

**SESSION AND PAPER
ABSTRACTS FROM THE
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CSHPS, AND HSS**



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SESSION ABSTRACTS

Alphabetical by Session Title

Please note that only contributed sessions have separate abstracts. For sessions of contributed papers, please see individual paper abstracts below.

A Century of Viruses and Cancer

In the 100 years since Peyton Rous first proposed that a tumor in chickens could be caused by what he called a ‘filterable virus,’ the study of cancer viruses has retained a constant, if controversial, place at the juncture of laboratory and clinical cancer research. In this session we trace that history. Sankaran explores parallels in the histories of cancer viruses and bacteriophages from the time of Rous’ discovery of the sarcoma virus until the 1950s when Andre Lwoff’s prophage hypothesis established the viral identity of these entities. Picking up in the 1950s when research on the viral etiology of cancer experienced a revival, Scheffler and Clarke describe their work on specific cancers associated with viruses. Scheffler discusses the progress and ambiguities of research on leukemia to show how the viral model became applicable to human cancers, while Clarke will focus on the the Epstein-Barr virus and Burkitt Lymphoma to illuminate the development of a heuristic that used herpes viruses as a model for cancer causation. Yi examines the history of the search for viral oncogenes by Robert Huebner at the National Institutes of Health to analyze the way in which a large-scale national program for cancer research emerged in the US between the 1960s and 1970s. Stark concludes the session with a history of clinical studies with Simian Virus 40 conducted on prisoners at NIH hospitals in the 1960s and the implications of this work for shaping subsequent international ethical frameworks for biomedical research with human subjects.

American Religion and Science: New Studies

This session features four new studies of the history of religion and science in the United States. The first paper examines how Americans read William Paley's *Natural Theology* in the period before the Civil War, prior to Darwin. Next, we present the religious activities and thought of Harvard geologist Kirtley Fletcher Mather, a leading American thinker about religion and science whose understanding of the place of humanity in the universe and the presence of values was deeply influenced by his former teacher, the great geologist Thomas Chrowder Chamberlin. A third paper focuses on the nuclear chemist Harold C. Urey, a self-described atheist who nevertheless believed that science relied upon the Judeo-Christian upbringing of its practitioners and who hoped that some “new prophet” would come who could combine science and religion into a new worldview for the Atomic Age. Finally, several inaccurate stories about the relationship between science and religion from American textbooks in history and science are identified and analyzed.

Beyond Transmutation: The Goals of Early Modern Alchemy

The pursuit of transmutation – the art of transforming base metals into gold and silver – has traditionally dominated the popular image of alchemy. In the historiography of alchemy, too, transmutation and theories of matter have long taken centre stage. Yet in medieval and early modern Europe, alchemists pursued a wide range of goals beyond “chrysopoeia” (gold-making). While many aimed to achieve concrete, practical outcomes, from preparing medicaments to refining metallurgical processes, alchemy also offered less tangible, but nevertheless highly desirable gains: political and economic power, access to divine knowledge, or strategies for surviving the anticipated apocalypse. This panel will investigate both the variety of medieval and early-modern alchemical activities, and the questions this multiplicity raises for historians of science, medicine and technology. Speakers will consider the goals of alchemy in relation to, respectively, medicine, religion, politics and natural philosophy, considering how alchemical pursuits were adapted to a range of settings, from princely courts to learned societies. In our concluding

discussion, we will ask how the diversity of alchemical goals can help historians situate this complex body of knowledge and practice within the wider culture of early modern Europe.

Sponsored by the Society for the History of Alchemy and Chemistry (SHAC).

Circulating Theoretical Physics: Scientific Exchanges between Europe, US, and Latin America

In recent years historians of science have increasingly shifted the focus of their investigations upon the transfer of knowledge, technical skills, and expertise. The hope is that this research might help to elucidate the cultural and material conditions of knowledge production in different local contexts. A variety of studies in history, philosophy, and sociology of science have demonstrated the bearings of local practices on the construction of scientific knowledge. However, theoretical physics has often been at the margin of the analysis on the circulation of persons, books, and procedures. Yet, although aiming at universality, theoretical knowledge is also embedded in local traditions. The papers of this session offer some snapshots of knowledge circulation in theoretical physics (broadly understood) that span part of the 19th and the 20th century. The red thread joining the talks is the transfer of problems, expertise, or people that resulted in a change of the local image of the theoretical knowledge itself. The episodes presented in the session illustrate several declinations of this process. In the first and the fourth talk, for example, it is discussed how American mathematical tradition redefined and stabilized problems that were born in the European culture. The second, the third, and the fifth paper hinge upon the embodiment of knowledge in various forms: from J. J. Thomson's famous lectures in Philadelphia, to Ives' alternative views on relativity theory, to the circulation of Brazilian Ph.D. students in the theory of nonlinear systems.

Death under the Microscope: Histories and Mechanisms of Apoptosis Research

Apoptosis or programmed cell death (PCD) has become a vibrant topic of research activity in only the last 20 to 30 years. It is essential for the normal development and maintenance of multicellular organisms and its disruption has been linked to cancer, autoimmune, and degenerative diseases. Recognized in the early 1970s as a form of cell death morphologically distinct from accidental death due to injury (necrosis), scientists have since been busy using the tools of molecular biology to uncover the multiple pathways and genetic programs that lead the cell to self-destruction. The papers in this session explore the route to the recognition of apoptosis as an important subject of inquiry, the visualization tools used that are essential to its definition, the metaphors and terminology employed to describe it as a phenomenon of significance, and the formal models and mechanism schemas constructed to explain how it works.

Defining the Instrumental: Navigation ,Longitude and Science at Sea in the 18th Century

During the 18th century, there were a number of developments which contributed to the improvement of navigation and to the conduct of science at sea and abroad. New instruments and the search for longitude at sea held promise for improving the safety and speed of ocean voyages, although many mariners continued to rely upon traditional tools and methods. Individuals and institutions also increasingly took to the sea to conduct waterborne and foreign observations and experiments, some of which involved multinational cooperation. This session considers the ways in which science, navigation and the use of technology, particularly precision instruments, were perceived and undertaken at sea in this period. The speakers are working on a project on the history of the Board of Longitude, funded by the Arts and Humanities Research Council and based at the University of Cambridge and National Maritime Museum (nmm.ac.uk/longitude). Their talks go beyond the Board itself to consider instruments, illustrations, language, lists and the role of individuals and wider public in the search for longitude and the use of technology at sea. The papers consider makers, users and commissioners of instruments; discuss the complex reality and idealized language of transporting and using scientific instruments at sea and overseas; and consider instruments as tools or objects of invention, investment, experimentation and authority. The commentator, Dr Robert D. Hicks, who has worked extensively on the history of

navigation, scientific instruments and material culture, can offer perspective on the papers and this collaborative project between a university and a museum.

Dusty Disciplines: Blackboards as Material and Culture in Science and Mathematics

Few technologies so dominate the built spaces of scholarly research and pedagogy as the blackboard. To walk into a classroom, whether populated by school children learning letters or seasoned professors sharing breakthroughs in theoretical physics, is to be reminded of the power and plurivocity of the particular blank slates upon which so much of our knowledge is forged and disseminated. And yet, with a few notable exceptions, the blackboard has not yet been systematically studied in its own right as a crucial theme and element in the history of science. This session begins to rectify this omission by placing the blackboard within the built and imagined spaces of elite mathematical and scientific pedagogy and research from the early nineteenth century through the mid-twentieth century. We explore how blackboards shape ideas and institutions alike, drawing on works from architecture to pedagogy, textbooks, and oral histories. Our studies emphasize the specifically disciplinary character of blackboards, in the many senses of "discipline" and across many contexts of use and figuration. While our examples are primarily from mathematics, we raise issues surrounding historical scientific and pedagogical practice that cut across the academic world's many and varied dusty disciplines.

Egalitarianism and Popular Science: The American Anthropology of Ashley Montagu

Ashley Montagu was one of the most visible public intellectuals of the latter half of the twentieth century, and an outspoken advocate for the ethical and political significance of the social and life sciences. Born Israel Ehrenberg on the East End of London in 1905, an origin he often denied, Montagu adopted his aristocratic name in college. He went on to study both physical and cultural anthropology in London and New York, earning his Ph.D. under Franz Boas and Ruth Benedict in 1937. He is most remembered today for his antiracism and involvement in the controversial 1950 UNESCO Statement on Race, but achieved his greatest fame among contemporaries over the decades that followed through his television appearances and dozens of popular books. After leaving academia in 1955, he pursued such public anthropology full time, publishing books on race, feminism, evolution, childhood, touch, play, and dolphins, among other topics. Throughout his work, Montagu drew ethical lessons of egalitarianism and cooperation from anthropology, biology, and other sciences, using his reputation and expertise to advocate not only for racial integration and egalitarianism, but also for the equality of the sexes (and more provocatively for female superiority) and against childhood genital mutilation. These three papers place Montagu and his work in the context of a postwar America shaped by McCarthyism and the authority of social science; by television and second-wave feminism; and by the Civil Rights Movement and its segregationist opponents.

Experimenting in the Baconian Style

Recent years have seen renewed interest in the study of early modern experimentation, a topic long overlooked by historians and philosophers of science alike. This session focuses attention on the methodological features of experiment in Francis Bacon, a nuanced subject covering different meanings and practices. On the one hand, Bacon's intellectual reflection on experiment was wide; Ian Hacking appropriately described him as the "first philosopher of experimental science" (*Representing and Intervening*, 1983). On the other, Bacon was also, to quote Graham Rees, the "indefatigable and imperfectly acknowledged practitioner of experiment and data collection" (*The Oxford Francis Bacon*, XI, 2004). Bacon's texts reveal a complex and elaborate 'phenomenology of experiment' – experiments performed, others only described and suggested for realization at a future time, and guidelines and standards for the production of experimental reports. This surprising variety of experimental practices is still an under-examined aspect of Bacon's work. In this session, we have a twofold objective. First of all, we want to call attention to the variety of Bacon's phenomenology of experimentation, considering and

analyzing specific cases. Secondly, we want to investigate the notion of a Baconian style, which permeated his experimental practices and differentiated Bacon's approach from other traditions in the seventeenth-century and beyond. Our session will delineate the specific character of Baconian experiment, going beyond the now commonplace historiographic interpretations of experimental practice as "nature constrained."

Experiments of the Experiential: Valuing Subjectivity in the Modern Earth, Medical, and Physical Sciences

Over the past twenty years, as historians of science have tracked the history of the concept of objectivity, they have also gestured at the persistent place of subjectivity. Their accounts have frequently characterized the subjective as a disruptive force needing to be purged from experimental practice. This panel proposes to shuffle subjectivity to the fore, and to elevate the epistemological value that some scientists attached to that concept. Drawing on modes of analysis already evident in the history of science, around embodiment and 'personal equations', and feminist works around the scripted constitution of experience, this panel will cut across the earth, physical, and medical sciences to examine how subjectivity became a crucial facet of some twentieth-century experimental work. Much of the focus will be on the role of writing practices in both representing and constituting subjectivity. In his paper on the earth sciences in fin-de-siècle America, Robin Vandome investigates the simultaneous function of metaphors as epistemological tools, and as elements of both subjective self-understanding and public portrayal as scientists in figures such as Simon Newcomb, Thomas Chamberlin, and John Powell. Daniela Helbig examines material flight recording practices and the corresponding attempts within the German aviation research community during the years of transition from the Weimar Republic to the Third Reich of separating the subjective from the experimental in establishing scientific knowledge about flight. Andrew Fearnley uncovers a moment within Anglo-American psychiatric research when some even imagined it would not be advantageous to do so. All three papers probe the connotation of the scientific with the objective both in the social and the epistemic realm.

Fighting Technologies: Military Confrontations with Telecommunications Systems, 1876-1918

Our session will show how practical military demands – with particular emphasis on privacy, secrecy, and control – led to significant adaptation of existing embryonic telecommunications systems. All telecommunications technologies originated externally to military bodies, but were quickly if cautiously adopted by them. We will draw out two modes of interaction with these technologies: their internal strategic use in the sphere of battle, and their external employment resulting in increased government control and interference. This rich and nuanced narrative moves beyond the standard military scholarship of strategy and technological artefacts to show how military demands shaped the future direction and commercial success of these innovative technologies. Our papers proceed chronologically from the invention of the telephone, through the development of wireless telegraphy, and on until World War One. Kay examines the British Army's interactions with the earliest telephones, revealing mixed responses. Bruton's study of the British Admiralty's use of early wireless telegraphy highlights that institution's early dissatisfaction with the new medium, and Cregan discusses the similar response to wireless systems from the US Navy. Military responses to telecommunications also indicate the importance of problematising use of new technologies; as Edgerton (2006) explores, more established technologies continue to be used alongside newer ones. This is especially true of military signalling, with heliographs and carrier pigeons being used into World War Two, and demonstrates the need to question the uptake of telecommunications technologies. We utilise this research method to develop a less deterministic and more contingent approach to understanding technological change within military telecommunications.

Genetics, Plant Breeding and Institution Building: International Perspectives from Britain, New Zealand and Italy

In the early twentieth century, a constellation of new institutes at which genetics was applied to plant breeding were established around the globe. There was some precedent for publicly funded plant breeding in the nineteenth century, in Sweden, the United States and elsewhere. However, the arrival of so many institutes at the same time is curious in itself. It would be a mistake, though, to think that the Experimental Research Stations at Cambridge, Christchurch and Rome were identical. The subtle differences between these widely distributed institutes reveal much about why they came into existence. The papers drawn together in this session explore both the broad trend (the appearance of so many plant breeding institutes), and the fine grained detail of why each institute came to be founded when and where it was, and to what scientific, political and economic effect. Accordingly, Dominic Berry offers a sophisticated analysis of the operations of the Development Commission, a key funder of agricultural genetics in Britain; Berris Charnley looks to the institutional context of genetics and plant breeding in New Zealand under Otto Frankel, while Luca Iori focuses on the development of agricultural genetics in Italy under the leadership of Nazareno Strampelli.

Historical Displays and Disciplinary Identity

This session explores the way disciplinary identities are formed and transformed through historical displays. Although the rhetorical deployment and ideological distortion of historical narratives (primarily textual) have been extensively studied, historical displays have not. Yet, large-scale trends in the historiography of science are often spectacularly illustrated by the various techniques of display; and conversely, the efficient visual organization offered within displays has the power to transform our understanding both of historical material and historiographical method. Displays draw on complex visual languages in order to tell grand stories and incorporate and disguise strongly polemical statements about the nature of history, progress and the place of science in culture.

The primary locus of display is the museum, but our use of the term is somewhat broader, including institutional displays and unrealized exhibitions in order to examine more closely the influence of displays on disciplinary identity. Three papers are presented, covering the period *c.*1913–*c.*1955, and all drawing on extensive archival research into local institutional politics. These cover: history of medicine as displayed in Henry Wellcome's Historical Medical Museum, London; Joseph Needham's historical charts that hung in the Dunn Institute of Biochemistry, Cambridge; and the controversial acquisition and display of Industrial Revolution-era artworks at the Science Museum, London.

The session will be chaired by Dr Anna Maerker (King's College London), whose research explores the material and visual culture of medicine since the eighteenth century.

“Improving” the Climate in the Early-Modern North Atlantic World

The theme of this panel is that of “improvement.” In his 2000 work on the colonial role of botanical gardens, Richard Drayton identifies a “fetish of improvement” in the early modern English colonial world. From Karen Ordahl Kupperman's study of the relationship of European settlers to the harsh climate of North America, to Alfred Crosby's environmental work, there has been a literature on intentional climate amelioration in the Atlantic world. How did natural philosophers of the early modern period support (or not) the colonial movement? Through the examination of such issues as the French and English gathering of meteorological data in early Quebec; the comparison of promotional literature for the early adventures in Ireland, Bermuda, and Virginia; and through a re-reading of the jaundiced ethnology behind the natural philosophical and historical descriptions of the Irish Plantations, we examine some moments in colonial history in which the seemingly distinct domains of science, economics, and nascent imperial ambition co-exist under the banner of “improvement,” and its various connotations.

Jewish Scientists in Interwar Vienna

Assimilated Viennese Jews played a key role in what scholars have called the Central European late-Enlightenment, a tradition that rested on combining social activism with the promise of reason and progress through natural science. Jewish thinkers played an especially important role in defining and shaping the policies of the Viennese Social Democratic Party after World War I. Despite their contributions to the culture of modern Vienna, however, the lives and work of Jewish scientists in the interwar period were challenged by the resurging racial and political antisemitism of the period. We explore how being singled out as representatives of a dangerous 'other' affected the lives and work of prominent Jewish scientists of the period. Sabine Brauckmann deals with the failed early career of neurobiologist Paul Weiss in Vienna, which was followed by renown in the US. Cheryl Logan addresses the impact of Jewishness on Julius Tandler and Paul Kammerer's failed interstitial cell hypothesis of somatic induction, stressing their quite different personal reactions. Veronika Hofer explores endocrinologist Julius Bauer's challenge to racism in genetics and his successful adjustment to a career in the US. For many scientists the antisemitism of interwar Vienna produced a troubling division between their regard for the values and ideals of German-speaking intellectual life and the culture that increasingly labeled the men and their science as pathological and/or misguided. Our comparative approach contrasts the variety of reactions and fates embodied in the lives of men of different temperaments and generations.

John Tyndall and his Correspondences

When most people think of famous Victorian scientists the names of Charles Darwin and Thomas Huxley often come to mind. However, during the middle of the nineteenth century the Irish physicist John Tyndall was one of the most important promoters and disseminators of scientific knowledge in Britain. However, because of a combination of different events – including his sudden and accidental death, and his wife Louisa Tyndall hoarding his journals and personal correspondences for several decades - his name has fallen from memory. Recently, Tyndall's scientific activities have garnered much attention. In 2006 Bernard Lightman organized a project at York University in Canada to transcribe and publish the correspondences of Tyndall. Building on these efforts, this session aims to show how large epistolary projects such as the John Tyndall Correspondence Project can shed new light of the careers of important Victorian figures. A key component of this session is to consider a methodology for using letters in historical research.

Mechanism, Life, and Embodiment in Early Modern Science

In the past decade and back into the 1990s there has been a great deal of provocative yet careful scholarship on three areas which overlap, yet never seem to explicitly take account of each other's accomplishments: work on the nature and diversity of early modern mechanism (Gabbey 2004, Meli 2006, Keller 2010, to which one can add the very useful philosophical commentary by Machamer, Darden, Craver 2000); work on the status of the body in early modern science (Wolfe and Gal, eds., 2010 and more distantly Lawrence and Shapin, eds., 1998), and lastly, work on early modern biological theories and 'life science' more generally, including medicine (see Smith, ed., 2005 for the former and Distelzweig et al., forthcoming, for the latter). Notable figures such as Descartes and Harvey have been interpreted in new ways in accordance with various insights stemming from these three historiographic trends; the question of the status of existing sciences such as medicine and the set of practices and natural historical theories that would partly come to be designated as 'biology' by the 1790s, has been a greater object of attention in studies of early modern science than in earlier generations. The work featured in this session tries to take account, obviously in differing ways according to individual participants, of problems surrounding the articulation of concepts such as 'mechanism', 'medicine', 'embodiment' and 'Life' in early modern science. Are they useful concepts? Are they anachronistic? Three papers focus on individual figures (Petrescu, Hutchins on Descartes, Proviijn on Harvey) while a fourth (Wolfe) takes a more synoptic perspective on the emergence of a form of 'teleomechanism' in the particularly 'embodied'

variant of early modern natural philosophy. It is hoped that the papers in this session will further articulate some of the methodological, conceptual, historiographic insights from the above-mentioned trends, in seeking to understand the interplay and tensions between models of mechanism, medical theory, and natural philosophy - whether or not these all contribute to a discourse of embodiment.

Meet the Author: Margaret W. Rossiter and Her 3rd Volume, *Beyond Affirmative Action: Women Scientists in America, 1972-2000*

This session will focus on the upcoming volume's analysis of women's experience in science after the 1972 legislation for affirmative action changed US women's access to scientific careers. Despite increased participation of women in science, solutions for melting the glass ceiling and the sticking floor have remained slow. Women scientists and historians from US, UK and Canada discuss how their own work relates to this new volume's findings and surprising conclusions. This session expands the exposure of historians of science in and out of Philadelphia to the recent history of women in science, thus building upon the momentum created during 2011 by the Centennial of Marie Curie's Nobel Prize.

Method and Discovery: Connections between Anatomy and Philosophy in the Early Modern Period

The process of learning about the body involved a number of interconnected philosophical issues in early modern Europe. Problems of teleology, mechanism, experiment and discovery are pervasive in the work of sixteenth and seventeenth century anatomists. Papers in this session will explore these intertwined issues, with special attention to interactions between natural philosophy and anatomy. Considering figures from the early 16th to the late 17th centuries, from pre-Vesalian to post-Cartesian contexts, this session will attempt to shed light on the changing ways that philosophical concerns informed anatomical investigations throughout the early modern period.

Models and Materiality

Philadelphia, the site of 2012's Three Societies Meeting, is home to many famous models, from the Franklin Institute's beloved Giant Heart to William Rush's strangely surreal anatomical models now in the collection of the Wistar Institute. This panel will explore the complex issues and mediations posed by scientific models and modeling, featuring scholars from a variety of disciplines including the history of science, art history, design studies, and material culture studies. Ellery Foutch will discuss the replacement of specimens with models in botany classrooms and museums, circa 1880-1920; in this period, a variety of media (including papier-mâché, plaster, wax, and glass) came to substitute for the traditional plant materials of the herbarium, with varying degrees of artifice and illusionism. Emily Candela considers 'ball and stick' molecular models and their importance not only to crystallographers but also in broader cultural phenomena of design and mass culture in 1950s Britain. Enrique Ramirez analyzes chronophotographer Étienne-Jules Marey's experiments with a mechanical insect, discussing this model's revelation of both animal flight and the materiality of air itself. Sarah Carter, in turn, will discuss the nineteenth-century pedagogical practice of "Object Lessons" as a kind of 'anti-model' that emphasized the study of real things rather than models to understand the world. Throughout these papers, questions of media, material, and scientific practice intersect with themes of edification and entertainment. Ruthann Dyer will chair this session, engaging participants with issues of mediation, scale, abstraction, pedagogy, and the relationship between models and specimens.

