway through the Germans, mostly the physiko-chemist Paul Harteck and K. F. Bonhoeffer have reached the decision to produce a heavy water reactor with the Norway heavy wa-ter. Since the Germans have only limited amount of pure Uraniumoxid, heavy water reactor did not require the same amount of Uranium compared to carbon moderator reactor to get critical [1, 10].

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THE CHEMICAL HERITAGE FOUNDATION INSTITUTE: AN INNOVATION IN PROMOTING CHEMICAL HISTORY

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In the United States and elsewhere, academic chemistry departments have experienced diminishing enrollments or have disappeared. Similarly, museums of science world-wide show declining or static visitation, and interest in traditional exhibits of chemical history elicit very little support. Against this challenge, the Chemical Heritage Foundation of Philadelphia, USA, is an organization unique in the Americas for its focus on collecting the material heritage of chemical and molecular sciences. CHF's collections include instruments and tools, fine art and works on paper which depict chemical processes, recorded and transcribed oral histories of technicians, entrepreneurs, researchers, and scientists, and archives of institutions and people, including Nobel Laureates. CHF also maintains one of the most important collections of books on early chemistry in the world. CHF is creating an *institute* to act as its public face for promoting an understanding of the history of the chemical sciences through its collections. The term "institute" implies an organization built around a cause, an educational body, or an intensive seminar on a focused topic. The CHF institute will realize all of these characteristics through interdisciplinary, multimedia techniques. This paper will outline its physical space, staffing, and outreach, with a particular focus on its outreach and exhibit themes.

As CHF's major outreach component, the institute will showcase CHF's rich collections of chemistry's material culture by producing both internal and traveling exhibits, the latter in partnership with major organizations and museums. Workshops and seminars will be held at the institute for educators to develop curricula grounded in science-and-society ideology. Web-based resources will augment exhibits to produce virtual museum displays and multimedia curricula for teachers. The institute has developed a partnership with a television producer for a major series on the history of chemistry through which CHF will contribute educational outreach materials, employing the collections. A conference center will be embedded within the institute exhibit areas, using visible storage to showcase the collections. What distinguishes CHF's institute is its audience and the multidimensionality of its message. Audiences include educators, academics, research institutions, and industry, educated adults for whom CHF is an "honest broker," a forum for diverse viewpoints. Institute exhibits will be oriented to these audiences, not to children, and the institute will not function as a public museum. Reflecting the audience, CHF exhibits and institute programs will be multidisciplinary, emphasizing the social contexts linked to chemistry, such as the impact of synthetic dyes on fashion, or the stimulus in war to industrial production of medicines.

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ÁGUAS LIVRES AQUEDUCT. SCIENCE AND TECHNOLOGY IN 18TH CENTURY IN PORTUGAL WATER SUPPLY

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The aim of this paper is to show how scientific knowledge, in the field of hydrogeology and chemistry is applied in the conception of the Águas Livres aqueduct. When conceiving the Águas Livres aqueduct, Manuel da Maia defends the construction of an aqueduct with no closed pipes, but open stone pipes with water being conducted only by gravity, against the principle of communicant vessels.

What water? Manuel da Maia, and the architects that succeeded him in the direction of the works, had, perhaps in an empirical sense, a correct understanding of the different kinds of water present in the aqueduct's sources, their different physical-chemical characteristics, building the aqueduct with a set of conditions that naturally depurated the water.

The knowledge of the physical-chemical characteristics of the materials that could be used in the construction of the pipes, and their reaction with water, also appears important. The refusal of all materials but limestone both by Manuel da Maia and, some years later, by Mardel, shows the state of the knowledge in this field. At the same time of this last architect we witness an interesting scientific discussion between different specialists, with arguments defending either the use of lead, iron, or other metals, and stone. But in the end, the limestone was favored.

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SCIENTIFIC/HISTORICAL TRAVEL SEMINARS IN EUROPE

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Two three-week, four-credit Allegheny College Center for Experiential Learning (ACCEL) study tours or travel seminars will be described. Led by one or two faculty members and involving from 7 – 20 undergraduates, the seminars offer students the opportunity to study topics of their interest while traveling abroad. "Traveling with the Atom: London, Cambridge, Oxford, and Paris" (May 2002) was led by the author and involved seven chemistry and physics majors interested in the history of the atomic concept and other history of science topics. "Traveling in the Liberal Arts Tradition: Berlin, Leipzig, Warsaw, and Prague" (May 2004), led by the author and a colleague in economics, involved 19 science and social science majors with specific interests in the history of chemistry and physics, comparative economics, language studies, European history, and music. Each trip was preceded by four days of on-campus presentations by the instructor(s), other group activities, and ample time for individual student research and writing. Each student was responsible for giving two short talks to his or her colleagues and mentors at appropriate junctures in the trip as determined by the instructor(s). These talks were followed up with short research papers due several weeks after return to the States. Itineraries, topics covered by instructors on campus, and the topics of student presentations and papers will be discussed. Other grading criteria used to evaluate student performance will be detailed. Exploratory trips to prepare the instructor(s) for leading these and other seminars will be briefly outlined.