Ownership and Invention of Medical Technologies

In recent years issues of patenting and ownership have emerged as major themes in the history of science, technology and medicine. This panel seeks to extend such studies by examining the contested ownership of medical technologies. It will focus on the ways in which medical innovators in particular, who were often practitioners, patented their designs to protect and capitalise on their findings. It will draw on studies in other fields, such as electrical engineering, in which innovators chose to patent or not to patent

for a wide variety of reasons (Gooday & Arapostathis, forthcoming) in order to demonstrate that medical practitioners had a similarly diverse range of concerns. As this panel will demonstrate, many medical practitioners made an active decision to preserve their professional integrity by allowing free access to their innovations, whilst others broke with orthodoxy and used patenting as a way of marketing (and profiting from) their devices. The three papers in this panel explore the impact of patenting on the development of medical technologies and how these innovations were sold to both professional and lay users, concentrating on hearing aids (Gooday), ethics and professionalism (Jones) and electrotherapy (Stark). Following on from the earlier, pioneering work of Christine MacLeod (*Inventing the Industrial Revolution*, 1988) and H. I. Dutton (*Inventing the Patent System*, 1984), this panel therefore builds on the themes of ownership and contested invention within the histories of science, technology and medicine, and seeks to examine how patenting and patents have shaped the medical marketplace.

Rethinking Spencer: Science and Philosophy circa 1900

When it came to assessing Herbert Spencer's (1820-1903) legacy during the century after his death, most historians of science were content to follow the likes of Ernst Mayr, who argued we could ignore him "totally in a history of biological ideas because his positive contributions were nil." Recently, however, scholars have challenged these views by showing that Spencer's ideas were taken very seriously in late nineteenth-century science. This panel builds on that work by considering Spencer's role in trans-Atlantic debates at the intersection of natural science, social science, and philosophy in the decades around 1900. By looking to specific figures at the boundaries of those fields—John Fiske, William James, and Leonard Hobhouse—these three papers bring revisionist scholarship on Spencer together with a recent scholarly emphasis on the complex relationships between science and philosophy in this period. As a whole, the panel will explore how Spencer's wide-ranging Synthetic Philosophy shaped questions of methodology and disciplinary identity for scientists and philosophers alike. While his grand "system-building" was often a cause for concern, it was just as frequently a source of inspiration. Indeed, as this panel shows, Spencer's work played a central role in the development and differentiation of science and philosophy in modern Britain and the United States.

Science and Art in the American South, 1750-1850

As pointed in "When the Botanist Can't Draw," drawing is/was both a means of learning about plants and a vehicle to disseminate knowledge, and according to Ann Shelby Blum, the same could be said for the rest of the natural world: "Acceptance of pictures as conveying authentic information about nature lies at the heart of scientific practice." While 19th century scientists gradually abandoned illustration, privileging the written word (systematics/ taxonomy) and purchasing illustrations from support-staff, until 1850 most naturalists were still artists, and this session focuses on three such artist-naturalists. William Bartram of Philadelphia defied Quaker censure to produce scientifically accurate illustrations of Southern plants desired by English and American patrons; Henry Gosse, an itinerant Englishman whose travels took him from Newfoundland to Alabama, worked various jobs to support his passion for entomology/ zoology, publishing many books, and an illustrated field guide; and Maria Martin of Charleston, SC, had both talent and aptitude as evidenced by her work in Audubon's *Birds of America*. Rendering the natural world both beautifully and accurately each of these individuals, in their own way, exemplifies the complexity and context of natural history illustration in a period that still valued the ability to transform a specimen observed in nature into a life-like image on paper.

Science and Technology in History

This session aims at reflecting and discussing the different possibilities of interaction between science and technology focusing on the diversity of forms of transmitting knowledge about science and techniques. It is known that science and techniques have been transmitted through oral, visual and tactile means.

Focusing specifically on the means, analyzing texts, images and instruments, we are interested in the ways societies have been elaborating and executing their technical and scientific knowledge.

Science in Public Culture

This session proposes that it is worth drawing together the several stands relating to the public culture of science in the past with the penetration of the concerns of the discipline of history of science into the public sphere in the present. On the one hand, questions of the ambiguity of cultural consumption in the past may assist an appreciation of the issues related to impact of our own endeavours in the present. On the other, questions arise from our own era; of expectations of a democracy of information and communication that can help us understand the difference of past, more stratified, societies.

Science in the Public Sphere

In the past science was seen as produced in private among scientists and then “popularised” in a diluted form within the public sphere. Today, historians have become more aware that many scientific concepts and ideas about science have been created and negotiated within the public sphere itself. Cathryn Carson has recently published a study of Heisenberg, subtitled “science in the public sphere.” Her pioneering work highlights the opportunity for further study of how such scientifically creative discussions have operated as part of the larger scientific world. We are now in the position to move from Habermas’ idealized conception of the selfless debate among public intellectuals to an understanding of raucous discussion among commercially, professionally and politically interested parties. This session is intended to promote such debate. It will explore three contexts: Robert Bud will examine talk about science in the mid-19th century public sphere in Britain, looking at the negotiation of the category of applied science through discussions of technical education both at the national level and in locally politicised newspapers and meetings, through building business for books and schools, professional self-promotion and management of the experience of precipitate technical change. Joshua Nall looks at the debates over the canals of Mars and the differing positions of astronomers identifying themselves as amateurs and professionals in the late 19th century. David Hecht looks at the interpretation of Rachel Carson’s *Silent Spring* and the balance of understanding of her particular concerns about DDT and the general issues of the use of technology.

Scientific Ethos and Epistemology in the Long Nineteenth Century

This session showcases new scholarship on the culture of scientific community and scientists’ knowledge making practices in Europe between 1790-1900. Taking as its premise that many of the transformations associated with nineteenth century science - professionalization, specialization, the expansion of the scientific journal, and the rise of modern scientific internationalism – demand further investigation, this session sheds new light on the politics of international cooperation in science, the process of communal identity building in emergent specialties, the changing norms of academic science, and the self-fashioning of the nineteenth-century scientist. Collectively these papers suggest that as nationalism emerged as the dominant feature of European political culture, scientific communities reimagined not simply their own allegiances to the state and to one another, but also the very grounds of the scientific enterprise.

Seeing and Believing: The Importance of Mechanisms in Human and Medical Genetics

This panel will explore the ways in which mechanisms play an important role in shaping how scientists, physicians, and patients understand human and medical genetics. Nathaniel Comfort examines how the development of new experimental techniques brought the science of human genetics up to par with plant and animal genetics. Andrew Hogan explores the nexus of the clinic and the laboratory in his study of the integration of cytological findings of a fragile site on the X chromosome with clinical findings of inherited intellectual disability in the creation of Fragile X syndrome. Judith Friedman’s study of genetic anticipation reveals the importance that the presence (or absence) of an acceptable biological mechanism

has on the ways scientists interpret biological findings. Finally, Jessica Mozersky will examine how a population at high-risk of breast cancer understands collective history as a mechanism for causing genetic disease.

The Sense of Things: Perception as Practice in Educational Settings

In *The Child and the Curriculum* the philosopher John Dewey wrote that a child's world is one of 'persons with their personal interests, rather than a realm of facts and laws'. The papers of this session take this insight forward by asking what kinds of sensory experiences were used to instil natural knowledge in educational settings. To approach this topic, the speakers focus on the sense of things, that is, how students learned how to perceive objects and teaching tools within specific kinds of learning communities. The session is arranged chronologically. It begins in the 18th century with Matthew D. Eddy's paper on how students were taught to discipline their perceptions by mapping their senses into the tabular templates that ordered their syllabi and notebooks. Bridging the 18th and 19th centuries, the second paper, by Carin Berkowitz, turns to the sensory world of anatomical drawing and shows the intimate connection between touch, vision and dissection. Moving into the 19th century, the third paper, by Melanie Keene, explains how a medley of everyday objects was used to attune the senses to scientific knowledge in Victorian households. We end in the 20th century with Alma Steingart's paper on how students were taught to perceive mathematical ideas through the act of drawing. All the papers reveal that, while facts and laws were indeed learned by students, scientific and medical education was also a matter of learning sensory practices that would guide their perception of the natural world for years to come.

The State of the Profession (Panel Discussion)

This session will reflect on the current state of the profession and discipline of the history of science, in transatlantic perspective. One of the joys of the Three Societies meetings is the opportunity to step outside our usual national communities. We all know, from casual conversations over the coffee breaks, that the institutional location and professional status of history (and historians) of science can be very varied; and we know that its disciplinary location and relationship to other disciplines is highly dependent on context. What this session aims to do is to create a forum for us to take a reflexive look at ourselves as a community of academics. Recent research on academic disciplines, institutions and professional communities has used approaches that will be familiar to any sociologically-inclined historian of science who has investigated the membership, behavioural norms, reward schemes, career structures and reputation of past communities of scientists. Why not apply the same techniques to ourselves? Tony Becher described academics as belonging to 'tribes' and having 'territories': what sort of a tribe are historians of science, what is our territory, and what struggles do we face to maintain our authority over that territory? Each of the three speakers will give a short talk engaging with these issues from their own personal, disciplinary and national contexts. The floor will then be open for what ought to be a vigorous audience discussion.

Technical Drawing and the Political Context of Science and Technology in 19th-Century France and Britain

Beginning in the eighteenth century a new visual language emerged in the representation of machines, scientific instruments, and other objects of material culture. This language was connected to cultural, economic, political, educational, religious, philosophical developments that shaped the industrial context of machine building, the professional context of scientific conventions, and the practices of artisans and craftsmen. The visual languages of technical drawing became critical tools that enabled practitioners to produce and communicate knowledge and practices, to claim professional and social prestige, and to commercialize invention. This session presents several French and British case studies that deal with technical drawing from different angles, including the study of the material practices of drawing (instruments), the profiles of draughtsmen and their social and professional legitimating strategies, and

the educational programs that shaped the configuration of a new language of representation (linear drawing). The papers collectively elicit the fertile and sometimes tense interactions among science, technology, and art that defined the evolution of visual languages in nineteenth-century scientific, engineering, and craft practices. The aim of this session is to offer evidence of the major role played by machine drawing in the making of science and technology and to unveil the practices, knowledge, and ways of knowing embodied in nineteenth-century visual representations of machines and (in the case of linear drawing) in the execution of products by artisans and craftsmen.

Tempo and Mode in Mid-20th Century Genetics

This panel explores the history of mid-twentieth century genetics, focusing in particular on how researchers in various areas of genetics research dealt with notions of time and tempo—as both objects of research and as variables to be manipulated during experiments. Joanna Radin examines the use of the concept of “latency”—the condition of life in a state of suspended animation—in the study of endangered human populations. Helen Curry’s contribution looks at the circulation among geneticists, cytologists, and plant breeders of a method thought to “accelerate” evolutionary change. Jenny Bangham considers how different human materials were made to yield information about past human migrations and evolutionary history for use in population genetics and physical anthropology. In exploring time and tempo in genetics research, each paper emphasizes the exchange of ideas, tools and practices between geneticists and researchers in allied disciplines, such as anthropology, plant breeding, cytology, and cryobiology. Each highlights how concepts and methods travelled across broad areas of research with institutional, disciplinary, and sometimes commercial consequences. Together, the papers serve to underscore the diverse applications of new biological techniques from blood typing to chromosome alteration to cold storage, within the study of genetics and beyond—and in particular in controlling or gaining knowledge of the pace of genetic and evolutionary change.

Tool of Science, Tool of Politics: Radioactive Contamination in Historical Perspective

The nuclear disaster in Fukushima, prompting the large-scale mobilization of biomedical and environmental expertise to decipher its biological meanings, is the latest testament to the dynamic production of risk knowledge through radioactive contamination. The uncontrolled release of radionuclides into the environment renders its complex geophysical, ecological, and physiological interrelationships suddenly “legible” to the watchful eyes of scientists. To borrow Ronald Rainger’s expression, radioactive pollutants constitute “a wonderful tool” of meteorologists, oceanographers, systems ecologists, and other earth and environmental scientists. The chronic exposure of many people to low-level ionizing radiation is also carefully processed into a “useful” set of epidemiological data for medical and biological scientists. All stakeholders, in turn, seek to mobilize these components of risk knowledge toward understanding, predicting, and ultimately controlling radioactive contamination—and human survival in the atomic age. This panel, collectively analyzing the environmental dimension of nuclear arms race during the Cold War, aims to capture a dynamic feedback process between the production of risk knowledge and the course of nuclear politics.

Toward a Global/International/Transnational History of Spaceflight

This panel explores the history of spaceflight from a global/international/transnational perspective; choose the term of your choice. The first paper, Roger Launius's “Projects to Institutions: The International Geophysical Year and the Origins of America’s Biggest Kind of Science,” suggests that the IGY's international component was a product of a unique set of circumstances during by Cold War. Audra Wolfe's “Private to Public: The Apollo-Soyuz Test Project and the Changing Character of American Scientific Diplomacy” explores transnational elements in a major cooperative space activity. Linda Richards's “Starfish, International Law, and Human Rights” offers a case study in international reactions to nuclear tests in space.

Transatlantic Reactions: Translating Chemistry between Continents

The circulation of knowledge has secured an increasingly central place in the historiography of science, thanks in no small part to James Secord's plenary lecture "Knowledge in Transit" at the 2004 Three-Societies Meeting held in Halifax, Canada [Isis 95 (2004): 654-672]. This panel will focus on one particular type of knowledge circulation: the transatlantic translations (both linguistic and locational) of chemical knowledge, practice, and educational models from the early modern period to the early twentieth century. In addition to examining the nature and context of translations (timing, direction, human agents, communication media, motivation, modification, institutional, political, and demographic backgrounds, among others), the panel will address their implications for identity. In light of such translations, to what extent and in which sense can we talk about "American" or "US" chemistry vis-à-vis its European counterparts, and vice versa – particularly from the points of view of historical actors? In investigating these questions, we will continue the discussion Owen Hannaway started 36 years ago in his now classic paper "The German Model of Chemical Education in America: Ira Remsen at Johns Hopkins (1876-1913)," *Ambix* 23 (1976): 145–164.

Session sponsored by the Forum on the History of the Chemical Sciences

Was the Modern Synthesis Actually a Synthesis, and in What Sense?

It is commonly acknowledged that the Modern Synthesis came to constitute the framework of modern evolutionary biology, by combining a Darwinian approach to evolution by natural selection with Mendelian genetics, and by bringing together different disciplines involved in the study of evolution. Many current theoretical debates in biology take this Synthesis as a reference point, asking whether we should expand it, extend it, overcome it (e.g. Pigliucci and Muller 2011), or go on with it (e.g. Lynch 2007). However, detailed conceptions of the Modern Synthesis vary quite widely and are often tied to the precise agenda of who proposes an alternative viewpoint. Moreover, even its temporal, geographical and disciplinary boundaries are not univocally determined. In this symposium we ask: What does it mean to refer to the Modern Synthesis today, and - considering that, besides the well-attested coexistence of distinct methodologies, many crucial topics (role of organisms, levels of selection, optimisation, etc.) were hotly debated and remained controversial among its core founders - in what sense was it a genuine synthesis? For reasons of precision we will focus primarily on the Modern Synthesis, as it was forged in the period 1937-1950. We wish to understand better (1) whether the theoretical framework that emerged in the 1940s in US was genuinely unique, or rather one version of something emerging elsewhere too (e.g. UK); and (2) how this particular version became the standard international view after 1950. On these two issues, we need a more comprehensive and context-sensitive view.

What is the Object of the History of Chemistry?

This panel takes as its problem the very boundaries and object of the history of chemistry. It explores how changing conceptions of theory and practice are reflected within the recent historiography of chemistry, the implications of this transition for treatments of the Chemical Revolution, and attempts to bridge the gap between contemporary and historical science. John McEvoy examines the dichotomy between postpositivist theoreticism and sociological histories of chemistry and suggests one means of transcending this division through an emphasis on praxis—the union of theory and practice. Mi Gyung Kim calls attention to the evolutionary nature of chemical objects, utilizing the relationship between analytic methods and chemical theories in chemistry prior to Lavoisier to destabilize the taken-for-granted fixity of "nature" and the descriptive, representative qualities historians have assigned to theory. Jan Golinski considers how practice-centered histories reaffirm that the Chemical Revolution was not a sudden shift in theoretical paradigms, but a prolonged transition, with chemists adjusting their practices and objects of study well into the nineteenth century. Finally, Hasok Chang demonstrates how incorporating the study of premodern science into chemistry classrooms can enrich students' appreciation of modern laboratory practices. Together, these papers span the period from the Chemical Revolution to the present, using

notions of practice to interrogate the project of the history of chemistry as a subfield of the history of science.

PAPER ABSTRACTS

Alphabetical by Author

Material Culture and the General Public: Cataloguing the Smithsonian's Protractors

Amy Ackerberg-Hastings, University of Maryland

Session: Material Culture

On the surface, protractors represent a classic example of commonplace objects. Yet, these mathematical instruments for measuring angles historically were manufactured in diverse forms. Examining the varieties of protractors provides a gateway into the histories of surveying, navigation, engineering drawing, and mathematics education. The author has recently re-catalogued the 64 protractors contained in the mathematics collection of the Smithsonian's National Museum of American History as a small part of an institution-wide project that intends to make all of the Smithsonian Institution's holdings available to the public. This illustrated talk provides an overview of this set of objects and reflects on the methodological lessons learned in preparing descriptions suitable both for general audiences and for professional scholars.

Looking for Life in the Mummy's Tomb: Vitalism, Mummy Wheat and Bacteriology

Alison Adam, University of Salford

Session: Bacteriology and Public Health

'Even in the life of a bacteriologist there are romantic moments.' Thus spoke Henry Bunker assistant bacteriologist to the UK's Royal Naval Cordite Factory in 1925. He was referring to his barely concealed excitement at the arrival of six tubes of dust collected from Tutankhamun's inner tomb by Alfred Lucas, Chemist to Egyptian Antiquities Department, immediately upon the tomb's first opening. The contents of the tube were analysed by Dr Thaysen, Head of the Bacteriological Laboratory. All the tubes were sterile, save one which contained two micro-organisms. Proof that that bacteria had survived thousands of years in the tomb? No. If bacteria had survived in the tomb, the tubes would have contained millions of them. The single mould spore and the micrococcus must have been blown in upon the draft when the tomb was opened. If bacteria could not survive, Bunker concluded, it was most unlikely that any seeds found in the tomb would still be capable of germination. The 'mummy wheat' myth had been in circulation for at least a century before. Nevertheless, after a century of botanical and bacteriological advances, belief in the myth of 'mummy wheat', capable of germination still persisted after the opening of the Tutankhamun tomb. On one hand the interest in life in the tomb can be read as a continued interest in vitalism and the limits of life. On the other hand, bacteriological samples could lend scientific authority to the pragmatic matter of whether the tomb had previously been contaminated by thieves.

Science and Sanitation: Joseph Kinyoun and the Microbiological Turn in American Public Health, 1885-1900

Eva Åhrén, National Institutes of Health

Session: Bacteriology and Public Health

In 1887 the Marine Hospital Service (MHS) established a laboratory for microbiology and sanitary science: the Hygienic Laboratory (HL). After four years at Staten Island the laboratory moved to MHS headquarters in Washington, DC. This early federal initiative in biomedical science later grew into a large institute for basic research and in 1930 it was renamed the National Institute of Health. The HL's first

director Joseph Kinyoun, who had trained at Bellevue Hospital and the Carnegie Laboratory, modeled the laboratory on those of Robert Koch in Berlin and the Pasteur Institute in Paris, where he visited repeatedly. The work of hygienists on both sides of the Atlantic was harnessed in national processes of state formation, at the same time as they participated in an increasing internationalization of scientific medicine. This paper identifies Kinyoun as an actor in international networks as well as in efforts to improve American public health. Bacteriology, immunology, serology, epidemiology, and public health had not yet been separated as medical specializations, and Kinyoun's work spanned over all of them. The paper examines Kinyoun's work at the HL: developing diagnostic methods; experimenting on chemicals for disinfection; teaching bacteriological analysis; testing water and air quality; and acting as MHS's representative to professional meetings, committees, and exhibitions. It also argues that Kinyoun was a driving force behind a shift in American public health during the last decades of the 19th century: an older form of sanitary science and engineering developed into a laboratory based and microbiologically informed profession.

"In One's Way of Seeing Lies One's Way of Action": Science and Art in Alfred Stieglitz's Photographic Experimentation

Chiara Ambrosio, University College London

Session: Bacteriology and Public Health

This paper investigates the relations between scientific and artistic visualisation and representation within the context of the early history of photography. Drawing on the work of Alfred Stieglitz, pioneer of avant-garde photography and former student of the German chemist August Hofmann, I explore how the status of photographic images became a fertile ground for negotiation and controversy between scientists and artists. I examine Stieglitz's contribution to modernist photography and avant-garde art in light of his early engagement with experimental science, particularly chemistry. I begin with a discussion of Stieglitz's early years as a chemistry student in Hofmann's laboratory in Berlin in the 1880s, and claim that his scientific training shaped his experimental aesthetics. I argue that the conceptual development of his works, particularly visible in photographic experiments such as "The Steerage" (1907), was strongly informed by an approach to visual representations as experimental practices, a framework that Stieglitz borrowed and elaborated from Hofmann's teaching. I conclude my paper with some general remarks on how Stieglitz's photography challenged concepts such as scientific observation and objectivity, and suggest possible ways in which the history of photography may offer a productive ground to reconcile historical and philosophical accounts of representative practices across science and the visual arts.

Editing Joseph Black's Correspondence

Robert Anderson, University of Cambridge

Session: Correspondence, Manuscripts, and Digitalization

Rather than describing in any detail the content of the 830 items which form the recently published correspondence of Scottish chemist and physician Joseph Black (1728-1799), the paper deals with issues concerning its editing, issues which might be applicable to other projects of this nature. Several questions arise at the outset. Should a two-way correspondence be tackled, or is it better to concentrate solely on the letters of the subject? There is the question of selectivity – should every last piece of inscribed paper be included, such as jottings on envelopes? If there is to be some selection, then how are decisions to be taken in a systematic way? Should the multi-authored medical reports be included? His household accounts? What about the subject's list of domestic silverware, and his last will and testament? Correspondences of the period are inevitably fragmentary – how can an editor start to think about what is missing? By taking the broadest view of what a correspondence might comprise, it is possible to provide a much more rounded picture of the life and work of Black, even though many of his personal and more social letters are almost certainly no longer extant. The resulting edition of his correspondence will be

broadly considered, concentrating particularly on the light thrown on the relations between an academic figure of the time, and the commercial and industrial world outside the university.

A Tale of Two Problems or How the US Joined Together What Europe Had Put Asunder

Massimiliano Badino, Max Planck Institute for the History of Science

Session: Circulating Theoretical Physics: Scientific Exchanges between Europe, US, and Latin America

Vienna, 1866; Paris, 1890; Cambridge, MA 1931. These are the stations of the conceptual journey subject of this talk. In 1866 Ludwig Boltzmann realized that, to treat a gas as a mechanical system and to apply probabilistic methods, the concept of ‘periodic trajectory’ had to be generalized. He assumed that molecules do not simply fly around along closed paths like planets, but tend to visit all allowed states. The notion of an ‘ergodic trajectory’ was born. For the first time the treatment of a mechanical system was separated from the classical ideal of periodicity stemming from celestial mechanics. Boltzmann’s statistical mechanics remained connected with the issue of the existence of ergodic trajectories, what came to be called the ‘ergodic problem’. But celestial mechanics proceeded as well. In 1890 Henri Poincaré turned the periodicity into an effective mathematical tool to attack the venerable three-body problem. Interestingly, Poincaré rediscovered results tightly related to Boltzmann’s statistical mechanics, but the two disciplines remained divided by a different understanding of trajectory. It was in 1931, that George David Birkhoff reunited these two branches of mechanics under a more general mathematical perspective. Birkhoff’s achievement resulted from a combination of several characteristic traits of the American scientific culture: among others, the tradition of celestial mechanics as a field of research for mathematicians and the strong tendency of American mathematical research towards generalization. These factors provided the environment to overcome the separation between celestial and statistical mechanics.

From Mechanism Schemas to Mathematical Models: Elucidating the Quantitative-Dynamic Aspects of Molecular Mechanisms

Tudor M. Baetu, University of Maryland

Session: Death under the Microscope: Histories and Mechanisms of Apoptosis Research

In this paper I argue that continuous (e.g., kinetic) and discrete (e.g., Boolean) mathematical models of gene and protein networks are not substitutes for or alternatives to mechanistic explanations. Such models assume that molecular mechanisms produce the phenomena under investigation, and are constructed from available qualitative descriptions of mechanisms (mechanism schemas) summarizing known interactions between genes/proteins. Based on an analysis of recent studies of the regulation of apoptosis (programmed cell death), I argue that mathematical models of gene/protein networks aim to provide putative explanations of thus far poorly understood quantitative and dynamic aspects of the functioning of molecular mechanisms, as well as of the biological phenomena produced by molecular mechanisms. On this account, current mechanistic explanations are incomplete. Most notably, they may fail to explain minute quantitative/dynamic aspects of the phenomena under investigation, to specify the precise concentrations of molecular components, duration of interactions, rates of reaction required in order to produce the target phenomenon, or to specify which modifications of a mechanism will generate a desired change in the target phenomenon or which modifications will result in little or no changes in the functioning of the mechanism. Mathematical models provide tools for investigating these ‘black boxes’ in our mechanistic understanding of biological phenomena.

‘Precision’, ‘Perfection’ and the Reality of Eighteenth-Century Instruments at Sea

Alexi Baker, University of Cambridge

Session: Defining the Instrumental: Navigation, Longitude and Science at Sea in the 18th Century

During the 1700s, the quality and precision of British scientific instruments were often represented in relatively vague terms, such as their having been ‘brought to perfection’ or to an unspecified degree of precision, with little reference to the complications commonly experienced in trying to use them. The reality is that most Georgian instruments were far from precise in the modern sense of the word and were also temperamental, being particularly sensitive to their surroundings. Exposure to movement and to changing environmental conditions often shook parts out of alignment and made materials shrink or expand. This tended to be even truer for instruments that travelled overseas and for their accoutrements and storage boxes, because of challenging conditions and because of being so distant from the tools’ original makers. The technology intended for use aboard ship faced the jarring motions of the waves and sometimes dramatic changes in temperature and humidity. This greatly hindered natural philosophical readings but also the use of navigational instruments and efforts to reliably ‘find the longitude’ at sea, whether by horological or astronomical means. Researchers and observers on scientific expeditions not only faced having their equipment disordered or broken *en route* by this environment but often faced arduous conditions once they reached their destinations as well, whether while on the move or at a temporary observatory or research station. As a result of these challenges, instrument usage constantly involved the making of adjustments and repairs and other compensatory practices - a pervasive ‘make do and mend’ culture.

Cosmology and the Crystalline Humor: Color Theory in Natural Philosophy and Anatomy in Late Sixteenth-Century Padua

Tawrin Baker, Indiana University

Session: Method and Discovery: Connections between anatomy and philosophy in the Early Modern Period

When Kepler moved the seat of visual sensation from the crystalline humor (i.e., the lens) to the retina in his 1604 *Ad Vitellionem paralipomena*, he was instituting more than a new mathematical account of vision. However, the contemporary significance of Kepler's move, as well as its ultimate historical importance, is not fully understood, in part because historians and philosophers have not examined sixteenth-century color theory in sufficient detail. In this paper I examine color theory and its connection to anatomy and natural philosophy in two highly influential figures at the University of Padua: the philosopher Jacopo Zabarella and the anatomist Hieronymus Fabricius ab Aquapendente. As Charles Schmitt has pointed out, in his *De viso* Zabarella uses direct experience with anatomical demonstrations to argue against Galen on the nature of vision. Fabricius in his *De visione*, in turn, employs a significant amount of natural philosophy in order to relay the structure, action, and use of the eye to his readers. In their accounts of vision, both rely on a theory of color which is, at its core, motivated by a belief in the incorruptibility of the heavens, and this color theory implies, for them, the necessity of the crystalline humor as the seat of visual sensation.

Skulls from the Dead, Blood from the Living: Studying Human Heredity and Race in Interwar Britain

Jenny Bangham, University of Cambridge

Session: Tempo and Mode in Mid-20th Century Genetics

In May 1935, the new Professor of Eugenics at University College London, R.A. Fisher, wrote a frustrated letter to his predecessor—eminent biometrician and statistician Karl Pearson—about the collections of skeletons and skins cluttering up the college’s museum rooms. Pearson had retired from UCL two years previously after decades of measuring and analysing skulls to understand human

inheritance and race types. Fisher implored Pearson to “make arrangements ... for housing this material elsewhere as it is certain that the museum will be increasingly needed for other purposes”; he needed room for the refrigerator, centrifuge and oven of his new Galton Serological Laboratory for blood group genetics. This example of departmental manoeuvring captures some elements of a disagreement over whether dead or living material gave best access to human evolutionary and racial history. Fisher lamented the “concentration of attention on skeletal remains to the comparative neglect of measurements of living populations”, while Pearson did “not believe that measurements on living people are of much value”. My talk is about how in the 1930s different materials were made to yield information about human evolution. It is also about how Fisher’s challenge to Pearson’s approach to race history and identity history was shaped by his attempts to establish his own cohesive programme of blood group genetics. This local story also gives us access to some of the far-reaching methodological and institutional changes in the interwar study of human heredity.

Board into their Minds: Sketching the Mathematical Blackboard in Anecdotal Memory

Michael J. Barany, Princeton University

Session: Dusty Disciplines: Blackboards as Material and Culture in Science and Mathematics

For much of their history in scientific pedagogy and research, blackboards have had a peculiar kind of ubiquity. Often taken for granted by the disciplines that came, over the last two centuries, to rely on them, blackboards permeate the technical and cultural background of accounts in many genres, from biography to fiction to cultural criticism. In place of texts discussing the medium directly, the historical record concerning blackboards is dominated by memories filtered through time, place, discipline, and narrative, tucked into anecdotes of users, events, or habits associated with the medium. This paper focuses on the oral histories collected in 1984-1985 by Tucker, Aspray, and Gillespie from mathematicians active at Princeton University in the 1930s, among a range of anecdotal sources from a variety of periods and genres, in order to consider anecdotal memory as a problem and possibility in the historiography of blackboards. It explores, in particular, what kinds of blackboard work tend to survive in anecdotal memory, what those survivals mean for the historical study of blackboards as a phenomenon of disciplinary identity, and what they can tell us about the historical uses and meanings for blackboards beyond what survives in anecdotal texts.

Longitude Inscrib’d: Early Pamphlet Solutions to the Longitude Problem

Katy Barrett, University of Cambridge

Session: Defining the Instrumental: Navigation, Longitude and Science at Sea in the 18th Century

The 1714 Act which founded the Board of Longitude initiated a flood of pamphlets proposing new methods of measuring longitude accurately at sea. These are one means of looking at how people thought about the ‘problem’ of longitude in the period before the first minuted Board meeting in 1737. A wide range of these pamphlets included an image to accompany the text. Frontispiece illustrations, geometrical diagrams, maps, and particularly illustrations of instruments all play specific roles within these pamphlets, and all might be said to act as ‘instruments’ for their owners visually to think through and demonstrate their solutions. This paper considers the function of the images that accompanied many of these early schemes, using Bruno Latour’s idea of ‘inscription’ with John Bender’s idea of ‘diagram.’ It looks at how illustrations of instruments acted as a means of communicating proposed designs to potential patrons, and a means of mobilising backers to get these instruments made and tested. Equally, new map projections allowed contributors to think about lines of longitude and latitude as themselves contested, but were also the instrument for testing other solutions. Such questions form the background to the discussions between the Board of Longitude and their most famous applicant, the clockmaker John Harrison, in the 1730s-60s. Inscribed lines – of cartography, of illustration, of print, and of mechanism – tied together the instruments, texts and images which collectively articulated possible solutions.

"...A Cleanly Cut Piece of Solid Light": Remembering the Long-Forgotten Spectroscopic Study of Radium Glow by William and Margaret Huggins

Barbara Becker, University of California-Irvine

Session: Recasting 20th Century Physics

William Huggins was 79 years old in June 1903 when Pierre and Marie Curie arrived in London to share what they had learned of the mysterious new element they called radium. Then President of the Royal Society, he, with his wife Margaret, hosted the renowned French scientists at the Society's annual conversazione. Like many others who were dazzled by radium's remarkable properties during its discoverers' brief visit, the Hugginses were inspired to undertake their own investigations. Together, they had shown the spectroscope's power to reveal new knowledge of the nature and structure of celestial bodies. Now they believed they could apply it to radium's eerie natural glow and unlock the secrets of the terrestrial realm. This paper will bring to light the Hugginses' long forgotten attempts to photograph and analyze the spectrum of radium glow and their struggle to understand the perplexing results of their ingenious experiments. It will also place their pioneering work in the context of contemporaneous investigations being pursued by experimental physicists like Oliver Lodge, Robert John Strutt and Ernest Rutherford.

John Tyndall and the Public(s) Communication of Science

Geoffrey Belknap, University of Cambridge

Session: John Tyndall and his Correspondences

John Tyndall is well known for the way he interacted with public audiences, over religious, political and scientific controversies. His lectures at the Royal Institution have been described as an important instance of science being made public, and his 'Belfast Address,' at the 1874 British Association for the Advancement of Science meeting, is a key marker in the historiographic divide between science and religion in the nineteenth century. Thus, Tyndall is seen to be addressing various public audiences at different times through different venues. However, Tyndall's interaction with these publics have traditionally been separated into individualized case studies, and has overlooked the relationship between the content and the form through which Tyndall communicated information, and the venue in which it was communicated. Taking Tyndall's correspondence letters as the starting point for the way in which he constructed a notion of a 'private public audience,' I will compare his other forms of public communication of science; in particular his lectures at the RI, and a selection of his articles within the scientific periodical press. Through this analysis I will deconstruct the ways in which the content of a scientific debate was constructed around the medium through which the debate was communicated and the audience or audiences that it was communicated to.

Books of Distillation: Science, Technique and the Printing Press in Early Modern Europe

Maria Helena Beltran, Pontifical Catholic University of São Paulo

Session: Science and Technology in History

The advent of printed books in mid XVth Century Europe increased the spread of texts that were already circulating in the form of manuscripts. Besides, the mobility of printed texts and images, favoured the emergence of different formats of books, aiming at diversified audiences. Thus, university's texts, as well as books and treatises - aiming to unveil the secrets of the arts – began to appear in printed versions. In this process, practical knowledge, which was traditionally transmitted by apprenticeship within the workshops, began to be presented in printed illustrated books, that could be accessible to anyone. This paper focuses on conceptions of science and technique underlying some of that different types of books. It also intends to study some interrelationships between science and technology expressed in the structure of these texts. The analysis focuses on two books concerning the art of distillation, both published in the 16th century: *Coelum Philosophorum* (Strasbourg, 1525), written by the scholar Phillip Ulstad, and the

Liber de arte distillandi de simplicibus (Strasbourg, 1500), written by the surgeon Hyeronimus Brunschwig.

The Surgeon's Seeing Hand: Teaching Anatomy to the Senses in Britain, 1750-1830

Carin Berkowitz, Chemical Heritage Foundation

Session: The Sense of Things: Perception as Practice in Educational Settings

Sir Charles Bell, surgeon, anatomist, artist, and teacher, is often viewed as having had wide-ranging interests. His natural theological Bridgewater Treatise on the hand (1833) and his text for artists titled the *Essays on Anatomy of Expression in Painting* (1806) appear to be quite separate pursuits from those represented in his textbook *Institutes of Surgery* (1838) or those served by his large collection of anatomical specimens housed in his own private anatomy museum. All, however, played roles in a unified and central aspect of Bell's scientific life: his pedagogical program. His was a program in which the hand and eye, complementary and analogous sensory organs governed by the will and muscular action, were trained to perceive and to act through a system of displays ranging from performances of dissection to jarred organs to chalkboard illustrations. Despite his frequent reference to training the hand and surgery's demand for manual skill, Bell spoke less about teaching hands to feel and more about teaching them to see—vision being a form of sensation not residing in the particular anatomical organs that we might expect. A variety of objects and images conditions the visions of both organs, hand and eye, vision that was strengthened by crafting anatomical objects, and much as it was by looking at them. The classroom, and the training of surgeons through the accumulation of sensory experiences, formed the essence of Bell's attempts to make medicine scientific and unites his seemingly disparate non-scientific texts on pain and natural theology.

Colonial Madness: Creating Practical Spaces to be Insane in Nineteenth-Century India

Anouska Bhattacharyya, Harvard University

Session: Science and Colonialism

The 1858 Indian Lunacy Act brought the apparently abnormal behaviours of the Indian populace into relief. Having utilized hospitals, prisons and schools to contain, control and understand their subjects for so long, it was only after the 1857 Indian Mutiny that the British Raj became concerned with native minds. In parallel to asylum reforms occurring in Britain, 'native' lunatic asylums were built across much of Northern India. However, when British psychiatry had no consensus regarding the diagnosis of insanity, and the native was 'different', by default, from white Europeans, what purpose did these asylums really serve? How did building these specialized institutions in India, the 'laboratory of Empire', affect the community in practice? My paper follows the 1858 Lunacy Act to reveal a remarkable everyday politics of madness. Contrary to the ways in which asylums were stigmatizing and isolated spaces elsewhere, official reports and vernacular newspapers reveal how Indian communities appropriated the 'native' asylum, converting it from a space of ambiguous therapy to a site of trade, employment and – quite literally – asylum. Patients, doctors, families and villagers constructed a space that was economically and culturally relevant to the community. Building on the South Asian subaltern school, I show how the chai wallahs (tea sellers), dhobis (laundry men) and gurus (holy men) permeated the asylum walls, creating a 'hybridized proto-psychiatry' unique to each institution. In this way, late-C19 'native' lunatic asylums existed successfully through to the twentieth century.

Colonial Chymistry: The Case of John Allin, Minister-Physician in Woodbridge, New Jersey (1680-1683)

Donna Bilak, Bard Graduate Center

Session: Transatlantic Reactions: Translating Chemistry between Continents

This study considers the re-export and application of medico-alchemical knowledge to colonial America via John Allin (1623-1683), a Harvard-educated Puritan alchemist whose transatlantic career spanned Interregnum Rye, Sussex; Restoration London; and, ultimately, Woodbridge, New Jersey. Introduced to alchemy at Harvard College, Allin became a medical practitioner and a respected operator within London's dynamic medico-alchemical milieu during the 1660s and 70s. Upon answering the call to be minister at Woodbridge, Allin returned to America at the height of his intellectual talents, bringing with him empirically gained scientific knowledge and an extensive library, the product of long-term collecting. As minister of the gospel and town physician, Allin's participation within Woodbridge's community involved the spiritual and physical wellbeing of its members. A contemporary of such other minister-physician, Harvard alumni as Michael Wigglesworth and Gershom Bulkely, Allin's service in this regard is representative of his formal education. This paper analyzes Allin's 1683 Woodbridge administration to address questions of impact and continuity around his iatrochemical work: i.e. Allin's exercise of theory and praxis in quotidian concerns around maintaining the health of people under his immediate care, and his pursuit of chrysopoeia for the betterment of humankind. However, in what ways, if any, did Allin's knowledge system contribute to medical pathways pursued by ensuing generations of physicians in America? Or did the iatrochemical genealogy that defined John Allin's mental framework and professional activities effectively end with him and his peers?

Chymistry and Censorship at the Early French Academy and Royal Society

Victor Boantz, University of Sydney

Session: Flows of Chemical Knowledge

Scientific societies and academies emerged during the second half of the seventeenth century as new venues where nature could be studied in an organized and collaborative fashion. Yet assembling members of diverging scientific, political, and religious persuasions ended in frequent debates, at the personal as well as corporate levels. This paper provides a comparative study of such tensions in the early French Academy of Sciences and the Royal Society of London, focusing on the trajectory of a research program for the study of mineral waters. Initially commissioned by the French Crown and performed by the Academy in the late 1660s and 1670s, the work combined natural historical and matter theoretical explanatory models. Despite inner opposition (especially to matter theory and chymistry), the Academy's leading chymist, Samuel Duclos, published a censored version of his findings in *Observations on the Mineral Waters of France* (1675). In the 1680s, some of the most controversial aspects of this project resurfaced across the Channel within debates in the Royal Society on chymical analysis, metallogenesis, and the nature of magnetism. I trace the migration of Duclos's chymical and matter theoretical views, from their inception and suppression in France to their reception by Martin Lister (author of *De fontibus*, 1682) in England, to their influence on Boyle, Hooke, Plot, and other members of the Society. Reconstructing the 'intellectual geography' of the *Observations* illustrates the interplay between conflicting perceptions used in negotiating distinctions like physical/chymical, organic/mechanic, as well as the generation and dissemination of personal versus corporate knowledge.

Working on Audiences: Comparing the Current and Historical Consumption of Popular Science and History

Tim Boon, The Science Museum, UK

Session: Science in Public Culture

Within the history of science, the study of popular culture has begun to be a mainstream activity. But, where we study science as performance, science as popularised or science as represented, at some point we have to confront the question of science as consumed. We need to consider what it meant to audiences in the past to encounter science. Over approximately the same period that popular science has risen from being the concern of only a few, the question of the impact of our own discipline on the general public has also come to be a significant issue. Sometimes this has been because the history of science has bulked small in the eyes of the media. More recently it has been because of the funding requirement for academic subjects to demonstrate impact, social, cultural or economic. For those historians of science who work in public-facing institutions such as museums, the issues are familiar, but not necessarily any better theorised or researched. In this paper I aim to scrutinise some of the issues that arise in the both the historical study of audiences for science and the seeking of audiences for our own academically-generated discourse. I will propose that, on the one hand, the historical experience of our lay predecessors may have something to teach us as we seek a greater impact for our own researches; and that the reverse proposition may also hold. Uncomfortable issues about elite knowledge can be expected to arise.

Marginal Men? Non-Conformity, Medical Men and the Subscription Library Movement in Leeds in the Eighteenth Century

Rebecca Bowd, University of Leeds

Session: In the Library

Prevailing historiography on subscription libraries places their formation among marginal men such as non-conformists and medics. This view has largely centred on research undertaken in the 1970s by scholars such as Thackray and Inkster in relation to the promotion of philosophical societies in Manchester and Sheffield. The traditional explanation for the foundation of the Leeds Subscription Library in 1768 likewise places it within this context: Joseph Priestley is often cited as its founder. However my paper will show that the library was formed collectively by medics and merchants, conformists and non-conformists alike as they sought to forge a new urban culture in local society. In assessing the influence of these different interest groups in the library, I will pay particular attention to the role of medical men. Brown's recent study of provincial medicine in York, *Performing Medicine: Medical Culture and Identity in Provincial England, c.1760-1850* (2011) has highlighted the integral role of medical men in provincial culture and I will also argue this was the case in Leeds. The involvement of Leeds's medical community in the Leeds Library was representative of their wider participation in civic society in this period. I will show that this was by no means restricted to Leeds: medical men also featured prominently in civic society and in the foundation of subscription libraries in provincial towns from Birmingham to Liverpool. This leads to my conclusion that subscription libraries reflected the mixed social, religious and political interests in provincial towns in the eighteenth century.