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THE *REVISTA DE CHIMICA PURA E APPLICADA* AND THE FOUNDATION OF THE PORTUGUESE CHEMICAL SOCIETY

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The foundation of the Portuguese Chemical Society (SQP) was directly linked to the *Revista de Chimica Pura e Applicada* (Journal of Pure and Applied Chemistry), that was published for the first time in 1905. This journal was created in Oporto by a group of Chemists, mainly University Professors, among whom

Ferreira da Silva was the most remarkable personality, to be the vehicle for the publication of papers on pure and mostly applied research in Chemistry in Portugal.

In the 7th volume, of the "Revista" the announcement that the constitution of a "Portuguese Chemical Society" was in preparation is published. The invitation letter for the preparatory meeting, dated 28th November 1911, is transcribed in the "Varieties". There is also the information that a preparatory meeting, chaired by Prof. Ferreira da Silva, took place on the 2nd December. A project of statutes was presented, discussed and approved on the 28th December and the final version is published at the end of the volume of 1911 of the Journal.

A note of the 26th January 1912 informs about the foundation of the Society. The siege of the Society came to Lisbon, and the "Revista" became then property and the official Journal of the Society, edited by Cardoso Pereira and administered by Hugo Mastbaum. This information appears on the cover of the volume of 1912. Already in 1912 and in following years there are changes in the structure of the Journal that gives great importance to the news of the Society, having a section where the activities of the Society are reported, publishing namely the minutes of the scientific and administrative meetings.

From February on, during 1912, there is an advertisement about the changes in the Journal and also inviting the subscribers to ask their admission as "effective" or "aggregate" members.

As a curiosity we refer that a statistics with the numbers of members of the different chemical societies that were part of International Association of Chemical Societies is published in 1912. There we see that the American Chemical Society was the biggest association (5603 members) and the Norwegian the smallest (106 members).The SPQ was not yet part of that Association. A similar statistics is published in 1914.

The first series of the Journal ends in 1914. In 1915 there is an interruption of the publication of the Journal that restarts in 1916 in a new series of only four volumes. A third and a forth series follow with interruptions, but the analysis of the SPQ references in the Revista in these other series is not the scope of this communication.

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DO YOU KNOW MR. STINVILLE?

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When, at the beginning of sec. XX, the great Portuguese industrial tycoon Alfredo da Silva (1871-1942), founder of "CUF Group", wanted to develop in Portugal and from grass-roots a modern industrial centre for the production of phosphate fertilizers, extraction of vegetable oils and production of inorganic chemicals, together with required under structures and facilities and capable to concur with other great European industrial complexes, he faced the imperious necessity to proceed, amongst other essential options for the success of his project, to the acquisition of a reliable engineering (including know-how), looking a construction engineer (chemical) capable to take and handle the application of the available local resources and to manage (or to direct the management) of the construction of a complete and integrated industrial complex in a country still lacking of a developed industrial tradition.. This is how Mr A. L. Stinville enters in 1907 in the history of the CUF and its "Barreiro Plants" and, through these, in the history of the chemical industry in Portugal.

Besides his active participation in the design and erection of that industrial complex of European dimension and the recruitment of expatriated management and technical personnel, Mr. A. L. Stinville was assigned the role of "technical director" of it, keeping this role between 1907 and 1927, with brief visits and local inspections, albeit always keeping the exercise of his professional activities and an effective permanence in his offices in Paris.

Curiously, much little information do exist about Mr. A. L. Stinville and, at the very beginning of this investigation, not even his full name was known. The present paper explains what has been, for its Author, the task to know more about this important technician whom, remaining modest in its representation and professional life, deserves to be represented in the toponymy of the city of Barreiro.

Describing what was already achieved, this paper equally calls the attention to the adventures and misadventures of an inquiry of this type, lead at a distance, and to the obvious interest of a more deep knowledge of the industrial and technological inter relations in the European chemical industry, the second half of the 19^{th} and the beginning of the 20^{th} centuries, and of their active and sometimes unapparent agents.

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THE DEVELOPMENT OF PHYSICS AND CHEMISTRY TEACHING AT THE UNIVERSITY OF COIMBRA AND THE EMERGENCE OF SPECTROSCOPY (1860-1880)

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Since the end of 1850s the Faculty of Philosophy of the University of Coimbra started a renewal enterprise that embraced specially Physics and Chemistry. In the following decade, this institution showed its interest in the emergence of new scientific subjects, the appropriation of new teaching methodologies - specially the establishment of classes devoted to practical teaching - and the importance of research.