Weiss' Resonance Inside Vienna's Academia

Sabine Brauckmann, Tallinn University

Session: Jewish Scientists in Interwar Vienna

My case study on the early career of the developmental neurobiologist Paul Weiss (1898-1989) introduces the obstacles he encountered inside the Viennese academia. In 1922 Weiss, a graduate student of Hans Przibram, finished his Ph.D. with a thesis on the motion patterns of butterfly wings; and two years later he claimed to have proven wrong Jacques Loeb. In the same year he entered the academic stage with a bang, namely the resonance theory, and the pretense to be the one who has solved the problem of nerve-muscle

reinnervation. To qualify as a university lecturer at the University of Vienna, he submitted his habilitation in 1924. After a two-year long polemic instigated by the paleontologist Othenio Abel and the comparative morphologist Jan Versluys, the Austrian Department of Education and Research rejected his habilitation for dubious reasons. The real motive for the rejection was a mixture of anti-Semitism, Weiss' fondness for intellectual duels, and the weak position of his supervisor Przibram. Although Przibram tried to appoint him *custos* to succeed Paul Kammerer in 1926, the failed habilitation spoiled Weiss' chances of a scientific career in Austria. Aside from sketching the scientific dispute on neuro-muscular connections I will focus on the controversy between Weiss, the aspiring scientist, and Versluys, a fervent adherent of the national right-wing extremism. My objective is (1) to disclose the hidden agenda of anti-Semitism rising inside Viennese academia in the 1920s, and (2) to provide a case study on how an individual scientist survived it.

Music and Technè: Distinctions between the Natural and the Artificial

Carla Bromberg, Pontifical Catholic University of São Paulo

Session: Science and Technology in History

By the sixteenth century Italy, it had increased the number of music treatises written in vernacular that had been widely read. Among the topics approached were Greek music scales, modes, instruments as compared to modern music theory and practice. Within this context it emerged discussions on tuning systems. Vincenzo Galilei and Gioseffo Zarlino had entered into this discussion. Galilei had calculated an approximated ratio for the equal semitone and had applied it to his lute, which was a tempered lute, in the modern sense of the world.

Although historiography had dealt with the relations between Zarlino and Galilei, respectively master and disciple- by the light of new manuscripts- it is shown that such discussions were not primarily based on mathematical concepts, that is, on the need of determining Music as either as an arithmetic science or as a geometric one. Their discussion had begun on the distinctions between the natural and artificial and had developed into a changed notion of the musical object. It is our purpose to present this new material, showing how relevant was for Galilei to describe the musical artifact, as a physical entity, subject to the laws of nature as an intrinsic element within the distinction between the natural and artificial.

“All He Does Is Play Himself”: Ashley Montagu on the Television Talk Show Circuit

Jennifer Brown, University of Pennsylvania

Session: Egalitarianism and Popular Science: The American Anthropology of Ashley Montagu

Trained in anthropology by Boas and Malinowski, the colorful independent scholar Montagu Frances Ashley Montagu (born Israel Ehrenberg) spent his fifties, sixties, and seventies appearing on late night television shows, writing for popular magazines, and publishing lively books that attracted a huge audience. He was arguably the most famous anthropologist in the mid-twentieth century in the United States, possibly surpassing even Margaret Mead for a period of time. In this paper, I consider his appearances on popular TV talk shows, after his book on *The Natural Superiority of Women* was published and beyond, focusing in particular on his multiple appearances on *The Tonight Show*, which are archived at the Paley Center for Media. I examine how and why Montagu came to be a frequent guest on the TV show and how his appearances reflected upon the discipline of anthropology and Montagu's scientific authority. These talk shows, and Montagu's life story, illuminate science and popular culture at the height of the Cold War.

Health as Natural History at the American Museum of Natural History, 1909-1922: The Failure of an Innovative Initiative

Julie Brown, National Museum of American History

Session: Bacteriology and Public Health

With the tremendous advances in the new applied biological and health sciences in the early twentieth century in the implementation of modern urban sanitation practices, food safety regulations, and bacteriological researches, the American Museum of Natural History took a lead in attempting to bridge this gap between professional scientific knowledge and that of the general public by establishing a new curatorial Department of Public Health. This paper addresses the two ways that this initiative was implemented by Curator Charles-Edward Winslow, a protégée of William T. Sedgwick's influential MIT program of applied biology. An innovative "Living Museum" of bacterial cultures was established for the stabilization of bacteriological classification and the circulation of these materials to research laboratories across the country. An ambitious plan was undertaken for a series of fifteen museum displays entitled the "Exhibit of the Natural History of Man" with sections dealing with the human body (with the Department of Physiology), heredity and disease (with Department of Invertebrate Zoology), hygiene and diet, microbes and disease, water supply and waste disposal, insects and disease. Despite these efforts over a ten-year period, the new Department came to an abrupt and "inglorious end" in 1922. This paper seeks to examine the reasons for this failure in the department's loss of independent financing from trustees, the lack of cooperative inter-departmental support, the declining commitment to the new sciences, and the inevitable effect of stronger institutional forces and privileged official agendas.

"Britannia Rules the Wireless Waves": The British Admiralty and Wireless, 1899-1914

Elizabeth Bruton, University of Leeds

Session: Fighting Technologies: Military Confrontations with Telecommunications Systems, 1876-1918

In July 1899 three Royal Navy ships tested Marconi wireless sets during naval manoeuvres and later that year Marconi wireless sets originally intended for the British Army were instead used by the Royal Navy during the Boer War. In 1901 the Admiralty signed a contract with the Marconi Company, one of the newly-established company's earliest and most important contracts. Henceforth the Admiralty continued to invest in wireless, both with land-based stations and on-board wireless sets. This process of installation and adoption would continue up to and through World War One. On the surface, the Admiralty's adoption of wireless telegraphy fits into the standard historiography of commercial development and early success of the Marconi Company. However, I will utilise previously unexplored primary source material to demonstrate a simmering and ongoing tension between commercial interests (represented by the Marconi Company) and state interests (represented by the Admiralty). Parallel to the Admiralty's public dealings with the Marconi Company, it arranged a series of secret interdepartmental conferences to discuss the validity of the company's patents and to argue for stringent domestic wireless controls in order to address concerns about privacy, secrecy, and interference. Increased regulation took the form of national legislation, the 1904 Wireless Telegraphy Act, and international agreements, the 1906 Radiotelegraphic Congress in Berlin. It would be this regulation, in parallel with related military demands, rather than commercial concerns that would control and shape the early development of wireless and lay the foundation for its later successes in World War One and beyond.

"Applied Science," Self-Interest and the "Public Sphere" in Mid-19th Century Britain

Robert Bud, The Science Museum, UK

Session: Science in the Public Sphere

The concept of applied science in mid-19th century Britain was negotiated through a process of public debate about science fuelled by private interest and expressed through stories about science in the past and elsewhere, particularly France and Germany. Participants negotiated allegorical tales of past

successes but also current failures and tales of foreign innovations in disputing the appropriate funding of technical education and the interpretation both of British commercial dominance when times were good and the loss of trade when times were bad. This paper will explore the use of such stories and the way in which they were hybridised with each other. Based on a study of a thousand newspaper and periodical articles about applied science in the third quarter of the nineteenth century, this paper explores the parallels between such stories and folklore. It will replace a focus on the leadership of men such as Lyon Playfair and a very few others at the Parliamentary level, by a broader view of the public sphere as a whole in which the category of applied science was constructed through press accounts of such national discussions blended with the reports of local meetings and institution building, through the promotion of business for books and schools, professional self-promotion and management of the experience of precipitate technical change.

Integration Rather Than Synthesis? On Rethinking the Unity of Evolutionary Biology

Richard Burian, Virginia Tech

Session: Was the Modern Synthesis Actually a Synthesis, and in What Sense?

Recent studies of the impact of molecularization on various biological disciplines suggest a revisionary account of what the Modern Synthesis accomplished and of the sort of integration that is feasible in the field of evolutionary biology. The recognition of ever more complex nesting of regulatory controls, interrelated and iterated in various ways, yet built from components that are amazingly stable across evolutionary time, has radically altered our view of what organisms are and how they evolve. This recognition, together with the recognition that the information extracted from DNA depends on the organization and historicity of the cells in which it is embedded affects what they and their ‘daughters’ can ‘read out’ of the DNA, challenge earlier views about the relations between biological disciplines and the sorts of theories that we can plausibly expect in evolutionary biology. I argue that this is the basis for a reassessment of what was and was not accomplished in the Modern Synthesis. Additionally, the entirely different modes of evolution that genomics and metagenomics have revealed in the microbial and sub-microbial worlds, never dreamt of in the synthesis, further demonstrates the need to use what we can now recognize that the Modern synthesis did *not* accomplish as a part of reevaluating exactly what it *did* accomplish. Attention to the conceptions of *theory* and of *disciplinary boundaries* will heighten the value of contrasting contemporary perspectives with agents’ perspectives.

The Invention and Contentious Social Setting of Linear Drawing in France, 1815-1828

Andrew J. Butrica, Research Historians Group

Session: Technical Drawing and the Political Context of Science and Technology in 19th-Century France and Britain

Technical drawing has become attached to the history of technology through its associations with industrial mechanization and invention. This paper looks at a specific type of technical drawing known as linear or line drawing (dessin linéaire) developed in France in 1818. While mechanical drawing served the needs of engineers, mécaniciens, and constructeurs, linear drawing was for artisans and craftsmen. The paper relates the institutional origins of the technique in the Société élémentaire and the Minister of the Interior, duc Élie Decazes, who instigated and underwrote the invention of linear drawing specifically so that French monitor schools established along the lines of the English Bell and Lancaster schools could teach drawing to the children of working class families. Students learned by imitation without the use of instruments or knowledge of geometry. Also discussed is the opposition to these schools by clerical and Ultra right wing factions who saw linear drawing and the monitor schools as representing revolutionary, republican, anti-clerical, and anti-monarchical social and political elements. They soon came to power and, by 1828, had decimated the number of these schools and drawing courses while multiplying schools run by the Brothers of the Christian Schools. The paper also notes the standardization of technical

drawing around the esthetic norms of the Academy and the implications of this link between technical and fine-art drawing for French industry.

A Science Out of Place: Early Modern Colonialism and the Making of Garcia de Orta's *Colóquios*

Hugh Glenn Cagle, University of Utah

Session: Science and Colonialism

No physician from Portugal's empire is better known than Garcia de Orta. His *Colóquios dos simples e drogas . . . da Índia* was printed in Goa in 1563 and then famously translated into Latin by the Flemish naturalist Carolus Clusius in time for the Frankfurt book fair of 1567. Less well known are the changes that Clusius made in the act of translation—the editing of content, the addition of woodcuts, the reordering of chapters—the list goes on. Through circulation, Orta's work was transformed. Clusius and Orta were engaged in projects that were similar but not the same. We know a great deal about Clusius and the influences that shaped his editorial vision. In this paper, I attempt to reconstruct those of Garcia de Orta. What drove his authorial decisions? I interpret these in light of the network of apothecaries, merchants, slaves, and statesmen who constituted his discursive community in Goa. At stake is a single, basic question: What might Orta have intended his book to do? Instead of probing his work—as is so often done—for traces of an emerging “modern” empirical sensibility linked to epistemological changes taking shape particular regions within metropolitan Europe, I am interested in how the colonial context of early 16th century South Asia gave rise to a particular set of tools for knowing the natural world, a particular set of techniques for defining and describing its contents, and particular set of representational conventions for circulating that knowledge in print.

Prospecting Algeria: Oil Geophysics and Diplomacy

Roberto Cantoni, University of Manchester

Session: Science, States, and Space

Between 1954 and 1962, Algeria was the scenario of an independence war against France. Formally, only these two countries were involved: factually, however, the situation was more complex than that. By the mid-Fifties, the French had found oil and gas in Algeria, so that prospecting the country for hydrocarbons became an attractive objective for the international oil companies. This was the case of oil moloch Esso, but also of the Italian public company Eni: these agencies manoeuvred in order to diminish the French influence in the country, by covertly helping the Algerian liberation front through funding, diplomatic stances and by providing the Algerians with geophysical and geological data on the oil potentialities of their country. The importance of technical information concerning oil and gas fields in the Algerian war has rarely been considered. This was instead essential, especially during the Franco-Algerian peace talks in 1962, as Algerian oil managers could count on under the counter data provided by Eni, allowing them to scientifically substantiate their claims to property rights over particular regions, and thus catch off guard French oilmen. On the American side, John F. Kennedy, personally involved in the American oil industry, embraced the anti-colonial cause during the war, thus indirectly supporting Esso's expansion strategy in North Africa. The end of the war and the Algerian independence would allow the penetration and development of American oil interests in the country, whose hydrocarbon reserves would cease to be a French monopoly and soon internationalise.

The British State and Storm Surges, 1919-1959

Anna Carlsson-Hyslop, Cardiff University

Session: Scientists and the British State

Extra-tropical storm surges have long been a major cause of ‘natural disasters’ in Northern Europe. In early 1953 over 300 people died in Britain and about 1,800 in the Netherlands in such an event. In Britain today, surges are forecast using computer models produced at the National Oceanography Centre (NOC)

in Liverpool. This warning system was one of the main government responses to the 1953 flood disaster and today the state is a strong patron of both day-to-day forecasting of storm surges and research into them. However, how have such disasters been made into the concerns of British scientists and the British state? When the NOC's predecessor, the Liverpool Tidal Institute (TI), was established in 1919, its work was funded primarily by the local shipping industry. Their work on forecasting surges was done to improve the accuracy of the periodic tidal predictions these patrons used. Only after a flood event in 1928, when 14 died in central London, did TI's surge work become about preventing flooding and was funded by local government actors. In the interwar period central government repeatedly refused to fund work into storm surges, seeing it as a local concern. Only after the 1953 event did central government become the main patron of storm surges forecasting research, but this was as much a cost saving effort as anything else. When studying the scientists at TI I also focused on their use of computational technology and mathematical practice, studying statistical research in the making as everyday work.

The Scientific Debate over Water Fluoridation: Optimism, Risk and Public Health

Catherine Carstairs, University of Guelph

Session: Science and the State in the Cold War

In the late 1930s dental researchers discovered that 1ppm of naturally occurring fluoride in water supplies could significantly reduce dental decay. No one knew if artificially fluoridated water would have the same effect, or if fluoridated water might have other deleterious effects on overall health. After a few preliminary studies, several cities began fluoridating their water in 1945 as part of controlled experiments to test the effectiveness of artificially fluoridated water. These experiments were supposed to continue for 10-15 years. But enthusiasm for fluoride meant that over the next few years, dozens of communities across the United States fluoridated their water supply. In 1950, the US Public Health Service and the American Dental Association endorsed fluoridation. The American Medical Association followed suit the following year. This paper will examine why fluoridation was adopted so fast. First and most importantly, I will show that evidence of the safety and effectiveness of water fluoridation mounted quickly, although there were still some significant gaps in knowledge. Secondly, dentists were eager to have a "magic bullet" that would enhance their professional prestige and they promoted it heavily. Finally, the enormous optimism and sense of possibility that informed postwar American science and public health made the scientists and doctors working on fluoridation (including biochemists, toxicologists and epidemiologists) quick to reject the possibility of potential side effects. By the early 1950s, "respectable" dentists, doctors, and biochemists agreed that water fluoridation would save children's teeth without harming anyone else and condemned the opponents of fluoride as cranks.

Model Lessons: Object Lessons, Specimens, and Models in the Nineteenth Century U.S. Classroom

Sarah Anne Carter, Harvard University

Session: Models and Materiality

Starting in the 1860s, teachers from across the United States attempted to replace rote learning with a new kind of pedagogy: Object Lessons. Object lessons assumed that material things had the potential to convey information to well-trained students. Teachers led their students to observe, understand, organize, discuss and later write about the "qualities" of quotidian objects, whether empirically observable—examining rubber and whalebone to understand the concept of elastic—or culturally defined—like concepts of foreign vs. domestic origin. These qualities could not be effectively conveyed through a model, a representation of the object of study that served to mediate a student's encounter with an object's qualities. In this way, the object lesson became a sort of "anti-model," a method that demanded students have access to the real thing. This paper examines two nineteenth-century classroom teaching aids, *Oliver & Boyd's Object-Lesson Cards* and *Bancroft Brothers Object-Lesson Cards*, that sought to make real things widely available in a miniaturized form, but not necessarily as models. A range of actual objects and substances were affixed to large (roughly 20 by 13 inches) cards: a boll of cotton became a square of

calico; a hunk of bark, tanned leather; a tube of sand, glass beads. The cards' arrangement necessarily emphasized certain qualities and stories. Did these things actually convey information about the material world or simply stand in for predetermined knowledge? With relevance beyond the classroom, this paper interrogates and compares the epistemological possibilities of object lessons, models, and specimens.

History of Chemistry: Benefits for Chemical Philosophy, Science, and Education

Hasok Chang, University of Cambridge

Session: What is the Object of the History of Chemistry?

What is the use of the history of science? That clearly depends on its audience. If historians only talked to each other, a great deal of potential would be lost. I consider the benefits we can deliver to three important "outside" audiences for the history of chemistry: philosophers, chemists, and students. Considering those benefits will also inform our own historiographical purposes and practices. I focus on what one can gain from learning the *content* of past science, without denying the benefits of socio-cultural history. For philosophers, history is an excellent critical tool: assimilating the apparently strange beliefs of respectable past scientists reveals clearly what is not universal or immutable in modern science, often more effectively than armchair criticism can. For chemists, history makes a recovery of scientific knowledge: the record of past chemistry will reveal valuable facts and ideas that have become forgotten or neglected; I will illustrate this claim with some concrete examples. For students learning chemistry, benefits of history go well beyond "human interest" and such peripheral roles: critique and recovery will transform the learning experience into a genuine process of independent discovery not dictated by the expectations of current chemistry. All of these points are pertinent to the history of any science. However, pre-modern chemistry is a particularly suitable area for reaping these benefits, as it treats many easily produced phenomena that also engage all of the senses vividly; these are the same reasons for which chemistry became the most exciting public science in the 19th century.

How Public? Medical History and Open Access

Simon Chaplin

Session: Science in Public Culture

Over the past ten years holders of research collections have embraced digitisation as a means of getting relatively inaccessible and little-used material out into the world. While commercially-funded digitisation projects have often been built for well-defined and long-established 'target audiences', publicly- or charitable foundation-funded digitisation has often been accompanied by more nebulous ambitions to 'engage' with lay audiences. Crowd-sourcing and co-curation models have been applied in an attempt to turn 'engagement' with digital content into a more democratic process: forms of 'public history' that involve a deliberate (if sometimes disingenuous) blurring of the boundaries of history as an academic discipline. Not unconnected with the drive to digitise existing collections has been a shift towards open access publishing, particularly in the biomedical sciences. This paper explores these issues in relation to the Wellcome Library's digitisation programme, and highlights some specific issues arising from history of medicine's essentially trans-disciplinary character, straddling medical science and the humanities. It argues that if the potential of digitisation to engender meaningful forms of 'public history' is to be realised, greater emphasis must be placed on making the range of outputs arising from scholarly research available to audiences outside the academy.

Alchemists in the United Kingdom in the 16th-18th Centuries: Social Networks and Transmission of Knowledge

Hsiao-Yun Cheng, National Tsing-Hua University

Session: Flows of Chemical Knowledge

My paper is focused on the transmission of alchemical knowledge and, more broadly, on the flows of alchemical information in the United Kingdom in 16th - 18th centuries. I will discuss three different approaches that may be used to reconstruct the connections between the alchemists. The first approach consists of a prosopographical study of direct links between them, especially the relationships between “masters” and “disciples” as well as connections between peers. This approach was used, for example, by Nicholas Mullins (1972) in his study of phage research in 1945-1953 and by Wu Yiyi (1994) in his study of traditional doctors in China in the 12-16th centuries. The second approach consists of reconstructing an “extended networks” including the alchemists as well as those non-alchemists who might have had strong professional or personal links with them, for example, book-publishers and book-collectors. The third approach is an attempt to identify groups of alchemists using in their texts similar technical terms and referring to same concepts. In my paper, I will discuss the results of application of these three approaches to a number of published alchemical works and biographies of alchemists, such as the Diary of John Dee and The Catalogue of His Library of Manuscripts (1842), Lives of Alchemistical Philosophers (1888), The Philosophical epitaph of W.C. Esquire (1675), among others.

The Epstein-Barr virus, Burkitt's lymphoma, and the development of the herpes heuristic

Brendan Clarke, University College London

Session: A Century of Viruses and Cancer

Burkitt lymphoma, a malignant tumour caused by Epstein-Barr virus (EBV) infection, was first described in East Africa in the late 1950s, and has gradually become an important model system for understanding human cancers. Drawing on three historical episodes, this paper illuminates the way in which particular methods contributed to the consensus that developed around specific models of causation. First, a range of mapping practices used to understand the distribution of the disease, revealed that the tumour was tightly geographically restricted. Consequently, a number of roughly equally plausible causal factors for the tumour were suggested. The multiplicity of causes presented by this mapping, however, presented a difficulty for the burgeoning Burkitt lymphoma research programme. I argue that the techniques and methods used to resolve this difficulty played a key role in bringing about the consensus that EBV caused Burkitt lymphoma. As EBV is a herpes virus, and many other tumours discovered in this period were also caused by herpes viruses, I conclude this paper with some remarks about the development of the 'herpes heuristic', by which herpes viruses became considered the most likely culprits for causing tumours.

Race Relationships: Professional and Personal Histories of the Race Concept

Peter Sachs Collopy, University of Pennsylvania

Session: Egalitarianism and Popular Science: The American Anthropology of Ashley Montagu

The early 1960s were a pivotal period in the history of scientific racism. The segregationist Carleton Putnam published his influential *Race and Reason* in 1961, prompting resolutions against racism from the American Anthropological Association and the American Association of Physical Anthropologists. The next year Carleton Coon, who was president of the AAPA as well as Putnam's cousin and secret advisor on *Race and Reason*, published *The Origin of Races*, which provided support for Putnam's claims. The geneticist Theodosius Dobzhansky became Coon's most vociferous critic, debating not only the nature of race but the responsibility of scientists for the political repercussions of their work. The backdrop for this debate had been set by the anthropologist Ashley Montagu, a vocal antiracist who began collaborating with Dobzhansky in the 1940s and brought his own attack against Coon in 1963. My story here

encompasses both the intellectual history of the race concepts Coon, Dobzhansky, and Montagu espoused, and the history of their relationships with each other. In the long 1960s, the Civil Rights Movement and debates about integration made the work of anthropologists and geneticists relevant to public policy, and increased relevance added fuel to already fiery scientific debates about the nature of race. Although their relationships had been amicable in the decades before, tension between Coon, Dobzhansky, and Montagu increased as their ideas about race were mobilized in the debate about integration.