Recurs to scientific travels was one of the ways of promoting modernity at the University. The main objective was to be acquainted and get practice on the new subjects of physics and chemistry research at the main institutions in Europe. After them, these professors were able to introduce in their classes the new subjects and new methodologies. Another appropriation of modern currents was the choice of textbooks according to the most famous ones adopted namely in France and the acquisition of some of the newest instruments to the Physics Cabinet and to the Chemical Laboratory.

In this paper, it will be made reference to some of these aspects, namely those concerned with the introduction of spectral analysis both in physics and in chemistry disciplines of the philosophical course. The University followed closely the works of the main European scientific establishments, namely in what concerns the interest on spectroscopy. It was possible to make spectral observations at the Physics Cabinet since 1859 and in 1863 the first Bunsen spectroscope arrived together with a map of alkaline spectra. In the following year, the Chemical Laboratory also acquired a Bunsen spectroscope. Bunsen and Kirchoff made the first spectroscopes in 1859 and started chemical analysis since then. This method introduced new possibilities and new elements were discovered.

The teaching of physics and chemistry at the University of Coimbra were complementary both in curriculum and teachers. At least in Physics, the evaluation process also gives us some highlight about the interest the subject had, through extant exams and dissertations. The practical teaching of them was surely implemented here by the end of the 1860s, and spectroscopy was part of it. In Britain and United States most of the laboratories were being settled after 1860s and spectroscopy was introduced as one of the new practical activities. This subject has recently attracted attention from history of science, particularly in the employment of visual representations. Spectroscopy was also a reason to implement scientific research, and this was considered a decisive step towards more advanced science. Among the efforts developed we can enhance some period of training with Secchi, one of the most famous spectroscopists. Though spectroscopy works in Coimbra are well-known since the beginning of the 20^{th} century, it is still missing some more knowledge about the way this subject was developed since the middle of the 19^{th} century. It can be devised as a kind of finger-print of the scientific teaching renewal that was undertaken at the University in that period.

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TWO CENTURIES OF PORTUGUESE CHEMICAL NOMENCLATURE

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The first document on chemical nomenclature published in Portuguese dates from 1801. The author of the book, Vicente Coelho Seabra adapted Lavoisier's new nomenclature to the Portuguese language. The book contains also bilingual alphabetical lists, in order that it could be used as a dictionary.

Since then, other documents on Portuguese Chemical Nomenclature have been published from times to times. Many of them ignore the existence of the prior Portuguese documents on the same subject.

The reason for this can be seen as a consequence of the non existence of National research schools in the nineteenth and early twentieth centuries.

The most exhaustive list of prior references had been compiled in 1946 by Rómulo de Carvalho, also known as poet under his pseudonym António Gedeão.

A list of the existing documents will be presented, together with facsimiles of the title and sample pages. Some are extremely rare documents. Only one copy is known of the book published by Vicente Coelho Seabra in 1801.

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ALCHEMY SURVIVED? AN ALCHEMICAL MANUSCRIPT, ANASTACIOS CHRISTOMANOS AND THE STATUS OF CHEMISTRY IN LATE 19TH CENTURY GREECE

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During the last quarter of the nineteenth century Anastasios Christomanos, professor of Chemistry in Athens University, made serious attempts to make chemistry in Greece a really modern science in a level comparable to that prevailing in central Europe and especially Germany where he had studied near Bunsen. In this paper we present for the first time some documents concerning Christomanos' studies and discuss his role in the development of this science, critical for the social and financial status of a new state, as the 19th century Greece was.

At the same time a parallel "underground" movement proved that alchemical beliefs had not been vanished, at least among the less educated strata of the Greek society. Among the signs which support this argument is the circulation in the form of a manuscript of an alchemical book having the title "Hermetic philosophy or Alchemy". Here we present this manuscript and discuss how can such ideas, which have been proved false with a lot of means, means of reason and experiment, to insist to survive during the course of the centuries.

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Poster session II

CHALLENGE OF PVC AND REGULATION – MUST WE ABANDON THIS IMPORTANT USEFUL MATERIAL?

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This paper aims at describing the laws currently regulating consumption of polyvinyl chloride (PVC), one of the most widespread plastics. PVC is widely applied in important economic sectors, especially in construction, consumer goods and food packaging. In the early 1970s, however, complaints surfaced about potential links between a kind of liver cancer and the monomer, a small chemical unit, vinyl chloride, that is used for synthesizing PVC.

From this starting point my thesis will be developed according to the following questions: Do we have enough knowledge about the purity of the product that we are using? Do we know all the implications for our health and environment? Why do we go on buying PVC items, even wrapping for our foods, and toys for children (a particularly vulnerable group)? Who is regulating PVC consumption in order to protect our welfare? Who is ultimately responsible - government, private industry, voluntary movements? Are all of them working in a cooperative way to minimize the risks caused by exposure to this chemical?

We will examine the role of experts on health and safety work within the industry. How are they attempting to balance the economic interests of the industry with both industrial and social safety concerns? This study also analyzes and argues several dimensions of the PVC challenge: social, political and economic. We will try to answer a central question: is it necessary to have such strict laws for regulating PVC consumption if this chemical is already found everywhere and has such a general acceptance?

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SAFETY REGULATIONS IN CHEMISTRY LABORATORIES IN SCHOOLS AND UNIVERSITIES – PAST AND PRESENT

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In the last decades, health and safety at work are becoming major concerns of legislators of many developed countries, in all what is related to chemistry laboratories. In Europe, very strict regulations have been established, in particular for chemical industry, but also for teaching and research laboratories, not only related to the workers, but also to the general population and the environment.

The concerns about chemical safety in chemical industry arose principally after some disasters like the Minamata Bay contamination and the Bophal and Seveso accidents. Before that, safety regulations were, in most cases, very loose, and no penalties applied to the infractions.

This was, and unfortunately still is in some extent, the case of school and University laboratories where the simplest safety rules were and are often neglected. However, even so, a long way has been done along the last centuries.

In this communication we present an analysis of school manuals and text books of chemistry of different periods in terms of safety rules or general information for laboratory work, included in an explicit or implicit way. We also present some versions of the “ten commandments of the chemist” and the regulations of the chemistry laboratories of the Industrial and Commercial Institute of Lisbon (1872), of the Practical Course of Chemistry in the Laboratory of the University of Coimbra (1879) and of the Mineral Chemistry Laboratory of the Polytechnic School of Lisbon (1889). This last one is particularly interesting as it establishes, besides a plan of regulations covering the work and services of the Laboratory, a whole set of rules of conduct of students, related to safety and assessment of the work done.

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GOLDEN PAGES OF THE HISTORY OF CHEMISTRY IN PORTUGAL

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I speak no lies, but what is true and most certain
Basic principle in alchemy -the Smaragdine Table

Gold is Man’s eternal myth, the Phylosophers Stone of the Alchemist and a noble metal worthy of kings and queens. In the fifteenth century alchemy was a noble art in Portugal as the first two of the *Five Treatis*es of the Phylosophers Stone are said to be due to Alphonso, King of Portugal (Afonso V- The African, 1432-1481) “written with his own hand, and taken out of his closet, translated out of the Portuguez into English”; the others being, one by John Sawtre a Monke, another written by Florianus Raudorff, a German phylosopher and the other a treatise of the names of the philosophers stone (Sol and Sal- portuguese words among infinite names of pleasure for the Phylosophers Stone) by William Gratacolle, to which is added the Smaragdine table- “By the paines and care of H.P.4° London: printed by T. Harper, sold by J. Collins in the *Little Britain*, near the Church door, 1652”.

Scientific chemistry in Portugal has its origins in four main areas, namely alchemy, assaying of precious metals, civic regulations with regard to adulteration of food and the application of chemistry in medicine via iatrochemistry/pharmacy. Considerable expertise must have existed from the sixteenth century on metals or food analysis in view of Portugal's vast trade in gold, spices, wines and other food items.

Chemistry began to be taught in Portugal as an independent scientific discipline, after reform of the University by the Marquis of Pombal in 1772: “Real advances in chemistry come from real discoveries based on observation and assidious work, not from vain systems and idle speculations”. The Portuguese Queen Maria I asked the British physician/mineralogist William Withering during his six months stay (Dec.1792-June 1793) to analyse the hot mineral waters of Caldas da Rainha. The results and details of the experiments were published in the *Actas da Academia Real das Sciencias de Lisboa* in 1795, the text being in Portuguese and in English, on facing pages. The developments paralleled those going on at the same time in Britain and in central Europe.

On the 8th of January 1873, King Luiz I visited HMS *Challenger* on her inaugural visit to Lisbon. The first oceanographic ship was made under the orders of Queen Victoria of Great Britain, by pressure of the Royal Society, under the strong recommendations of the Portuguese scientist José Vicente Barbosa du Bocage. The *Challenger* was equipped with laboratories and on this voyage around the world, which lasted three and a half years, took on board six scientists who represent the dawn of the scientific disciplines Oceanographic Biology, Chemistry, Geology and Physics. It is most probable that Prince Carlos, 9 years old at the time, accompanied his father on the visit which may have triggered the Prince’s passion for the Sea and a wealth of scientific developments.