Genetics without Sex: Going Molecular in Human Genetics

Nathaniel Comfort, Johns Hopkins University

Session: Seeing and Believing: The Importance of Mechanisms in Human and Medical Genetics

The principal obstacle to human genetics, both basic and applied, has been the ethical taboo against controlled mating. Unable to carry out genetic crosses in humans, early human geneticists sought “natural experiments” where crosses were done for them and invented statistical devices to estimate gene frequencies other geneticists could simply measure. Eugenicists, bent on modifying those frequencies, resorted to controlling the bodies that carried the genes, through manipulating marriage, fertility, and immigration. Beginning in the 1950s, biochemical genetics and cell culture enabled researchers to study human genetics without sex. Techniques such as Oliver Smithies’ starch gel electrophoresis and Charles E. Dent’s paper chromatography enabled human geneticists to study traits of cells rather than bodies. Cell lines, such as that unwittingly contributed by Henrietta Lacks via her physician George Gey, provided a synecdoche of sex; the cell stood for the body, enabling researchers to study genetic recombination in the absence of procreation. With the advent of recombinant DNA in the 1970s, genes could be studied and manipulated independently of bodies and even species. Bacteria, for example, could be induced to transcribe human genes in a dish. Human genetics, which had long lagged behind the genetics of animals and plants, was now on par. These methods revised the dreams of those who would ameliorate mankind through heredity. Molecular genetics obviated the need for crude marriage and sterilization laws, making Charles Davenport’s eugenics obsolete. Contemporary genetic medicine is based on subtler—and far more powerful—mechanisms for controlling our own evolution.

“Myrmidons, Disciples and Parasites”: Spencer, Spencerians, and American Psychology

Henry Cowles, Princeton University

Session: Rethinking Spencer: Science and Philosophy circa 1900

This paper takes up Herbert Spencer’s impact on American psychology in the last quarter of the nineteenth century. While the circulation of his *Principles of Psychology* and his general prominence after the Civil War have been acknowledged, the exact contours of Spencer’s impact on American psychology have been understudied. Attention to William James’s hostility toward Spencer and his followers (he once dubbed them “myrmidons, disciples, and parasites”) brings the issue of “systems” into focus. I argue that it is James’s opposition to philosophical “systems,” more than objections to any particular Spencerian view, that explains his well-known vitriol. To understand this antipathy, I argue, we must come to terms with James’s particular conception of the nature and methods of science itself—a conception that framed his own psychological and philosophical work. For James, science meant both stability—the surest path to clarity of terms and commitments—and instability, and it was the latter sense that turned him against the systematic efforts of Spencer and even of his friend Charles Sanders Peirce. By bringing Spencer’s (negative) impact and James’s methodological vision into the same frame, we can begin to examine both the affinities and disjunctions between their ideas as well as the wider intellectual context in which they took shape.

Ranyard West's Research on the Effect of Curare in the Central Nervous System Diseases

Daniele Cozzoli, Pompeu Fabra University

Session: Novelty in Medicine

By the end of the 1920s, Robert George Ranyard West (1900 - 1986) began a research program on the use of curare in tetanus therapy. Despite initial encouraging results, in the second half of the 1930s West, having failed in getting the support of the Medical Research Council and of the Colonial Authorities of British Guyana, gave up his research. In the 1960s, he tried to resume his investigation. Again failure in getting support from pharmaceutical companies and from scientific institutions led him to give up his project. In this paper, I will argue that West's project failure is rooted in his failure in dealing with the complex organization of the integrated research and production pharmaceutical system and in his underestimation of the role of the pharmacologist in coordinating the work of clinicians and chemists. Indeed, West was a clinician and thought that he could carry out his research without the help of a pharmacologist. In the 1940s and in the 1950s, Daniel Bovet was able to realize a research program with these 4 elements. In 1957, he would be awarded the Nobel Prize for his findings on antihistamines and on curare-like substances, such as succinylcholine. However, Bovet's success determined in some sense West's failure in the 1960s in resuming his project. As succinylcholine does not possess that effect of selective relaxation of the muscles, the "lissive" effect that West deemed very promising in the study of the CNS.

Monopoly Games: The US Navy and domestic wireless during World War One

Elizabeth Cregan, Monmouth University

Session: Fighting Technologies: Military Confrontations with Telecommunications Systems, 1876-1918

World War One represents a major shift in both the commercial and military use of radio in the USA. Prior to the conflict, the military was reluctant to adopt radio communications with concerns centered about commercial development, patent claims, and privacy. Much of the pre-war wireless developments in the USA came from overseas companies and were dominated by Britain's Marconi Company. Unlike in Britain, the US made no attempt to establish a domestic wireless system or industry. This may have been hampered by the American patent system which delayed technological developments by restricting access to the various components. In 1914 and three years prior to US entry to the conflict, President Wilson issued Executive Order 2042 which enacted the governmental control over all radio systems on American soil for national security, including high-powered transmitters built by German wireless companies. When the US joined the conflict in 1917, almost all amateur wireless stations were shut down and wireless came under a de facto domestic monopoly. Furthermore a patent pool was created so that the best wireless apparatus could be manufactured without fear of patent litigation. These efforts allowed the US military to fully embrace and financially support radio communication. The United States Navy, in conjunction with the Army Signal Corp, worked to advance radio technology as well as standardization. After the war, advancements in wireless systems developed for and by the military would enter the commercial sphere and would evolve from a point-to-point communication system into broadcast radio.

Cultures of Discovery and Priorities of Publication in 1840s France and Britain

Alex Csiszar, Harvard University

Session: Scientific Ethos and Epistemology in the Long Nineteenth Century

During and after the Napoleonic wars, European savants struggled to revamp their institutions and forms of life in the context of rapidly evolving political cultures and legal frameworks. The procedures, functions, and genres associated with scientific publishing constituted a particularly central site for these attempts at reinvention. In Britain and France, the scientific journal – a more or less new kind of publication with roots in the late eighteenth century – took on central roles in registering knowledge

claims, in adjudicating priority, and in the formation of savants' identities. This paper will focus on controversies over the role of print in priority disputes during 1840s. First, the problem of how best to mark discovery claims arose in France in a controversy between François Arago and Guglielmo Libri; this began as a disagreement over how to write the history of science, but expanded into a broad controversy over the status of the meetings of the Académie des Sciences after its public character had become associated with an official journal (the *Comptes rendus hebdomadaires*). These norms and procedures then became a matter of dispute between French and British savants over the discovery of the planet Neptune in 1846. At stake was the nature and bounds of the appropriate public for discovery claims, the relationship between discovery and other forms of intellectual property (these controversies took place alongside movements in both Britain and France to reform patent law), and the politics of national and international cooperation in the sciences.

The “Evolution Accelerator”: Colchicine in Cytogenetics and Plant Breeding, 1937-1950

Helen Anne Curry, Yale University

Session: Tempo and Mode in Mid-20th Century Genetics

In late 1937, several plant biologists independently reported that they had discovered a chemical tool for inducing the doubling of chromosomes in plants. The chemical, called colchicine, was immediately an object of great interest among plant biologists. The ability to double chromosomes at will in many plant species opened up a range of cytogenetic investigations previously undertaken only with great difficulty. Because chromosome doubling was a process known to occur in nature and thought to be a critical mode of plant speciation, the technique also drew interest as a means of mimicking evolution. Plant breeders especially warmed to the possibility of “speeding up” or “accelerating” evolutionary change by causing chromosomal change on demand, hoping in doing so to create polyploid varieties or to hybridize otherwise uncrossable species with this new technique. This paper uses the history of the “colchicine fad” to explore the intersections of cytogenetic research and plant breeding in mid-twentieth century genetics. As I describe, the researchers who first recognized the chromosome effects of colchicines were both well acquainted with the theories about the role of chromosome change in evolution and primed by their backgrounds in agricultural research to see an immediate practical use for a tool that multiplied chromosomes. The result was that after announcing their genetic and cytological findings they quickly moved into implementation as a means to confirm evolutionary speculation and, more important, to produce new crops and flowers. When it came to research on this particular aspect of plant evolution – and artificial means of inducing it – academic research interests and agricultural prospects were deeply, inextricably intertwined.

Mary Somerset, the First Duchess of Beaufort and Stories of Science from Badminton House

Julie Davies, University of Melbourne

Session: Botany and Natural History

The Somerset family has been renowned for rapidly changing fortunes, hunting prowess and the magnificent gardens of their estates. However, they have not been widely acknowledged for their contributions to the blossoming experimental sciences in late seventeenth- and early eighteenth-century Britain. In this paper I will explore some of the networks of Mary Somerset, an enthusiastic botanist and horticulturalist, involving several members of the Royal Society of London. Through this study I will shed light on her contributions to the emerging botanical discipline and the role “science” played in the lives of amateur practitioners. Somerset participated in the Royal Society’s creation of knowledge through her engagement with the *Philosophical Transactions*, her patronage of fellows such as Joseph Glanvill and her familial relationship to several significant members including William Brereton and Robert Boyle. Further to this peripheral involvement with the Royal Society, Somerset’s correspondence with leading botanists such as Sir Hans Sloane and John Ray make Mary Somerset an ideal candidate for an

examination of how women engaged with the “new science” and its institutions both ideologically and intellectually.

Altruism and the Administration of the Universe: Kirtley Fletcher Mather on Science and Values

Edward B. Davis, Messiah College

Session: American Religion and Science: New Studies

Few American scientists have devoted as much attention to religion and science as Harvard geologist Kirtley Fletcher Mather (1888-1978). Responding to anti-evolutionism during the 1920s, he taught Sunday school classes, assisted at the Scopes trial, and wrote *Science in Search of God* (1928). Over the next forty years, Mather explored the place of humanity in the universe and the presence of values in light of what he often called “the administration of the universe,” a term and concept he borrowed from his former teacher, the great geologist Thomas Chrowder Chamberlin. Human values, including co-operation and altruism, had emerged in such a context: “the administrative directive toward orderly organization of increasingly complex systems transcends the urge for survival.” He was also active in the early years of the Institute on Religion in an Age of Science, an organization created by his friends Ralph Wendell Burhoe and Harlow Shapley.

Bacon’s *Sylva sylvarum* and the Practice of the Great Instauration

Peter Dear, Cornell University

Session: Experimenting in the Baconian Style

Francis Bacon has been remembered, since his nineteenth-century canonization as the father of inductivism, primarily as the author of *Novum organum* (1620). But Bacon's philosophical fame in the seventeenth century, both in England and in continental Europe, was more associated in practice with his posthumous *Sylva sylvarum*, published in 1626 along with the now much more celebrated *New Atlantis*. In the seventeenth century the work, also known as his “Natural History,” went through at least sixteen editions in English, another in French (1631 and subsequently reprinted), and three in Latin. The classical use of the word “sylva,” or “silva” (literally a “wood”), to mean a collection of raw materials for some future project, served as a way of emphasizing the multiplicity of Bacon's own projects in a general “natural history.” Represented by his editor William Rawley as a part of Bacon’s *Great Instauration*, the *Sylva* certainly represents in typical fashion Bacon’s style of gathering and presenting materials for that philosophical enterprise. Those in mid-century England who adopted Bacon’s name as an icon for their reform endeavors (such as Samuel Hartlib or John Webster) evidently saw the Bacon of the *Sylva* as their guide and prophet: a practical natural philosopher of material things and material appetites. The *Sylva* was a touchstone for such philosophy throughout the seventeenth century. This paper considers it, together with Bacon's other, similar works of the 1620s, as a book designed to be an instrument of topical collation whereby a natural history could be compiled that was also a form of Baconian natural philosophy.

“The Starry Sky above Me”. The Role of Paradoxes in Kant’s Cosmology and Theoretical Philosophy

Silvia De Bianchi, University of Rome ‘La Sapienza’

Session: Enlightening the World

The aim of this paper is to shed light on the origin of the most relevant philosophical questions that Kant raised in the 18th century. One of his most relevant statements, “Two things awe me most, *the starry sky above me* and the *moral law within me*”, can give us the chance to deal with a historically-informed philosophical investigation of Kant’s system, and to display new approaches to the understanding of his philosophy of nature. By taking into account Kant’s scientific background in the pre-Critical writings, it is possible to show the impact of traditional paradoxes and dilemmas that grounded his cosmology and cosmogony. In the first part of the paper, I shall draw the relevance of the Kepler and Halley’s paradox,

better known as the starry-dark-sky paradox, which has been later discussed and formalized by Olbers in the 19th century. In the second part of the paper, I shall clarify which elements of Kant's cosmology can be read as an answer to this paradox, involving a specific hierarchical structure of the universe. Conclusively, I shall show that, contrary to the received view, the first answer to this paradox that was offered in terms of a hierarchical structure of the universe was not embodied by John Herschel's system, but rather by Kant's *Universal Natural History and Theory of Heavens* (1755) and in the *Antinomy of pure Reason*.

If the Synthesis Ended, How Would We Know It?

David Depew, University of Iowa

Session: Was the Modern Synthesis Actually a Synthesis, and in What Sense?

The Modern Evolutionary Synthesis arose not to rebut saltationist mutationism, but to displace prior *Darwinian* theories which, in responding to mutation theory, assigned too causal a role to mutations and not enough to natural selection. They treated the latter merely as eliminating mutations that happen not to be fit and retaining those that, no less accidentally, are fit. The Synthesis used mathematical population genetics to show how adaptation, radiation, speciation, and phylogenetic diversification are a lot more "creative" than that (see Beatty). To do this requires what Mayr called "population thinking." By its very nature, however, the populationist mode of representation rules out treating ontogenetic processes as directly relevant to evolutionary change. Organisms develop, but don't evolve; populations evolve, but don't develop, as Hull said during the later history of the Synthesis. I support this view of the Synthesis by citing claims made at its foundation. I then ask whether the "return of the organism" brings with it elimination-centered conceptions of natural selection that are enough like those eclipsed by the Modern Synthesis to suggest that, rather than modifying, extending, or expanding the Modern Synthesis, the contemporary turn to development eclipses the Modern Synthesis as productively organizing the pursuit of knowledge about evolutionary processes.

Émilie Du Châtelet on Gravity and the Nature of Matter

Karen Detlefsen, University of Pennsylvania, and Andrew Janiak, Duke University

Session: Enlightening the World

During the first half of the eighteenth century, many French Enlightenment philosophers confronted the following problem: after the many difficulties with Cartesian ideas had been exposed in the previous few decades, it was clear that Leibnizianism had become the leading metaphysical system, and Newtonianism had become the leading system in physics. But whereas Cartesianism had presented a single unified system, it was evident that the ideas and methods of Leibniz were incompatible with those of Newton. So the philosophical question of the moment was this: was there some way of systematically integrating the metaphysical views of Leibniz with the physics of Newton? Émilie Du Châtelet (1706-1749) is a pivotal French figure on this problem, and in this paper we examine one aspect of her attempt to grapple with it. We focus on the sixteenth chapter of her magnum opus, *Institutions de physique* (1740), in which she uses Leibnizian principles to argue that Newtonians such as John Keill (1671-1721) and John Freind (1675-1728) extend Newton's ideas too far. Specifically, while Châtelet believes that Newtonian attraction can be used to explain a wide range of phenomena, she disagrees that attraction is a property of matter, which therefore can account for the cohesion of bodies. We examine her arguments in order to elucidate how Châtelet conceives of the relationship between Leibnizianism and Newtonianism, how she understands the role of hypotheses in physics, and how she conceives of the difference between Newton and Newton's followers on what constitutes proper scientific method.

Reconciling God with Nature: John Tyndall's Science and the Philosophies of Carlyle, Emerson, and Goethe, as Seen through His Correspondence with Thomas Hirst

Ursula DeYoung, Harvard University

Session: John Tyndall and his Correspondences

This paper argues that John Tyndall's vision of nature and science was profoundly influenced by Thomas Carlyle and Ralph Waldo Emerson, as well as by the writings of Goethe. The paper uses as its main primary source the many letters that Tyndall wrote to his friend Thomas Hirst, in which he pondered the complexities of science, philosophy, and religion. Examining his idolization of Carlyle, the paper shows the way in which Tyndall adapted Carlyle's call for authority figures in society to his own vision of scientists as social commentators. It then analyzes the connection that Tyndall made between the glories of the Alps and the naturalistic vision of Emerson, whose writings offered to Tyndall a reverential view of nature not based on organized religion. With the Carlylean and Emersonian creeds as a philosophical foundation, Tyndall promoted science as the ultimate cultural guide and urged Hirst to do the same. Goethe's poetry-infused science gave Tyndall a model by which he could demonstrate the importance for individuals of both rationality and emotion but also the necessity of science as the arbiter of fact and social policy. Together Carlyle, Emerson, and Goethe, though each differed from Tyndall in his views and occupation, gave direction to Tyndall's ambitions and shaped both his philosophy of the natural world and his vision of science in society. Tyndall's correspondence with Hirst, among the most heartfelt and personal of his life, reveals the passionate, often difficult intellectual journey that he made to reach this vision.

Philosophical Anatomy: Teleology in Harvey's *De motu cordis*

Peter Distelzweig, University of Pittsburgh

Session: Method and Discovery: Connections between anatomy and philosophy in the Early Modern Period

It is sometimes suggested that William Harvey eschews appeals to final causes in the *De motu cordis*. Indeed, this 'feature' is singled out, perhaps together with his understanding of observation, as characteristically modern. This picture, though, is over-simple to the point of being misleading. Harvey, it is true, suggests he does not know the final cause of the circulation (though even here he is willing to speculate). However, in his treatment of the heart and arteries Harvey does provide final causal explanations of anatomical features and their variations in different animals. In this, the *De motu cordis* reflects a central feature of Harvey's understanding of his anatomical project. This project is articulated in his lecture notes from (roughly) the decade leading up to the publication of *De motu cordis*; it is also reflected in notes on muscle anatomy Harvey was working on as he moved *De motu cordis* to publication and in a programmatic passage in the *De motu cordis* itself concerning the study of the lungs. In this paper, I articulate the place of teleology in Harvey's anatomical project drawing on these resources. I then trace its role in the *De motu cordis*, distinguishing (with Harvey) his opinion '*de motu & usu cordis*' and '*[de] circuitu sanguinis*'. I conclude with some observations concerning the inadequacies of interpretations of Harvey and his work that are preoccupied with dichotomies such as modern vs. Aristotelian or experimental vs. theoretical.

The Man With Too Many Qualities: The Afterlives of Adolphe Quetelet's Average Man

Kevin Donnelly, Alvernia University

Session: History of the Human Sciences

Adolphe Quetelet's much-derided "average man", supposedly killed off by more sophisticated statistics at the turn of the twentieth century, has had a remarkable afterlife, one shaped far more by the context for its sporadic reappearances than by the content Quetelet provided in his celebrated work *Sur l'homme*. From statisticians Pearson, Galton, and Lombroso to sociologists Durkheim, Maurice Halbwachs, and Frank

Hankins to modern philosophers Ian Hacking and Paul Rabinow, each generation has enlivened the “average man” according to its own needs. From liberation to a form of surveillance and control, from social physics to social biology, the average has been surprisingly elastic to claims from the extreme. In this paper I follow Quetelet’s creation through this twisted path to arrive at the central place of l’homme moyen in the world of information today. As the logistics of information retrieval and control move more towards the quantitative, a surprising paradox has developed in how we know: our specific and particular searches for knowledge require better ways to manipulate general and impersonal probability. Even if the universalist and egalitarian ideals of Quetelet’s original average man have long since faded as expectations for information, the quantitative mechanisms he helped to initiate have continued to gain importance. By analyzing several incarnations of the average man’s odd history, I hope to sketch the outlines of his dramatic reemergence today.

The Mind on Paper: The Shared Visual Order of Science and the Humanities during the Late Enlightenment

Mathew Eddy, Durham University

Session: The Sense of Things: Perception as Practice in Educational Settings

The term ‘Enlightenment’ is a visual metaphor, one that treats knowledge as light and ignorance as darkness. This metaphor has long been associated with vision as a sensation, a direct imprint upon the retina of the eye. But vision also involves perception, and this aspect of learning, despite its inherent visual nature, has somehow remained absent from the shelves of Enlightenment artifacts that are so often placed on display by historians. I wish to change this situation by asking how children and adolescents were taught to ‘see’ – to understand, to value—the lines, words, and space of the graphic structures they used on a daily basis during their formative years. In this paper I investigate this topic by identifying the reoccurring visual patterns used to order the knowledge systems taught to students who attended Scottish universities during the late Enlightenment. In the first section of the paper I argue that student notes and professorial lecture heads were designed according to a shared spatial template, the rules of which served as an immutable mobile, a visual logarithm, that serialized information through graphic standardization. In the second section of the paper I place this visual logic in conversation with the traditional methods used to classify knowledge at the time, suggesting that most syllabi, which were treated by professors as systems, were truly combinatorial in that students could access the via both spatial and nomenclatural cues.