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FROM THE "INSTITUTO INDUSTRIAL E COMERCIAL DE LISBOA" TO THE "INSTITUTO SUPERIOR TÉCNICO" – WHAT TRANSITION? (1892 – 1922)

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The "Instituto Superior Técnico" was created the 23d May 1911 in Lisboa shortly after the first half an year since the fall of the Portuguese monarchy. In itself, it was a republican creation and the first Portuguese advanced college structurally and exclusively dedicated to the formation of engineers and to introduce in our country the branches of electro-technical and industrial-chemical engineering.

Appearing in a rupture context, this Institute also consisted of an original model, with great influence of the German advanced schools, and imposed itself as a paradigm of change, in opposition to the educative reality then recently applied to the non university institutions – such as "Academia Politécnica" and "Escola Politécnica", "Instituto Industrial e Comercial de Lisboa" and "Instituto Industrial e Comercial do Porto" - as places where «much was taught, but little was learned».

This mark of change however, was not enough to eliminate all the links with the institution that, in certain way, preceded it, that is, the "Instituto Industrial e Comercial de Lisboa", this being due to some peculiarities of that reform, such as the partial continuation of the teaching staff from the extinct Institute, and the use of the same building in the Conde Barão area, in Lisboa, to shelter the new educational establishment.

Even the founder of the "Instituto Superior Técnico", Alfredo Bensaúde, was, himself, an eminent professor of the former "Instituto Industrial e Comercial de Lisboa" that, at the beginning of the nineties of the 19th century, had already revealed his intention to proceed to deep reforms in that educative institution. However, the bad reception to his proposals did not allow to modify, at that moment, any meaningful aspect and only the deep political rupture that followed the revolution of the 5th October 1910, with the proclamation of the Portuguese Republic, seems to have effectively allowed that intended reform to proceed and, with it, the creation of the new institution.

This paper intends to analyze the creation of the "Instituto Superior Técnico" and its first years of activity, in a perspective of change, and, on the basis of a comparison with the "Instituto Comercial e Industrial de Lisboa", to identify links and affinities between the two institutions, thus establishing a possible line of continuity between them. It will also discuss the adequacy of these new engineers to the reality of the industry then operating in Portugal.

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BERNARDINO ANTÓNIO GOMES AND THE ISOLATION OF CINCHONINE IN THE EARLY 19TH CENTURY – A POLEMIC WORK

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Malaria is a disease that has affected humanity since long ago. In Europe, for centuries, there was no effec-

tive treatment for those "fevers" which cause was not known. Only in the 17th century, with the discovery of the therapeutic action of the bark of cinchona trees upon certain types of fevers (malaria) a real treatment was envisaged for this disease, although the cause remained unknown. The bark of cinchona trees was used in South America, namely in Peru, by local populations that knew, for a long time, their virtues against malaria. Those barks came to Europe and soon the cinchona trees were in the top of the list of vegetal species with scientific and economic interest. However, bad management of natural resources associated to the greed of some people, almost caused the extinction of this species.

Understanding the vulnerability of this situation, the Portuguese tried to find in Brazilian species of cinchona trees an alternative to the barks originated in Peru. From Brazil many samples of barks were sent to Portugal in order to evaluate their therapeutic properties, namely their antipyretic action. Both in Coimbra and in Lisbon, clinical and chemical tests were undertaken, often in difficult conditions. The researchers were confronted with some lack of material resources and also of scientific information caused by the political situation of the country by that time. However, reports of the time, that survived the destruction of documents in consequence of the French invasions at the beginning of the 19th century, show the commitment of the Portuguese researchers who studied the precious barks of the cinchona trees from Brazil.

During these studies Dr. Bernardino António Gomes isolated the first alkaloid of the family of quinine, the cinchonine. This isolation was carried out twelve years before the works of Caventou and Pelletier in the isolation of quinine.

The work of Bernardino Antonio Gomes was received with some scepticism by the Portuguese scientific community. The theories about the antipyretic principle of the cinchona barks varied from author to author, many of them disagreeing with Gomes, in some cases in a very rude way. In articles published in the *Jornal de Coimbra* and later on in the *Investigador Portuguez em Inglaterra*, a scientific Portuguese journal published in England in that period, this controversy is very vividly expressed. The objections of the editors of the *Jornal de Coimbra* as well as the arguments of Gomes constitute an opportunity to get a better knowledge of the work of this distinguished Portuguese scientist, considered a very important chemist in the early discoveries related to the cinchona alkaloids.