The Universe of Light in the Kingdom of the Pearl: The Gem Test and the Spread of Machine-Mediated Appraisal, c. 1920-1935

Kjell Ericson, Princeton University

Session: Instruments and Measurement

This presentation takes as its focus the gem test, a configuration of human and machine appraisal, and the dynamics of its widespread implementation in emerging testing laboratories and gemological pedagogy. I will work through a key turning point in a longer story: the arrival of spherical pearls cultivated along the coasts of the Japanese empire into Europe's two largest gem entrepôts, Paris and London. Wholesalers in both cities scrambled for secure ways to tell “cultured” pearls apart from “natural” ones. Unless one could distinguish between two pearls that looked the same on the surface, the value of all pearls would be suspect. Instrumental tinkers with convergent interests in X-rays, crystal structures, and mineralogy helped to mold methods of optical analysis into a new style of commercial detective work. As with other technologies of truth-telling, the gem test required the formulation of interpretive rules as a condition of its existence. It was necessary to know beforehand what a true answer, here in the form of an authentic pearl, might look like--both on the inside and out. A successful test would either show proof that a given gem's characteristics matched those it was supposed to possess, rendering it fit for sale as advertised, or else reveal that a gap existed between a gem's

purported status and its real identity. I argue that the quest for an infallible gem test was a transformative challenge to a model of trustworthy appraisal that rested on the jeweler's expert eye alone.

“Checking Out Forms”: Research Subjects and Psychiatrists’ Use of the Subjective

Adam Fearnley, Edge Hill University

Session: Experiments of the Experiential: Valuing Subjectivity in the Modern Earth, Medical, and Physical Sciences

Beginning in the 1940s, American psychiatrists began to think hard about what research meant to their discipline. Countless investigators recognized that unlike neighboring medical fields, psychiatry relied greatly “upon the individual patient’s reports of his subjective states.” It was a realization that provoked much friction, not least because it led some to conceive of their relationship with human subjects “as collaborative all[ies].” After all, as one practitioner sensibly recognized, “only the patient knows how badly he feels.” Yet it was not enough to celebrate how people felt or what they thought; stabilizing these ways of knowing also involved significant challenges—as those involved in the study of pain and maladies like chronic fatigue syndrome would later understand. The discovery that some human subjects found that “checking out forms [was] helpful...in gaining an understanding of [their] symptomatology” provided one possible solution. Two groups of Maryland-based researchers certainly re-considered the use to which such documentation might be put in the context of these discussions. In contrast to many who spent these years worrying that the intrusion of such regulatory bureaucracy would undermine their experimental methods, these psychiatric researchers presented such instruments as “a valuable asset to research design.” This paper considers how some American psychiatrists became interested in “the subjective experience of the research patient,” how mundane administrative documents were reimagined as a means of illuminating the subjective, and how distinctions between objective research and subjective ways of knowing began to seem much more residual than they now do.

Meta-Mathematical Rhetoric

Jacqueline Feke, Stanford University

Session: Ancient Science and Technology

This paper brings the meta-mathematics of Hero of Alexandria and Claudius Ptolemy into conversation for the first time. Hero and Ptolemy lived in or around Alexandria at the beginning of the common era—Hero in the late-first century and Ptolemy in the second century—and they wrote texts contributing to a variety of mathematical sciences. In the introductions to several of their texts—specifically Ptolemy’s *Almagest* and Hero’s *Belopoeica*, *Pneumatica*, and the third book of the *Metrica*—they employ identical rhetorical strategies. They place the mathematical sciences in collaboration with as well as in contradistinction to philosophy. More specifically, they each describe mathematics as one particular form of philosophy, within a hierarchy of intellectual inquiry. Mathematics addresses a set of philosophical problems, and this set intersects with the problems investigated by philosophers. In this way, Hero and Ptolemy place mathematicians and philosophers in competition. Subverting the mainstream evaluation of mathematics as propaedeutic to philosophy, Hero and Ptolemy argue that mathematicians succeed where philosophers fail. In particular, both Hero and Ptolemy claim that the distinct method of mathematics, geometrical and/or arithmetic demonstration, establishes mathematics’ epistemological supremacy. The direct influence of Hero’s meta-mathematics on Ptolemy’s is impossible to prove, but the co-occurrence of these specific and rare rhetorical tropes in Hero and Ptolemy’s texts mandates, if not a direct influence, at least the indirect influence of Hero’s meta-mathematics on Ptolemy’s.

Constructing a Diseased Mind: Testing Animals, Studying Patients, and Mapping Brains in a Victorian Asylum

Michael Finn, University of Leeds

Session: Novelty in Medicine

In March 1873, the Scottish neurologist David Ferrier conducted a series of famous electrical stimulation experiments on the brains of animals in the laboratory of the West Riding Lunatic Asylum in Yorkshire, Northern England. His work, which was quickly accepted and widely copied by the scientific community, provided evidence for the contested theory of cerebral localisation: the doctrine that the brain cortex is functionally differentiated. The following year he returned to the Asylum and, using its pathological records in conjunction with his continued animal vivisection studies, he produced the first modern map of the human brain. Far from practicing in provincial isolation, Ferrier was in a laboratory surrounded by other investigators in one of the most active centres of scientific research in Europe. The whole Asylum, led by the effervescent James Crichton-Browne, operated as a research school which had as its object the systematic study of the insane brain. Drugs were trialled, patients observed, bodies dissected and, with Ferrier's maps in hand, diseased brains could be drawn. Mental illnesses could be understood solely by reference to the physical appearance of the brain. In this paper it will be argued that Ferrier's work, often understood as the final step towards a modern conception of the brain, should be seen as the culmination of the Asylum's research programme; and furthermore, it will be argued that these research activities were rooted in practical and theoretical concerns that were fundamental to Victorian psychiatry.

**“To See the Moveing Pensil; display a Sort of paper Creation, which may Endure for Ages”:
William Bartram as a Natural History Artist**

Joel Fry, Bertram's Gardens, Philadelphia

Session: Science and Art in the American South, 1750-1850

William Bartram (1739-1823), son of Philadelphia botanist, John Bartram (1699-1777), is recognized as a natural history illustrator, based largely on a single collection of drawings discovered at the Natural History Museum, London at the beginning of the 20th century. The collection comprises roughly one third of Bartram's remaining oeuvre—made in the American South, 1773-1776. But Bartram's career as an illustrator spanned from his teens into his sixties—and major collections of his work may be found in several places. Drawings sent to Peter Collinson in London are preserved in the Earl of Derby's collection, and drawings from Philadelphia collected by Benjamin Smith Barton are housed at the American Philosophical Society. Letters and other manuscripts suggest many drawings have been lost or await discovery in obscure archives. Scattered engravings were also published in Europe and America—most toward the end of Bartram's career as an artist. This presentation will survey William Bartram's illustrations and examine the scope and influences of his career. Raised as a Quaker, Bartram's religious training was opposed to the very idea of graphical art—but Bartram seems to have eluded Quaker prohibitions by producing useful, scientific illustrations. Bartram was largely self-taught, tutored by the illustrated books in his father's library—Catesby, Edwards, Sloane, Parkinson, and others. He mentored a new generation of young American natural history artists in the early 19thc. including nieces and nephews, neighbors, and most significantly the ornithologist Alexander Wilson.

‘Resembling as Near as Possible’: Botanical Models and Botany Instruction in the Nineteenth Century

Ellery Foutch, University of Wisconsin-Madison

Session: Models and Materiality

In the nineteenth century, botany professors and museum curators yearned for a new way to represent plant life. No longer were wood samples, seed pods, cones, or the dried, pressed leaves of the Herbarium sufficient to engage their students and the public. Greenhouses and botanic gardens failed to produce the

needed live plants. As a result, museums and universities turned to modelmakers, and plants were represented in papier- mâché, wood, plaster, wax, and glass. At the January 1873 meeting of the Philadelphia College of Pharmacy, naturalist J.M. Maisch proudly displayed Brendel models that were described as beautiful in appearance, resembling as near as possible in color the natural objects. The models are made large enough to be seen by a class of students, and by coming apart exhibit the internal arrangements of portions of the plants.... A beautiful flax plant was shown, showing the structure of the flower, with the stamens and pistils distinctly visible; also models of various fruits, showing the seeds attached, and displaying the embryo. These specimens were made of materials of various kinds, most resembling the parts of the plant.¹ This paper will examine scientists' concerns about "resemblance" and substitution by analyzing period botanical exhibitions and reviews, university and museum correspondence, and the models themselves. In addition to Brendel's papier-mâché works, this paper considers the plaster molds and models of the American Museum of Natural History, economic botany models in plaster, wax, and porcelain at Kew Gardens, and the Blaschka glass models at Harvard.

Science Fiction to Science Fact: The Role of a Biological Mechanism in Validating Genetic Anticipation

Judith Friedman, National Institutes of Health

Session: Seeing and Believing: The Importance of Mechanisms in Human and Medical Genetics

The term anticipation was first coined in the early 20th century to describe a pattern observed in certain hereditary diseases where the illness manifested earlier and often more severely in succeeding generations. Although there was no biological explanation for these findings, medical specialists in the first half of the twentieth century reported anticipation in a number of diseases including Huntington's disease, myotonic dystrophy, and schizophrenia. In the second half of the century, findings of anticipation were rejected following the publication of a paper on the subject by the influential British human geneticist Lionel Penrose. He argued that the appearance of anticipation was the result of a combination of allelic modification, ascertainment bias, and poor experimental design. These explanations were used to explain away findings of anticipation even in the face of evidence undermining Penrose's hypothesis. Anticipation remained in the realm of science fiction until the discovery of a genetic mechanism that underlay it in 1991. Within a very short time this concept, which had been disbelieved for decades, became a part of scientific orthodoxy—at least in cases where these specific types of mutations (expanding DNA repeats) were shown to exist. Anticipation was validated in the case of myotonic dystrophy and Huntington's disease but remained a contested finding in schizophrenia. This paper will examine the importance of the discovery of a biological mechanism in establishing the validity of the concept of anticipation in hereditary disease.

The Enlightenment, the Pacific Laboratory and Natural History

John Gascoigne, University of New South Wales

Session: Enlightening the World

This paper will explore the way in which Pacific exploration acted as a stimulus for developments in natural history. This reflects in turn the way in which, particularly in France under Buffon, natural history came to adopt a wider role than the fact collecting which had been Francis Bacon's earlier conception of its scope. Natural history came increasingly to take seriously its role as a form of history which enabled it to map changes in the earth and its living inhabitants over long periods. Travel, particularly to the Pacific, provided a way of illustrating the extent of such changes over time giving natural history a role in developing explanatory frameworks which reached their apogee after Darwin's voyages but which were beginning to become more evident in the late 18th and early 19th centuries.

Life-History of the Modern Synthesis: An Enquiry over Sixty Years of Periodicals Devoted to Evolution (1947-2011)

Jean Gayon, IHPST, Paris

Session: Was the Modern Synthesis Actually a Synthesis, and in What Sense?

From its origins (1930-1950), the Modern Synthesis had both a disciplinary and a theoretical dimension. The disciplinary aspect, paradigmatically expressed by Huxley in the foreword of his *Evolution: the Modern Synthesis* (1942) consisted in a deliberate convergence of several disciplines involved in the study of evolution, which yielded a professionalized field after the creation of the Journal *Evolution* in 1947. The theoretical aspect consisting in a general explanatory framework accepted by supporters of the Synthesis, was well summarized by Huxley: “Natural selection, acting on the heritable variation provided by the mutations and recombination of a Mendelian genetic constitution, is the main agency of biological evolution” (1951). The present communication will examine how far the disciplinary and the theoretical aspects of the Synthesis actually structured the field of evolutionary biology after 1947. I will examine the periods of the constitution of the Synthesis as a paradigm (approx. 1950-1970) and that of its controversial dissolution (1970-). At first, only one journal —*Evolution*— was exclusively devoted to the topics referred to in its title. In the early 1980s, there were five; today: 32. Examining the evolving disciplinary, intellectual, and geographic cartography of these periodicals should explain: 1) How far did the reference to the “Synthesis” explicitly structure studies on evolution? 2) How did the spectrum of admissible disciplines change? 3) How did the need of a “synthesis” actually affect the structuring of the domain? 3) How far did the theoretical nucleus referred to above function as an attractor or a source of division?

The Rules of *Experientia Literata*: The Case of Bacon’s Magnetic Experiments

Laura Georgescu, University of Bucharest

Session: Experimenting in the Baconian Style

One of the peculiar aspects of Bacon’s methodology of experimentation is his insistence on replacing single experiments with ‘processes of experimentation,’ i.e. groups of experiments connected by means of specific methodological rules. This aspect, I argue, is central for the way in which experiments function in Bacon’s works, not as mere illustrations of theories, but as investigative devices. In *De augmentis scientiarum*, Bacon offers a detailed description of the rules used for putting together such ‘processes of experimentation,’ but he provides no answer to the question as to why these particular rules are used to connect specific experiments. Similarly, no explanation is given for the way in which this specific methodology of experimentation permits the transfer of experiments from one domain of research to another. Therefore it is not clear why the resulting ‘art of experimentation,’ *experientia literata*, should be considered the *norm* for ‘good’ research practice. In the attempt to answer this question, I propose a thorough investigation of Bacon’s rules at work in the case of magnetic experiments. *Inquisitio de magnete* is a schematic work dealing with the magnetic property of attraction mainly through experiments or experimental results that offer a provisional map of the ‘power of attraction’ by appeal to the rules of *experientia literata*. By examining these connections, I will show that Bacon’s experimental practice in creating magnetic ‘processes of experimentation’ is driven by the presupposition that nature will impose limits on experimental work and force some results rather than others.

Race, Caste, and Class: Analogical Thinking in the Human Sciences during the Mid-Twentieth Century

Sebastián Gil-Riaño, University of Toronto

Session: History of the Human Sciences

How did social scientists conceptualize and study the issue of race during the period when the very biological existence of race was being called into question? This paper examines the role analogies have

played in producing social science knowledge about ‘race’ during the twentieth century, when scientists called into question the usefulness of ‘race’ as a scientific concept and in the context of an emerging “scientific antiracism” of the 1920s and 1930s. Focusing on sociological and anthropological studies of race relations conducted in the US during the period between the two world wars, and in Brazil in the post-war era, I argue that analogical reasoning has also played a key role in defining the basic features of ‘race’ within the human sciences of the twentieth century. However, whereas eighteenth and nineteenth century naturalists sought to produce knowledge about ‘race’ through a set of analogical inferences comparing the differences between the so-called ‘races of mankind’ with the differences between men and women, as Nancy Stepan has shown, in the twentieth century caste and class become key concepts by which “race” is characterized as a sociological category of analysis. This paper concludes by suggesting that the analogical patterns by which race has been historically constituted help to explain the resilience and persistence of ‘race’ as a scientific object in the twentieth century and its continuing importance in our contemporary.

Historiography and Disciplinary Identity: The Case of Humphry Davy

Jan Golinski, University of New Hampshire

Session: What is the Object of the History of Chemistry?

The eighteenth century has provided a testing-ground for various approaches to the historiography of chemistry. A generation ago, the prevailing questions concerned theoretical paradigms. Scholars debated whether or not the discipline had attained a theoretical foundation prior to Antoine Lavoisier’s self-proclaimed “revolution” in chemistry—and, if it had, whether the theory in question derived from Robert Boyle, Isaac Newton, or Georg Stahl. More recent historians have shifted attention from the theories to the practices of eighteenth-century chemistry, and to some extent to the materials it worked with. They have devoted attention to such matters as pedagogy, instrumentation, taxonomy, and the practices of the chemical arts. They have considered how the discipline was defined in an academic context, and how it asserted its prerogative as the theoretical foundation of various technical fields. With this change in focus, the once-privileged Chemical Revolution has receded from view. Instead of a rapid shift of theoretical paradigms, we now recognize a relatively prolonged process of transformation and stabilization of chemical practices and the objects they disclosed. Scrutiny of the career of Humphry Davy suggests that this process continued through the first two decades of the nineteenth century. Davy’s work was directed at harnessing new instrumental powers to disclose new chemical entities, while the putative theoretical foundations of the science remained uncertain and contested.

Cold War Science at the Last Frontier: Messing with and Measuring the Magnetosphere.

Gregory Good, Center for History of Physics

Session: Toward a Global/International/Transnational History of Spaceflight

In the 1950s and 60s, many geophysicists simultaneously pursued academic research topics while picking up side-contracts with the military. This was true for specialists in Earth’s magnetism, in particular as rockets and satellites became available for exploring the upper atmosphere and near space. How researchers negotiated this boundary is an important story, but it is obscured by the multitudes of satellite names, new kinds of instruments, etc. This paper examines the nascent community of “space physicists” in the International Geophysical Year (IGY) and its follow-up projects the International Year of the Quiet Sun (IQSY) and the World Magnetic Survey (WMS), to expose some of the tensions inherent in these multiple allegiances and to see how these tensions were modulated by cooperative research carried out under the banner of the International Union of Geodesy and Geophysics. Although a few key figures in this story include Lloyd Berkner and Sidney Chapman, most of the players are now forgotten, as much of their work occurred outside the public eye at research centers like the Carnegie Institution of Washington, military think tanks like the RAND Corporation, and in government labs.

Hearing Aids at the Historical Nexus of Patenting, Prosthetics, Physics and Physiology

Graeme Gooday, University of Leeds

Session: Ownership and Invention of Medical Technologies

Understanding the development of hearing aids requires perspectives from history of science, medicine, technology, disability and commerce. Just as ophthalmic spectacles have long been prescribed for myopia, assistive amplification devices have been marketed to the myriads of the hard of hearing. For centuries available in the high street independently of clinical intervention, unlike their optical analogue, hearing aids have long been subject to regimes of patenting. The first to patent was the Anglo-German Rein family of prosthetics vendors who began their mass production in London c.1800. I examine the motivations for this in terms of patents as a makers' protection against piracy; as a vendors' mark of quality to prospective consumers, and as a user's hallmark of trustworthiness. More than that, this paper looks at how this culture of acoustically and physiologically informed innovation was reflected in a remarkable historical diversity of patented forms. These ranged from conspicuously luxuriant hearing horns used by the rich to select their audience, to the discreetly diminutive electrical amplifiers that borrowed from late Victorian innovations in telecommunication. I map this phenomenon up the advent of the "Medresco" hearing aid in 1948 that resulted from a collaboration of the UK's Medical Research Council and Post Office radio engineers. While this National Health Service device competed controversially with commercial suppliers in being distributed free to the poor, it also brought hearing aids into line with the medical orthodoxy of eschewing patents – just as that very orthodoxy was under strain from clinicians' collaborations with industry.

The Universal Language of the Slavs: German and the Identity of Russian Chemistry

Michael Gordin, Princeton University

Session: Scientific Ethos and Epistemology in the Long Nineteenth Century

Chemical societies, usually defined in national terms (French, German, Italian), spread rapidly across Europe in the middle decades of the nineteenth century, and a historiographical interest in professionalization has understandably emphasized the identity of chemists within these national boundaries. By shifting the emphasis from institution-building to vehicular languages, this paper demonstrates the importance of German as a positive resource in the establishment of a communal identity among St. Petersburg chemists. The many instances in which Russophone chemists chose to use German -- when communicating amongst themselves, publishing abroad, or formulating patterns for nomenclature -- scramble assumptions about the nationalist character of Russian chemistry. In fact, I argue, those assumptions are themselves retrospective projections from a later, and more linguistically militant, phase of the history of Russian science.

Parody Conservation: The Tradition of Humor at the Niels Bohr Institute

Paul Halpern, University of the Sciences in Philadelphia

Session: Recasting 20th-Century Physics

During the 1930s it was a tradition at Niels Bohr's Institute for Theoretical Physics in Copenhagen to end each of its annual conferences with a comic performance involving institute members. While the most famous of these was a production of Faust, there were other, lesser-known productions. Another tradition, which carried on into the 1950s, was to honor Bohr's major birthdays (50th, 60th and 70th) with satirical works. We will discuss the nature and role of these humorous performances and writings, describing how they reflected the scientific issues and debates of the times.

Textbook Physics: An Examination of Early 20th-Century Medical Pedagogy

Vivien Hamilton, Harvey Mudd College

Session: Textbooks

Speaking to a crowd of British radiologists in 1928, W.S. Hedley, senior surgeon to Middlesex Hospital, spoke of the physicist in reverent terms. The physicist, he argued, was the “pre-eminent medicine-man of the tribe,” who had “asserted his mastery and proved his incredible statements by making the electron the humble servant and plaything of man.” That same year, prominent hospital physicist Sidney Russ published a physics textbook for medical students, expressing the modest hope that his book would instill an interest “in a subject which is often rather disliked.” If a first encounter with physics was unpleasant for most medical students, they nonetheless emerged with their admiration for physics intact. This paper explores the role of textbooks in encouraging that admiration. I examine several British and American physics textbooks for medical students, published between 1902 and 1930, comparing the topics covered, the types of problems assigned and the different strategies used to motivate student interest. The physicists who came to medicine after the discovery of x-rays came with an already established cultural capital, and these textbooks represent one way in which that authority was maintained and nurtured. Recent historical scholarship on science pedagogy has focused on the formation of scientific identities and practices (Warwick 2003, Kaiser 2005). The textbooks in this study were not meant to educate future physicists, but the attitudes they encouraged were nonetheless of crucial importance when radiologists turned to hospital physicists for help establishing dosage standards for radiation therapy and protection guidelines for x-ray work.

Ptolemy’s Visual Theory Applied to Astronomy

Elizabeth Hamm, Saint Mary’s College of California

Session: Ancient Science and Technology

Claudius Ptolemy’s astronomical theories are built upon numerous astronomical observations. While visual observations are crucial for the construction of his astronomical theories, the second century A.D. astronomer discusses the limitations of vision when observing the night sky in several of his works. In the *Almagest*, the *Optics*, and the *Planetary Hypotheses*, Ptolemy explores topics concerning astronomy and vision. He describes the problems with observations of heavenly bodies taken near the horizon or the zenith, the impact of great distances on perception, and the different types of optical illusions. In this paper I will discuss Ptolemy’s visual theory as applied to astronomy. In particular, I will explore the degree to which Ptolemy believes one can trust different types of observations, and what he thinks can be done to compensate for the weakness of the human eye. An examination of Ptolemy’s visual theories in relation to astronomy enriches our understanding of the application, practice, and history of Greco-Roman science.