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A DATA BASE OF ANCIENT LABORATORY MATERIAL OF CHEMISTRY AND PHYSICS EXISTING IN OLD SCHOOLS AND IN THE SCIENCE MUSEUM OF THE UNIVERSITY OF LISBON

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Secondary education in Portugal has undergone a major reform in 1836 (known as Reforma Passos Manuel) with the creation of National Lyceums in the main cities of the country and introduction of scientific disciplines in the courses, in particular *Principles of Physics and Chemistry* and *Mechanics Applied to the Arts and Crafts*, that should be taught in special premises, namely chemistry laboratories. Actually in many cases the laboratories existed only in the legislation and not in reality. In 1860 the general regulation for the lyceums was officially approved and chemistry laboratories were effectively established and modestly equipped in some schools. But it was by the beginning of the 20th century that practical work in chemistry was actually implemented in many schools that were then well equipped. In 1936 practical work in sciences became compulsory in secondary schools that were further equipped with good teaching laboratory materials.

With the political changes that occurred in 1974 there was a great increase of the number of students in secondary school and laboratory classes could not work anymore in many schools. Laboratories were often transformed in ordinary classes and the equipment, that in some cases was already obsolete, was ranged in boxes, shelves, or drawers and sometimes completely forgotten. Nowadays many schools still possess interesting old equipment, sometimes in bad conditions, which often is considered as occupying a space needed for new equipment. It is important to make teachers and directive boards of schools in this situation aware of the importance of preserving that scientific patrimony.

In 2003, a project titled “For a History of the teaching of Chemistry in the 19th and 20th centuries”, financed by the Fundação para a Ciência e Tecnologia, proposed, as one of its tasks, the construction a data-base of scientific equipment for Chemistry and Physics teaching in secondary schools. Initially the project proposed to do the complete inventory of the teaching materials/ equipments existing only in one ancient school of Lisbon - Liceu Pedro Nunes – and the construction of the data base that allows the access to information and images of the materials. This pilot project was later extended to another ancient school in Madeira. Moreover, the possibility of cooperation with the Science Museum of the University of Lisbon that has an extremely rich collection of scientific equipment of the 19th and 20th centuries brought a much greater dimension to the project. Both inventories in the secondary schools are now complete but that in the Science Museum is still being carried out, because of the great number of pieces to identify and catalogue.

The data base, that is now currently in tests, allows to search by object, maker, date, name, origin, type etc, informing also about location, conservation or other important information. It also allows to access to historical texts related to the instruments and presents several other functionalities specific for the organization of exhibitions or maintenance, for example. This data base, loaded with relevant data, will be in demonstration during the conference, allowing searches and exploitation of functionalities.

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FERREIRA DA SILVA AND TOXICOLOGY IN PORTUGAL BY THE END OF THE 19TH CENTURY: THE LEGAL CASE OF URBINO DE FREITAS

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By the end of the 19th century, Portuguese society was shocked by a medico-legal process that became known as the “Urbino de Freitas Legal Case”. The circumstances related to the alleged crimes, the social status of the persons involved as well as the polemics generated by the subsequent medico-legal investigation, originated hot discussions and fed the imagination of the public during some months.

The symptoms revealed by the victims (one of them, a child who died) could be related to a typical framework of poisoning by alkaloids. The main suspect was Urbino de Freitas, the assistant medical doctor of the family and also relative of the victims. Indeed, he had motivation (economical), opportunity and scientific knowledge needed to choose the best drugs for the purpose. All this was on the basis for the charges of murder against this well known doctor and professor of Porto.

A key issue of this process was the determination of the cause of the death of the child, nephew of Dr. Urbino de Freitas. First of all it was indispensable to know if a poisoning had occurred. If so, the poison had to be identified as well as the way of its administration. A committee of experts, including Prof. Ferreira da Silva, was then nominated for that purpose. The work of these experts was often criticized by the lawyers of the defendant who even attacked their professional competence. Nevertheless, although somewhat violent, from this confrontation of ideas, a global overview of the various aspects of Portuguese toxicology, by the end of the 19th century, can be obtained. Through the statements presented during the trial it is possible to get a perception of the procedures for the toxicological analysis undertaken and of the innovations in the area. Actually the investigations related to this case contributed to develop organic analytical chemistry. In the course of his work Ferreira da Silva discovered a new reaction characteristic of cocaine, which had a great impact in the scientific community. Until then, the detection of cocaine was based on its physiological activity, as local anaesthetics. In the Ferreira da Silva reaction cocaine was identified by a characteristic odour. At that time, alkaloids were usually identified by chromatic reactions, and so this reaction was not well accepted at the beginning. However no one of the reactions by then proposed as alternatives had equivalent degree of precision and level of detection, and so the Ferreira da Silva reaction became used in many toxicological laboratories.

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PORTUGUESE CHEMISTS AND RADIOACTIVE MINERALS

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In the first part of the 20th century, in our country, Chemistry was developed mainly in the applied areas and, consequently, the existence of practical applications of radioactivity was a strong incentive for its study by Portuguese chemists. Actually, from a commercial point of view, radioactive waters and minerals were interesting subjects, that motivated a lot of Portuguese chemists who undertook applied research in that field.

The Portuguese works on radioactive waters were already studied by us. In this communication we deal with radioactive minerals that, not only had great interest for Portuguese economy, but occasionally constituted a good research theme too. The subject brought about stimulating collaborations between chemists and mineralogists, namely Marieta da Silveira, Torre de Assunção and Francisco Mendes. This collaboration begun in the forties in the Faculty of Sciences of Lisboa and was later developed in a centre of nuclear energy (*Centro de Estudos de Energia Nuclear*) founded in 1952.

Even though the study of the radioactive waters and minerals was an applied subject, it was an important vehicle of reception and transmission of scientific knowledge on radioactivity in Portugal. Moreover, the research activity in the radioactivity field had an important role in the transformation of the Portuguese

University in the 20th century.

In our communication, that deals with these diverse aspects related to the study of radioactive minerals in Portugal, we present an analysis of the most important related papers published by Portuguese scientists, mainly in national Journals, between 1913 and 1960.

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RETORTS – MYTHIC PIECES OF CHEMICAL EQUIPMENT

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When we look at chemical instruments in a Museum of Chemistry we can see the evolution of scientific instruments and scientific thought. If we look deeper, instruments can also tell us stories about the main topics that characterize different periods of chemistry evolution.

One good example is the retort, which is an amazing piece that has a remarkable past. Images of retorts can already be found in alchemic manuscripts, and its origin can be traced perhaps to Maria the Jew in the second century AC. Along time they have suffered some small changes due to the evolution of chemists' needs, but they maintained the same overall aspect.

Although nowadays almost not used in many modern laboratory and so unknown by the young generations of chemists, they have a mythic value which is apparent in their use in symbolic representations of chemistry. We can see images of retorts in logotypes of different chemical institutions, for example of the Portuguese Chemical Society.

The word retort is also associated to pieces of iron/steel equipment with very different aspect, used for example in food processing or coal distillation. But we only refer here to the classical retorts, usually in glass.

In the Science Museum of the University of Lisbon, that has an important collection of chemistry glassware of the 19th and 20th centuries we can find several types of retorts that correspond to the images found in books and catalogues of this period. Many of these retorts were used in practical work by students and researchers during many years and still remain in good conditions.

In this communication we present photographs of different kinds of retorts (in French "cornues") existing in the Science Museum, with different sizes, longer or shorter necks, with or without tubules and also of two unusual glass retorts with two opposite long necks not yet found in any catalogue. Besides the photographs we include the corresponding images of catalogues of laboratory glassmakers. We also present a selection of images and protocols of experiments using retorts retrieved from chemistry books and school manuals of different periods, paying special attention to Portuguese references.

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CHINA ROOT IN CONNECTION TO THE CURE OF THE SYPHILIS

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This Poster is about the plant named *China root* in connection to the cure of the *Morbus gallicus*/ Syphilis.

AMATO LUSITANO (JOÃO RODRIGUES DE CASTELO BRANCO), one of the Portuguese physicians of the 16th century was very enthusiastic about the value of the China root, which was brought from China by the Portuguese sailor, Vicente Gil de Tristão (Vicentius Gilius a Tristanis), in 1540.

In his medical writing, *Curationum Medicinalium Centuriae Septem*, Amato Lusitano reported to the treatment with China root to the patients, one of them a person of distinction, as we will see in Cent. II, Curatio 31 (Rome, 1551).

Also the Portuguese physician GARCIA D'ORTA in *Coloquios dos Simples*, Coloquio 47 (Goa, 1563) mentioned the treatment of syphilis with China root.

CRISTOVÃO DA COSTA (CRISTOBAL ACOSTA), based on the work of Garcia d'Orta presented a description and an image of the plant China root in *Tractado de las drogas* (Burgos, 1578).

The Germanic anatomist VESALIUS, physician of the Emperor Charles V, dealt in the properties of this root in one of his opuscules called *De Radice Cynarum (1546).*

Illustrations to the chapter on tuber and rhizome drugs from the *Bencao gang mu (1603)* in Staatsbibliothec, Berlin showed the plant China root (Smilax china L.).

More recently, KEYS in *Chinese Herbs: Their Botany, Chemistry and Pharmacodynamics* (Tokyo, 1976) wrote that the China root can be employed as alterative and diuretic in syphilis, gout, skin disorders, rheumatism and it contains the crystalline saponin smilacin ($C45\ H74\ O17$; soluble in water and hot alcohol), tannin and resin.

The plant China root seems to be an important tool to the medicine of the XVI century in Europe and in relation to the discoveries in the new world.

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HOVIONE—THE IMPORTANCE OF ANALYTICAL CHEMISTRY IN INDUSTRY

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" - Hovione - Who we are and what we do
- The importance of Analytical Chemistry in Industry - How to know what is happening inside the vessel?
How to prove compliance with the monographs?