“Almost out of a Woman’s Natural Thinking”: Considering Science and Gender through Charles Darwin's Private Correspondence

Philippa Hardman, University of Cambridge

Session: Scientific Correspondents

Both in Europe and in America, women remain under-represented in the world of science. Science, it seems, is manly work. Or is it? Raising questions about emerging theories of the so-called “biology of gender” which attempts to explain contemporary sexual inequality in the world of science with reference to the biological make-up of men and women, history shows very clearly that women’s (and indeed men’s) participation in the world of science is influenced significantly by gender ideology or the social and cultural expectations attached to their sex. To see science as exclusively masculine is to over-simplify a more complex scenario. It is now broadly appreciated, for example, that certain aspects of the sciences (most famously Botany) have the potential to be aligned with the feminine; at once legitimizing women’s

participation and challenging men's. The gendering of science, however, goes much further than this. Gender ideologies impact not just on men and women's subjects of study but at every point of their engagement with the world of science - from the channels through which they get involved, to the sites of their work, the roles they perform and, perhaps most fundamentally, the way in which they see and describe the world around them. Charles Darwin's epistolary network offers a rare opportunity to study men and women comparatively in the scientific context. Seen side-by-side, Darwin's correspondents bring into sharp focus the relationship between gender ideology on the one hand and scientific participation on the other.

Selling – and Selling Short – *Silent Spring*: Environmentalism, Economics, and the Public Sphere.

David Hecht, Bowdoin College

Session: Science in the Public Sphere

In 2007, a minor controversy erupted when Senator Tom Coburn opposed a bill to honor Rachel Carson. Carson is most famous for her 1962 bestseller *Silent Spring*, often credited with galvanizing the modern environmental movement. Coburn insisted that Carson was unworthy of an official tribute, because a ban on DDT inspired by her work led to millions of deaths from malaria. Coburn is not alone; criticism of Rachel Carson has become common among free-market fundamentalists in recent years. Of course, *Silent Spring* has its defenders as well. My focus, however, is not on the relative merits of the two positions, but rather on the fact that debate about her book has come to be framed in these particular terms. This is a curious development, as DDT is but one of the pesticides Carson mentioned. Furthermore, she explicitly situated her critique in the context of broader challenges to untrammelled faith in technological progress and modern capitalism. Nevertheless, historical memory of *Silent Spring* has become intertwined with – and often defined by – the ban on DDT it helped inspire. This paper traces the process by which this happened. How did an influential book about ecology become shorn – in cultural memory – of its radical components? And what might this marginalization tell us about public consumption of science in the final third of the twentieth century? The complex and evolving reception of *Silent Spring* provides an excellent case study of how economic interest mediates the interaction between science and its publics.

From Subjective Experience to Experimental Subjects: Test Pilots in the Weimar Republic and Nazi Germany

Daniela Helbig, Harvard University

Session: Experiments of the Experiential: Valuing Subjectivity in the Modern Earth, Medical, and Physical Sciences

The struggle over the distinction between the experimental and experiential built into the notion of objective modern science was at the center of a debate among German experimental pilots during the 1920s through the 1940s, the period when aviation became a scientific enterprise and developed rapidly alongside various disciplines in the physical and engineering sciences. This paper investigates how that struggle shaped and was shaped by various flight data recording practices in physical and medical aviation research during the decades of Weimar and Nazi Germany. It traces the concurrent shift in both the notions of 'subjective experience,' and of 'experimental subjects' within and beyond the aviation research community. In choosing the appropriate way of recording flight experiment data, the role of the test pilot as experimental subject was immediately at stake. Recording methods developed in material continuity between the physical and engineering disciplines, and aviation-related medical experiments on voluntary and involuntary human subjects. They ranged from hand-written notes by the pilot to recordings of the movement of the pilot's hand exerting force on the controls. But these different practices did not easily map onto a vision of the pilot as observer versus observed in a scientific experiment. Rather, they problematized both the notion of scientific experiments as situations independent of subjective experience, and that of subjective experience as constituted independently from the scientific practices in which an individual may engage.

‘As Good a Laboratory as Can Be Desired’: The Chymical Correspondence of William and Thomas Molyneux

Sue Hemmens, Marsh's Library, Dublin

Session: Scientific Correspondents

In 1683, Thomas Molyneux of Dublin travelled to Leiden to study medicine. His brother William remained in Dublin, where he busied himself with the establishment of the Dublin Philosophical Society, a learned society modelled on the Royal Society in London. Although both brothers were later to be known for excellence in other fields (Thomas in medicine and William in optics) their correspondence shows a strong interest in chymical operations and theories, William going so far as to plan the erection of a laboratory for their investigations, to be built when they were once again in the same country. Although these plans seem not to have come to fruition, the brothers entered into a chymical discussion in print, initiated while Thomas was at Leiden, concerning the mechanism of ‘dissolution and swimming of heavy bodies in Menstruums far lighter than themselves.’ A letter on this topic to Pierre Bayle from Thomas resulted in a publication in Bayle’s *Nouvelles de la republique des lettres* in 1684. William’s response was published in the Philosophical transactions of the Royal Society in London, with comments from Thomas. While at Leiden, Thomas stayed with Christian Margraaf (1626-1687), with whom he took a ‘private college’ in chymistry, and heard public lectures from Carel de Maets (1640-1690), numbered among the ‘great Chartisians’ in the Leiden circle. Both in their private and published writings in the latter years of the seventeenth century, the Molyneux brothers showed evidence of the influences of their contacts and reading on their chymical thinking.

Nevil Maskelyne and the Instruments of Scientific Exploration, 1760-1800

Rebekah Higgitt, National Maritime Museum, UK

Session: Defining the Instrumental: Navigation, Longitude and Science at Sea in the 18th Century

In the later 18th century, as voyages of exploration gained official sanction and state support, Nevil Maskelyne, the Astronomer Royal, frequently dictated what scientific instruments would or should be provided. His lists, drawn up for the Royal Society or the Board of Longitude, have clear resemblances and could be considered as defining the instruments of scientific exploration at this period. This was despite the fact that, although Maskelyne had first-hand experience of maritime navigation and observations in the field, he had never personally been involved in the exploration of new territory. It will be argued that, although the role of Astronomer Royal was key, Maskelyne’s experience of and interest in the use and management of instruments at sea and in the field pre-dated his appointment. It is possible to argue that Maskelyne, personally rather than *ex officio*, helped shape the scientific exploration carried out by Britain and its navy from the 1770s to the beginning of the new century. As well as considering the genesis and content of Maskelyne’s lists of scientific instruments, this paper will highlight the related work he undertook, including selecting and improving instruments, writing scientific instructions, and choosing the expeditions’ observers. It will also reflect on how, depending on location and context, similar objects might be instruments of exploration, of experiment or of routine observation. Indeed, it was a defining characteristic of such voyages to include a range of scientific and strategic objectives, facilitated by, or involving the testing of, key sets of instruments.

Same Data, Different Conclusions: Radioactive Fallout, the U.S. and British Scientific Committees, and the Diverging Role of Expertise in Public Affairs

Toshihiro Higuchi, Stanford University

Session: Tool of Science, Tool of Politics: Radioactive Contamination in Historical Perspective

The so-called Bikini incident in 1954 triggered a public debate with regard to fallout hazards. In response, the U.S. and British governments respectively asked their national scientific authorities, the

U.S. National Academy of Sciences (NAS) and the British Medical Research Council (MRC), to conduct an “objective and dispassionate” assessment. To ensure a unanimous view, the NAS and MRC experts exchanged data and drafts behind the scene. This coordination, however, did not prevent their conclusions, simultaneously published in June 1956, from being widely divergent. While the NAS endorsed one-tenth of the occupational permissible concentration of Strontium-90 as universally acceptable for the general public, the MRC recommended one-hundredth. Why did the two national expert committees reach the strikingly different conclusions based on a very similar set of scientific data? To explain the divergence across the Atlantic, this paper will analyze the structural and philosophical contrasts. The U.S. committee, made of six panels, strove to be authoritative through its comprehensive and interdisciplinary character. Instead of working together, however, each disciplinary panel insisted on its own turf of expertise while deferring judgment about uncertain elements. The U.S. experts, except for those in the genetics panel, also preferred to stay clear of administrative problems and recommended further research as a solution. The British committee, in contrast, adopted a much simpler structure and took into account various uncertain elements. Keenly aware of its regulatory mission, it was willing to recommend an administrative “warning dose.” The paper will demonstrate the different role of expertise across the Atlantic.

Julius Bauer’s Fight with Mendelian Enthusiasts Concerning Human Genetics

Veronika Hofer, University of Vienna

Session: Jewish Scientists in Interwar Vienna

Julius Bauer is considered one of the most influential voices in Vienna’s medical culture to challenge the Nazi’s legalizing of forced sterilization in the early 1930s. In this talk I will show the conceptual basis on which and the circumstances under which his engagement with Julius Tandler’s constitutional pathology began and why it thrived in the interwar period in Vienna. Tandler and Bauer developed the Viennese interpretation of Friedrich Martius’ constitutional pathology as an alternative to Koch and Pasteur’s concentration on pathological agents. In the first part of my talk, I outline their theory of health and disease as a solution to the crisis of medicine. In the second part of my talk, I show Bauer’s contributions to a school of internal medicine in interwar Vienna that enjoyed a remarkable reputation in US medical circles. I will stress his striking integration of diverse medical terrains including psychiatry, endocrinology, and human genetics. Bauer eventually challenged how research in human genetics was used in eugenics. The third part of my talk will address what kind of eugenic measurement he considered appropriate for Austrian society and describe his criticisms of the “scientific” basis for the Nazi’s legislation enacting forced sterilization. I will show how his career and prestige in Vienna and abroad were affected by the official reaction against his 1934 and 1935 articles in the medical press. I will end with remarks on his successful emigration from Vienna to America.

Stabilizing the ‘Fragile X’: Analyzing the Integration of Newly Visible Genetic Markers with Existing Clinical Disorders (1969-1989)

Andrew J. Hogan, University of Pennsylvania

Session: Seeing and Believing: The Importance of Mechanisms in Human and Medical Genetics

Fragile X syndrome is one among many forms of intellectual disability historically classified as ‘nonspecific x-linked mental retardation’. This categorization reflects both a common inheritance pattern, involving the X chromosome, and the lack of other significant clinical abnormalities in those affected. The delineation of Fragile X syndrome as a unique disorder was a multi-decade process, which involved clinical and laboratory analysis at multiple locations, using various physiological and genetic techniques. In this paper, I build upon existing work by Susan Lindee, Maria Jesús Santesmases, and Soraya de Chadarevian on clinical cytogenetic analysis. The term ‘Fragile X’ syndrome comes from its association with a visible abnormality on the X chromosome. Though this chromosomal marker was first identified in 1969, it took until the late-1970s for researchers to work out a method for making the aberration reliably

visible microscopically. Even with this accomplished, many questions remained about how this abnormality on the X chromosome was mechanistically associated with the clinical manifestation of Fragile X syndrome. Was this chromosomal aberration the cause of Fragile X syndrome, or was it instead another visible result of a different, still unseen, genetic etiology? This study draws upon a thorough analysis of the published medical literature and interviews with clinicians, researchers, and other medical professionals to analyze the multi-decade stabilization of a visible genetic marker for Fragile X syndrome. Based upon this historical data, I analyze the process by which clinicians integrate newly visible genetic evidence into existing understandings of the mechanism and manifestation of clinical disorders.

A Scientific News Service in Late-Eighteenth-Century London

Roderick Home, University of Melbourne

Session: Correspondence, Manuscripts, and Digitalization

Though he published a considerable number of scientific papers, the Portuguese experimental philosopher and erstwhile Augustinian monk João Jacinto de Magalhães (Jean Hyacinthe de Magellan) (1722-1790) is not known for any major scientific novelty. By virtue of his diligent letter-writing, however, he played a significant role within the scientific community of his day. For over twenty years he conducted, from his base in London, an extraordinarily wide-ranging correspondence with other scientific enthusiasts across much of Europe and, through this, contributed materially to the exchange of information at a time when there were few established avenues for achieving this. There is no major collection of Magellan's papers, and it is clear that many of the letters he wrote have not survived. Some 700 letters written either by him or to him have been located, however, in libraries and archives in various parts of Europe and North America—enough to provide a good basis of understanding of both the way in which his correspondence helped to promote science, and his motives in maintaining it.

'That Was Decided for Me': Science Graduates and the British State from World War II to the Early 1960s

Sally Horrocks, University of Leicester/National Life Stories

Session: Scientists and the British State

From World War II to the early 1960s the conscription and National Service policies of the British state combined with perceptions that the direction of scientific manpower was important to national interests to shape the initial career options of male science graduates in significant ways. The administrative decisions and the procedures that they initiated are relatively easy to track in official sources and have been discussed elsewhere, but what is less clear is how individuals experienced these processes, the long-term impact they had on personal and professional lives, how they responded to this state direction and what they felt about the experience. This paper makes use of the availability of interviews undertaken by the Oral History of British Science project with scientists and engineers who started their careers during the period to begin to address these questions. These interviews take the 'life story' approach and cover all aspects of the interviewee's life and career, not just their involvement with significant innovations or moments in the history of science. Each of them provides insights into the range of responses to these circumstances and the arising personal and professional consequences. Together they suggest the extent to which these policies could impact on individuals and their careers and the ways in which this changed over time as scientists were integrated into the 'warfare state' in new ways.

Modern medicine, ancient ancestors: Babylonian gods and disciplinary identity in Wellcome's Historical Medical Museum, 1913

Ruth Horry, University of Cambridge

Session: Historical Displays and Disciplinary Identity

In 1913, pharmaceuticals entrepreneur Henry Wellcome opened a Historical Medical Museum in London, where doctors could learn about the history of their profession. Its displays presented a narrative of progress, which culminated in a hall of statuary. Here, healing deities from Babylonia rubbed shoulders with their ancient Greek and Egyptian counterparts. Literate civilization flourished in Mesopotamia (Assyria and Babylonia)—the geographical area that is now modern Iraq—from c.3500–75 BCE. Through his unique purchasing power Wellcome created his own narrative of the roots of modern medicine, which included ancient Mesopotamian civilization. Wellcome commissioned his own versions of Babylonian statues for his Museum, turning two-dimensional originals into reconstructed three-dimensional versions to fit his own aesthetic. Mesopotamian imagery was manipulated and became more ‘classicized’ in style. The Museum’s displays thus presented Babylonian gods as part of Western medicine’s lineage, albeit subordinate to Classical equivalents. Ultimately, however, Wellcome’s audiences from the Royal Society of Medicine remained unconvinced by the non-Classical elements of his narrative. This paper discusses how Wellcome’s Historical Medical Museum integrated Mesopotamian sources into histories of medicine dominated by ancient Greek ancestry. It provides a case study of an early-twentieth-century trend in historicizing medicine to strengthen disciplinary identity. Further, Wellcome’s museum is a rare example of a cross-cultural history of modern medicine, which departed from Hellenic-based ancestry and incorporated new knowledge from Assyriology and related disciplines.

The Competing Definitions of Evolution According to the Modern Synthesis

Philippe Huneman, IHPST, Paris

Session: Was the Modern Synthesis Actually a Synthesis, and in What Sense?

Most of the criticisms to the Modern Synthesis concerned its alleged gene-centrism. The textbook definition due to Dobzhansky, “evolution is the change in allelic frequencies in population” has been challenged many times, e.g. from the view point of evo devo. It expresses the idea that population genetics is the science of the process of evolution by natural selection, hence contesting this role goes with suggesting other definitions of evolution, e.g. Carroll (2005): “evolution is the change of developmental programs along time”. The core of the controversy is therefore the role of gene dynamics in evolution: is it causal (making PG causally explanatory), or a correlated effect? However, within MS itself alternative definitions of evolution have been proposed, so that clearly the currently challenged gene-centered definition was not a common claim: e.g. Mayr wrote: “Evolution is not a change in gene frequencies, as is claimed so often, but the maintenance (or improvement) of adaptedness and the origin of diversity. Changes in gene frequency are a result of such evolution, not its cause.” (Mayr 1997) In a word, MS simply established that change in the frequency of alleles goes together with evolution, but not that it constitutes or causes evolution. I will examine definitions of evolution by Mayr, Dobzhansky, Wright and Fisher in order to determine which have been the endorsed theoretical positions concerning the relationships between gene frequency change and evolution, and therefore build the Modern Synthesis space of theoretical options regarding the role of population genetics in the understanding of evolution.

“A Mechanism for Staying Alive on this Planet:” The Environmental Meanings of Global Nuclear War in the U.S. and the USSR, 1954-1986

Jonathan R. Hunt, University of Texas-Austin

Session: Tool of Science, Tool of Politics: Radioactive Contamination in Historical Perspective

This paper examines the historical development of perceptions, norms, and theories concerning the effects of global nuclear war on built, natural, and transnational environments. I employ a local-global

framework to explicate how minority and majority discourses of nuclear doomsday shaped Cold War nuclear strategy and diplomacy from 1954 to 1986. Doomsday notions sprung from the environment's significance in three, identifiable ideological schools—sovereign territorial, high modern, and ecological. These environmental paradigms played a central role in strategic and diplomatic thinking about nuclear war during the Cold War. The paper will begin with a discussion of the 1950s and 1960s debates over radiation hazards, local, regional, and transnational fallout, and the “winnability” of an all-out thermonuclear war. Pre-Limited Test Ban Treaty (1963) nuclear discourse featured prominent environmental and ecological themes alongside strong appeals to national sovereignty and security. Next, I will explore the advent of deterrence theory and mutual assured destruction in the 1960s and 1970s in terms of environmental implications. I argue that territorial productivity, rather than casualty figures, was the crucial factor in these two nuclear paradigms. Finally, I investigate the environmental values and suppositions at play in three key, related moments during the Cold War's denouement: the hypothesis of nuclear winter in the U.S., the Soviet meltdown at Chernobyl, and the disarmament negotiations at Reykjavik, Iceland. I speculate that the growing traction of environmental arguments in popular and elite discourses facilitated a momentous shift away from brinkmanship and confrontation and toward U.S.-Soviet détente and nuclear negotiation.

The Fire without Light: The Non-Mechanical Foundation of Descartes' Mechanical Physiology
Barnaby Hutchins, Ghent University

Session: Mechanism, Life, and Embodiment in Early Modern Science

I claim that Descartes' mechanical account of the body rests on a non-mechanical foundation: the ‘fire without light’. Descartes takes himself to have a fully-mechanical physiology, and he is usually regarded as the instigator of iatromechanism, with the unadulterated mechanism of his physiology taken as its chief innovation. I claim, however, that Descartes' extensive mechanical physiology is underpinned by something non-mechanical. The fire without light in the heart, his principle of (animal) life, turns out to be underdetermined by mechanical explanation. In the work he had published, Descartes merely states the heat of the heart as a given, offering no further explanation. It is only in the correspondence and the unpublished *Description of the Human Body* that he approaches any kind of explanation. But rather than an explicit account, he provides only allusions to obscure chemical processes: heating by lime and fermentation – the standard comparison for the heat of the heart since Galen. Where he addresses these processes (*Principles*), the former is addressed by vague, incomplete comparison to the latter, which itself is one of Descartes' more cursory and speculative accounts of a natural phenomenon. The connections between the heat of the heart, lime, and fermentation are left undetermined. It is remarkable that Descartes, who explains the rest of the body's systems in intricate mechanical detail, should leave obscure the principle on which those systems depend. Descartes' iatromechanism thus appears to be dependent on a non-mechanical principle imported from the Aristotelian and (al)chemical traditions.

The Accuracy of the Timeball and the Development of Electrical Timekeeping in Liverpool, 1850-1870

Yuto Ishibashi, Imperial College London

Session: Instruments and Measurement

The objective of this paper is to trace the significant developments of accurate timekeeping that occurred in mid to late nineteenth century Liverpool. Initially, this paper will explore the scientific credibility of a timeball that was created by the Electric Telegraph Company. This will involve an examination of a series of discussions between George Airy, the seventh Astronomer Royal and John Hartnup, the director of the Liverpool Observatory as to its degree of accuracy. The logic and evidence used in their correspondence not only to cast doubt on, but also to help to prove the actual degree of accuracy of the timeball will be examined. Another focus of the paper addresses a system of regulating clocks by an electric current sent from a standard clock at an astronomical observatory. This new kind of scheme, invented by R. L. Jones

and originally introduced in Liverpool, was accepted as one of the most useful ways of synchronising clocks among the scientific, engineering, and horological communities in Britain. This subsequently led to the transfer of the method to other cities including London, Edinburgh, Glasgow and one of the British colonies. This paper will attempt to assert the idea that Jones's plan was of great importance to the early history of electrical timekeeping, as it became a decisive tool at the observatories in these cities in order to successfully disseminate time for the local populace.

The Hunt of Pan: The Creative and Heuristic Role of Experiments in Francis Bacon's Natural Histories

Dana Jalobeanu, University of Bucharest

Session: Experimenting in the Baconian Style

For Bacon, the proper objects of philosophy, the 'principles, fountains, causes and forms of motions, that is, the 'appetites' and 'passions' of every kind of matter' (OFB V 246) are to be investigated through a carefully regulated experimental procedure called *experientia literata*. Bacon pictures his experimental methodology as torturing nature and obliging it to reveal her secrets. This procedure, however, is fraught with conceptual difficulties. In Bacon's view, natural phenomena and all properties of bodies ultimately arise from the 'appetites' and 'desires' of spirits. Although material, spirits are not 'like' matter. Unlike the mechanical philosopher, Bacon did not postulate similarity between macroscopic/visible phenomena and what happens on the microscopic level. In his view, there is no reason to believe that the invisible spirits trapped in bodies act in the same way as macroscopic bodies that are subject to experience, and there is no reason to infer anything concerning the nature of spirits from the visible effects of our experiments. Experiments cannot function as evidence for Bacon's matter theory. In this paper I show that Baconian experimentation was not primarily designed to provide evidence for a speculative theory of matter. On the contrary: experiments have a number of different functions. I will identify three such functions: (i) experiments can serve as models for understanding more complex phenomena; (ii) experiments can work as classificatory devices in a presupposed cosmological scheme/matter theory; (iii) experiments, by providing 'ministrations' for the senses, memory and intellect, contribute to a more general program of 'medicining the mind'.