- Evolution of Analytical Techniques - from acid/base titration to capillary electrophoresis and NIR
    - between 1950 and 2000
    - the 21st century
    - nowadays

examples and figures "

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CHEMISTRY APPLIED TO MEDICINE AND PUBLIC HEALTH—THE WORK CARRIED OUT BY CHARLES LEPIERRE (1867-1945) IN PORTUGAL

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At the turn from the nineteenth to the twentieth century, chemistry was recognised as a scientific discipline responsible for the foundation of public health. In fact, chemical and microbiological analysis made it possible to evaluate the state of drinkable water, thermal water, food items, milk, wine, medicines, several toxic products, etc. In this way, it became possible to advance in the sanitary discipline of the population.

In Portugal, in the last twenty years of the nineteenth century, scientific establishments were founded, where these analysis were carried out, following both private or official initiative. For example: the Microbiology Office of the University of Coimbra, the Municipal Chemistry Lab of Oporto and the Bacteriological Institute of Lisbon (Câmara Pestana).

Several scientists became notable in the field of chemistry analysis applied to public health, from the end of the nineteenth to the first half of the twentieth century. We will mention particularly the Frenchman Charles Lepierre (1867-1945). He had a degree in chemical engineering and came to Portugal in 1888 to work in the Polytechnic School and in the Industrial Institute of Lisbon. One year later, he went to Coimbra, where he worked in the Industrial School and, since 1891, in the Microbiology Office of the Faculty of Medicine, University of Coimbra. There he created a degree in biological chemistry and carried out some work with pioneering techniques in Portugal. He published several articles on chemistry and microbiology applied to public hygiene. He was appointed as director of the municipal gas services in Coimbra (1905). In 1911, he went back to Lisbon to teach chemistry in the Technical Superior Institute, mainly working in the fields of technological chemistry, chemical analysis and organical chemistry. He published a great amount of articles that resulted from his research work and his aid to the community. He published a noticeable amount of work within the scope of chemistry applied to medicine, water analysis, both at chemical and bacteriological level. He practically analysed all the waters in Portugal, showing a special interest in thermal waters. He held several offices and missions in Portugal and abroad. The value of his work is recognised at the national and international level. This recognition was also evident in the Portuguese press when he died in 1945.

In the current paper the authors show the important role taken by the French scientist Charles Lepierre in Portugal, in the application of chemistry to public health, at the technical and scientific, as well as institutional level. This case makes it possible to emphasize the importance of chemistry in the process of "scientification" of public hygiene and, therefore, its value in the struggle against disease and for the health of the populations.

* * *

KRAMERS-CHRISTIANSEN CONTRIBUTION TO CHEMICAL KINETICS

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The development of the Transition State Theory by H. Eyring and M. Polanyi between 1920 and 1935 shadowed other interesting approaches to chemical reaction dynamics. The mainstream of concepts originating TST begun between the end of the nineteenth and the beginning of the twentieth century with the thermodynamics systematization of chemical kinetics and with the idea of activation by H.J. Van't Hoff and S. Arrhenius. From then onwards, the problem, from the characterization of vague principles as affinities or chemical forces, became the comprehension and the theoretical description of the activation process and its dynamics. On one hand the chemical process, from the viewpoint of statistical thermodynamics, was described with more and more refinement as a reconfiguration of the atomic-molecular system in the phase space. On the other hand the activation problem showed more troublesome difficulties. The TST and the introduction of quantum mechanics in chemical kinetics may be seen as the culmination of the statistical description of the molecular reactive system. It represents the first auto consistent theory of the chemical kinetics not flawed by phenomenological data or approximations. The description of the process of activation showed a less linear development and caused fiery debates. Finally the unimolecular activation, sustained mainly by the radiation hypothesis, was overwhelmed by bimolecular activation caused by particles collision. Meanwhile, at the same time (around 1920-40), the Dutch physicist H. A. Kramers and the Danish chemist J. A. Christiansen in Copenhagen developed an alternative approach to the description of reaction dynamics. In this approach chemical reactions were seen as diffusive processes. This description derived from the tradition of studies about Brownian motion and colloid dynamics opened by A. Einstein and M. v. Smoluchowski's works and culminated in an important article by H. A. Kramers of 1940. In this work the reaction is seen as an activated process and its dynamics is studied stochastically solving specific variants of the Fokker-Planck equation of diffusion. Some year before (1936-38) Christiansen had proposed the vision of reaction as an intramolecular diffusion of atoms. Both Christiansen's intervenation and later Kramers' article remained unnoticed by chemists community until the sixties when computational resources became sufficient to fully support this approach. However the reason of this delay may not be only of methodological nature but also derive from an exaggerated success of TST.

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