The Role of Editing Manuscripts in Post-1945 History of Science

Frank James, Royal Institution

Session: Correspondence, Manuscripts, and Digitalization

As historians today we are so familiar in using unpublished material in our work and having access to complete edited editions of papers and correspondence (e.g. Boyle, Darwin, Faraday, Einstein etc), that it is difficult to conceive how the subject might have been practiced before such texts became so easily available. Yet the introduction of manuscript studies into the history of science was considered by many historians in the 1940s and 1950s not to be important or indeed relevant to the study of the development of science which was taken to be a form of public knowledge. In this talk I will link, through examining the work of the husband and wife team of Rupert and Marie Boas Hall, the development of manuscript studies with new historiographical trends in the 1950s and 1960s. In particular I will discuss the role that editing manuscripts played in developing (and ultimately overthrowing) the concept of the scientific revolution. The Halls were responsible for publishing for the first time many of Isaac Newton's manuscripts and also the thirteen volume correspondence of Henry Oldenburg. Appropriately for this talk, a significant portion of the argument will be based on their own love letters.

‘Coalbrookdale by Night’ and the Science Museum by Day

Boris Jardine, The Science Museum, UK

Session: Historical Displays and Disciplinary Identity

Art historian F.D. Klingender’s seminal 1947 book *Art and the Industrial Revolution* was the first to establish a ‘canon’ of depictions of the Industrial Revolution. In addition, its staunchly Marxist polemic depicted industrialization as ‘process’, with highly differentiated and locally specific rates of change, false-starts and uprisings, fidelity to actors’ categories and the establishment of working-class consciousness. This paper explores the complex relationship between Klingender’s book and the Science Museum—a institution fond of technical and progressivist narratives of a very different hue. Under the enlightened direction of Frank Sherwood Taylor in the early 1950s, the imaginative and artistic portrayal of all aspects of the Industrial Revolution were brought under the Museum’s purview, often contrary to the old historiography and to the chagrin of the curators. In addition to collecting paintings vital to Klingender’s thesis—for example P.J. de Louthembourg’s remarkable ‘Coalbrookdale by Night’ (1802)—the Museum began acquiring contemporary depictions of industry, and commissioning large murals to adorn galleries on the history of mining and agriculture. I argue that this was Sherwood Taylor’s attempt to engage with a range of contemporary political movements and philosophies of history, examining not only the ideology but also the reception of these new museological departures.

A Wormy Kind of Death: H. Robert Horvitz’s Genetic Study of Cell Death in *C. elegans*

Lijing Jiang, Arizona State University

Session: Death under the Microscope: Histories and Mechanisms of Apoptosis Research

Set amid a number of projects aimed towards identifying genes from mutants of nematodes *Caenorhabditis elegans*, molecular biologist H. Robert Horvitz’s genetic work on programmed cell death was exceptional, and was recognized as such with a Nobel Prize in 2002. This paper traces Horvitz’s research path in which cell death in *C. elegans* turned from a subject of mapping cell lineage to that of mapping genes significant for human health and diseases. Arriving at the Laboratory of Molecular Biology in Cambridge, England in 1974, Horvitz joined Sydney Brenner’s ambitious plan for determining molecular mechanisms in complex organisms using the worm model. Employing a laser microsurgery technology that resembled techniques in classical experimental embryology, Horvitz helped complete a full description of the organism’s somatic cell lineages by 1977. Intrigued by cell death in the development of *C. elegans* as one of the “problems of developmental biology at the level of resolution of single cells,” Horvitz used mutagenesis and mutant screening technologies to hunt for what he metaphorically called “death” and “killer” genes. After identifying two “death genes” by 1986, Horvitz also fished out “protector” genes that prevent cell death, and eventually found homologies between these fateful worm genes and human genes that relate to diseases including cancer. From mapping cell fates to mapping genes, Horvitz’s study from the late 1970s to early 1990s crystallized a trajectory in which the study of cell death metamorphosed from approaches of classical experimental embryology to a field of molecular developmental biology and biomedicine.

Joe Trenaman’s Investigation of BBC Listeners’ Understanding of Science

Allan Jones, The Open University

Session: Science in Public Culture

During 1949, Joe Trenaman in the BBC’s Further Education Department conducted an experiment into listeners’ comprehension science broadcasts (and some non-science broadcasts). Subjects listened to a recorded broadcast and then wrote everything they recollected. Their recollections were marked and correlated with their educational qualifications and level of interest. The major findings were that subjects who understood the talk best were not the ones who found it most interesting. Rather, it was subjects for whom the talk was only just comprehensible who found it most interesting. This ‘scientific’ test of

comprehension had a number of outcomes for the various interested parties. Trenaman conducted further experiments and eventually become an academic educationalist. For the BBC, the findings supported existing institutional practices, in particular the three-service network that had been developed just after the War. For scientific advisors to the BBC, however, the findings played into a current debate with the BBC over the form science broadcasts should take. Trenaman's results were announced just as scientist-advisors were on the defensive, having had their claim that science broadcasts concentrated unduly on 'social issues' disproved by evidence from BBC managers. Trenaman's findings were used by scientists to support their argument that science broadcasts should be managed by an outside scientist, who would ensure that they adhered to requisites of comprehensibility and scientific coherence. The outcome was the experimental appointment of a coordinator for scientific broadcasts.

“A Barrier to Medical Treatment”? British Medical Practitioners and the Patent Controversy, 1880 - 1920

Claire Jones, University of Warwick

Session: Ownership and Invention of Medical Technologies

The number of British inventors patenting product designs dramatically increased throughout the nineteenth century. Yet, while patents legally protected the intellectual property of the inventor, their registration resulted in fierce opposition from some manufacturers, who saw the practice as restricting growth by placing ownership in the hands of only one inventor. Whilst historians such as Adrian Johns have recognised that late-nineteenth and early-twentieth century attitudes towards patenting were diverse, the ways in which these attitudes manifested within specific trades and their impact on trade-specific innovation remains largely unexplored. This paper seeks to examine attitudes towards, and the effects of, patenting within the medical and surgical instrument trade in late nineteenth and early twentieth century Britain. Patenting became a prominent and contentious issue for the medical profession during this period because inventor-manufacturer tensions, common to many British trades, were further complicated by unique ethical and professional concerns. As periodical-based debates show, the medical profession was strongly opposed to patenting because it represented “a barrier to medical treatment” and was thus detrimental to the nation's health; this claim was made by few opponents in other professions or industries. As this paper outlines, the profession's development of strict codes of conduct forbidding members from patenting their designs led to rebellion among some medical practitioners, who increasingly sought the legal protection from patenting they believed they deserved for their role in medical innovation. Such polarised opinions within the medical trade remained unresolved long into the twentieth century and continue to affect current medical practice.

Oxford Serialised: Revisiting the Huxley-Wilberforce controversy through the Periodical Press

Nanna K. L. Kaalund, Aarhus University/University of Toronto

Session: Science in the Press

At the 1860 BAAS meeting a debate took place that has come to represent an iconic moment in the relationship between science and religion in nineteenth-century Britain. This event has been canonised because the Bishop of Oxford, Samuel Wilberforce and T.H. Huxley had a heated exchange of opinions regarding the significance of evolution for Victorian society. Building on the work of historians such as Bernard Lightman (2001), Jonathan Topham (2000), James Secord (2004) Frank James (2005) and J. Vernon Jensen (1998), this paper will show how using material from the periodical press can cast new light upon important historical events. By examining the way the North American presses portrayed this British event, this paper will show not only differences in representation between North America and Britain perspectives, but also give indications towards the way in which news travelled and changed through distance and time. Taking together this perspective, with considerations of the textual strategies of the authors, this approach provides a means for analysing the experiences and conceptions of the event at the BAAS meeting from the perspective of the contemporary readers. Moreover, it makes it possible to

shed light upon the contest for cultural authority as it was manifested in mid-nineteenth century press. Through a close study of undertreated material, I will show that there is much to be learned from looking at the ways in which the press influenced both 19th-century and contemporary understandings of the readership of such moments as the 1860 BAAS meeting.

Exploring the Archaeology of Light in Roman Britain

Zena Kamash, University of Oxford

Session: Ancient Science and Technology

With the arrival of the Romans in AD43 a variety of new practices were introduced, which changed the shape of life in Roman Britain to varying extents. In this paper I will explore the ways in which light was manipulated in Roman Britain. As well as looking at the well-documented evidence for new lighting technologies, I will also examine how these affected other material ways of engaging with the world, asking the extent to which these technologies had a knock-on effect on e.g. domestic living. By comparing the material culture of light in the Roman and Iron Ages, I will demonstrate how understandings of, and responses to, light changed under Roman rule.

Phone Lines on Front Lines: The Victorian Army and the Telephone

Michael Kay, University of Leeds

Session: Fighting Technologies: Military Confrontations with Telecommunications Systems, 1876-1918

This paper will examine attitudes within the British Army towards the telephone, from its invention in 1876 through several military campaigns in the 1880s. Although the Army successfully employed the telephone during combat in India, Afghanistan, Egypt and Sudan, few histories of military technologies discuss telephony. Likewise, existing histories of telephony rarely note early military use, and thus omit an important and innovative early user of this technology. Military requirements occasionally demanded more of telephone instruments than civilian usage, resulting in technological improvements. Opinions on telephony varied; having seen the telephone in active service, some praised its portability. Anyone could use it, and it could transmit important and difficult messages immediately, without confusion. Others lamented the lack of written record and the disturbing noise of the telephone bell. Many generals and other high ranking officers opposed telephone use. One factor in the uptake of the telephone was the availability of pre-existing infrastructures of telegraph lines which could be converted to telephone use if required. Using contemporary periodical sources such as the Times and the Electrician, and the archives of the National Army Museum and Imperial War Museum in London, this paper will demonstrate the Army's importance as an early user of the telephone and the ways in which this use shaped the development of the fledgling technology. The paper will conclude with a brief mention of the Army's use of the telephone during the Boer War at the turn of the century, providing a chronological segue into the next paper.

Myths about Science and Religion in History and Science Textbooks in America

Michael Keas, Southwestern Baptist Theological Seminary

Session: American Religion and Science: New Studies

American astronomy textbooks over the past few centuries have told a number of inaccurate stories about the historical relationship between science and religion. What roles have these myths played in American education? This study focuses on textbooks myths having to do with the history of ideas about earth's shape, location, motion, size, and significance. We shall identify the worldviews that have shaped astronomy textbook content at the intersection of history, philosophy, science and theology. Johannes Kepler's vision of science and theology as contained in the first modern astronomy textbook (*Epitome Astronomiae Copernicanae*, 1618-1621) provides a background of previous teaching against which subsequent textbook wandering may be charted.

‘Things Familiar’: Object Lessons in Victorian Science and Literature

Melanie Keene, University of Cambridge

Session: The Sense of Things: Perception as Practice in Educational Settings

The use of familiar objects as both physical didactic devices and literary pedagogic analogies was particularly prevalent and powerful in the mid-nineteenth-century sciences. Candles and cups of tea, pebbles and primroses, salt and see-saws were recruited to explain and entertain, as scientific education was placed at the heart of Victorian domestic life. In this talk I shall introduce the aims and artifacts of what I term ‘familiar science’, exploring how the quotidian, commonplace world was used to communicate novel facts and fascination phenomena to childish audiences, through sensory practices. This widespread means of scientific instruction and participation revealed the everyday environment as saturated with the sciences, and transformed it into a wonderland. More widely, and elevation of the familiar to a central part of scientific practice and communication can, I suggest, provide a new prospect on and a refined analysis of popularisation. In particular, I shall explore how the Wilkinson family—father, mother, brothers Harry and Tom, wealthy Uncle Bagges, and the servants—learned about the sciences in a series of after-dinner conversations in 1850. The ‘mysteries’ of the boiling kettle on the stove, the ‘laboratory’ to be found within their bodies, and the ‘history’ of the glowing candle on the table-top, provided opportunities to show off and impart scientific knowledge, as well as allude to family in-jokes and the news of the day. The Wilkinsons’ discussions were literary representations that appeared in articles by Percival Leigh for Charles Dickens’ weekly periodical, ‘Household Words’; nevertheless, as I will show, they reveal important aspects of how familiar science was supposed to be integrated with family life, verbal debate, and embodied experience in the period.

The Three Societies: An Alchemical Agenda in the Early Oxford, Royal, and Dublin Societies

Vera Keller, University of Oregon

Session: Beyond Transmutation: The Goals of Early Modern Alchemy

Largely excluded from academic settings before the seventeenth century, alchemy did not divide between manual and theoretical work as did, for example, academic medicine. Yet it was the union of the manual and philosophical which allowed a range of practices, from glassmaking to dyes, to flourish alongside loftier goals. As a major interest of late seventeenth-century learned societies, alchemy offered a model for the extramural study of nature which covered the spectrum from the most utilitarian to the most speculative knowledge. Claiming to fulfill the public interest by addressing this full range, Fellows of the Royal, Oxford, and Dublin societies drew up *desiderata*, or research agendas, for areas far from traditional academic purviews. This paper explores the relationship between the traditionally most epistemically prestigious academic goals, such as *chrysopoesis*, and less elevated agenda items within Robert Plot’s “Catalogue of some of the Arcana and Desiderata in Chymistry.” Plot composed the list for the Oxford Philosophical Society and communicated it to the Oxford and Dublin Societies at their request in 1684/5. I will argue that the practice of framing research problems in the form of *desiderata* affected the ways society members related to the multiplicity of alchemical aims. The *desiderata* list did not frame the philosophers’ stone as the ultimate fount of all alchemical knowledge, but as one among many desired processes. This attention to individual processes raised the status of non-chrysopoetic processes, which posed important research questions in their own right.

Anglo-American Connections in Japanese Chemistry

Yoshiyuki Kikuchi, Harvard University

Session: Transatlantic Reactions: Translating Chemistry between Continents

Constructing an effective system of technical education was an issue of global importance throughout the nineteenth century and beyond in Europe and in North America. A nascent East Asian nation-state which

tried to build a higher education system as part of its industrialization policy, Japan in the Meiji period (1868-1912) desperately needed models for exactly this kind of pedagogy. Widely conceived as the most practical and utilitarian of all scientific subjects throughout the nineteenth century, chemistry was one of the first academic subjects institutionalized in Japanese higher education and therefore was at the center of this educational development. The dominance of American and British teachers in this process during the 1870s affords historians a unique opportunity to examine to what extent chemical pedagogies in the United States (especially on the East Coast) and Britain in this period were related to each other and how they were compared by contemporaries. To look into these questions, this presentation focuses on how three categories of actors, 1) Japanese educational officials such as Hatakeyama Yoshinari educated at University College London (UCL) and Rutgers College in New Brunswick, New Jersey, 2) foreign advisors on Japanese educational affairs such as Dutch-American missionary Guido Fridolin Verbeck and Rutgers professor David Murray, and 3) chemistry teachers such as Rutgers-educated William Eliot Griffis and UCL-educated Robert William Atkinson, perceived and compared American and British models of chemical pedagogy, translated them, and negotiated with each other to build a workable and locally relevant pedagogical regime for Japanese chemistry.

Stabilizing Chemical Objects

Mi Gyung Kim, North Carolina State University

Session: What is the Object of the History of Chemistry?

Chemistry in its historical evolution may be characterized as a science of analysis and synthesis. One could legitimately argue that chemical practice consisted mostly in analysis until the advent of organic synthesis in the nineteenth century. This seemingly self-evident characterization belies the unspoken assumption, however, that chemists analyzed “nature” into her hidden components to put them back together or to make new substances, as represented in chemical equations. Little thought is given to the *evolutionary* nature of chemical objects contingent upon the *methods* of analysis and synthesis – that chemists at any moment of history began with the substances that were prepared by the available analytic methods and could make new ones only by inventing new methods of synthesis. The evolutionary nature of chemical reality has been hidden from our view in part because our understanding of chemical theory has been linked to the mathematicophysical theories that supposedly “re-present” nature. Lavoisier’s efforts to inscribe chemical operations in algebraic equations thus marked the beginning of “modern” chemistry. The problems posed and the vocabulary developed by the philosophers of science around the theory-experiment distinction bypassed the plastic repertoire of “methods” which engendered theories and facts. This paper will examine the dialectic relationship between analytic methods and chemical theories in pre-Lavoisian chemistry which stabilized chemical objects as hybrid-natural entities to delineate the constructive, rather than the representational, function of chemical theory in the laboratory.

Engineering Consent: The Scientific Rhetoric of Public Relations in Interwar USA

Michael Kliegl, University of Kent

Session: Science in the Press

It being in their nature, early public relations practitioners went to great lengths to promote their new profession. And given the rising cachet of science in the interwar years, it seems only natural that these public relations pioneers would seek to create a scientific aura for their profession. Even before the First World War, publicity men referred to themselves as ‘doctors’ of publicity. The trend was given a new direction, however, by Sigmund Freud’s nephew, the so-called father of public relations, Edward L. Bernays (1891-1995). Influenced by his uncle’s theories, Bernays introduced the concepts and the language of psychoanalysis and psychology to public relations. Via a systematic utilisation of symbols and cultural references, the public relations professional would be able to tap into- and manipulate people’s unconscious drives and desires. Furthermore, underpinning his desire to apply scientific methodology to social problems, Bernays claimed that public relations were essential for maintaining a

stable democratic society – a trend which culminated, after the Second World War, in a volume edited by Bernays entitled *The Engineering of Consent*. By engineering the wants and desires of the public, the contributors claimed, it could be ensured that the people would remain docile and happy. In looking at Bernays's correspondence with Freud and with his clients, as well as his numerous books and publications, this paper aims to uncover how he used the rhetoric of science to help establish the new profession of public relations with a scientific aura.

Untangling Entanglement: Probability, Stalinism, and the Paradoxes of Quantum Mysticism

Alexei Kojevnikov, University of British Columbia

Session: Recasting 20th Century Physics

The paper analyzes the responses to strange and new quantum mechanics in the Soviet Union and reconsiders the relationship between dialectical materialism, in its Stalinist version, and the ideological challenges presented by the “spooky” paradoxes of quantum interpretations. Post-WWI cultural debates in Soviet Russia engendered idiosyncratic reactions to such sensitive aspects of quantum mechanics' Copenhagen philosophy as individualism, indeterminism, and *Anschaulichkeit* (possibility of visualization). The analysis of Soviet mathematicians', physicists' and philosophers' debates regarding the unseen reality of the microscopic world helps uncover the ideological and cultural attitudes behind the modern foundation of the mathematical probability theory by Andrei Kolmogorov in 1933 and the development of the ensemble interpretation of quantum theory by Dmitry Blokhintsev in 1949.

Seeds of Exchange: The Russian Tradition of Apothecary and Botanical Gardens in the First Half of the Eighteenth Century

Rachel Koroloff, University of Illinois, Urbana-Champaign

Session: Botany and Natural History

The botanical tradition in Russia, often dated to the establishment of the gardens of the Academy of Sciences in St. Petersburg in the 1730s, appeared at the confluence of a variety of traditions of plant cultivation already familiar in Russia in the 17th century. These traditions, flourishing in monasteries, hospitals, and in imperial as well as private estates, provided fertile ground for the growth of an eighteenth-century botanical tradition colored by local knowledge mined from a broad array of Russian society. Apothecary gardens in particular sought to maintain common knowledge of medicinal plant use in combination with European developments in classification, and existed in dynamic exchange with the newly founded botanical gardens in the empire's capitals. The relationship between the apothecary and botanical gardens in St. Petersburg in the first half of the 18th century provides a clear example of how a network, forged by the early apothecaries and maintained by the state, circulated seeds, texts, and personnel throughout the Russian empire in an attempt to create an interconnected web of gardens founded upon a belief in the importance of Russia's unique natural resources. The movement of the material objects through space particular to botanical and apothecary practices traces the landscape of Russia's early scientific community and suggests the essential importance of mobility and material culture in creation of an intellectual approach to the natural world simultaneously defined by the borders of empire and yet confined to the roads and itineraries that held it together.

Science, Ideology and Worldview: John C. Greene's Long Correspondence with Theodosius Dobzhansky and Ernst Mayr

Stewart Kreitzer, University of Florida

Session: Scientific Correspondents

This paper examines the career of John C. Greene, the author of the influential book, *The Death of Adam: Evolution and Its Impact On Western Thought*. Greene served for many years as an officer and president for the History of Science Society, which awarded him its highest honor, the George Sarton Medal, for a

lifetime of scholarly achievement. Greene's interest focused on the interplay of science, ideology and worldview, especially in the study of evolutionary biology. Green also discussed this subject in extended correspondences with two of the twentieth century's leading evolutionary biologists, Theodosius Dobzhansky and Ernst Mayr. In each conversation, Greene brought his classical training in the history of ideas, criticizing both men for their casual interjection of private metaphysics into public presentations of evolutionary theory. With Dobzhansky, Greene argued Christian metaphysics should be avoided in natural analyses, while with Mayr (and others), Greene argued that expressions of evolutionary humanism similarly undermined scientific integrity. As Greene himself stated: "To ignore the difference between science, philosophy, and religion and roll them into one evolutionary gospel claiming to disclose the meaning of existence" could prove "as dangerous an idea to science as it is to philosophy and religion." He suggested that virulent creationism was in part a reaction to carelessly mixing personal philosophy with professional science, and feared it potentially threatened the "hard won ideal of disinterested inquiry guided by insight and logic." Greene's engagement as a historian with scientists, suggests a role for historians that may be beneficial for both historians and scientists.

The Biography of the Blue Dye: Science, Nature and the Limits of Improvement

Prakash Kumar, Colorado State University

Session: Material Culture

This paper will debate if there is something "natural" out there that sets an ultimate limit to historical action. Historians of science, those in the constructivist program, have long questioned the antiquated assumption that science is the progressive unraveling of an ultimate fixed natural knowledge. But there still remains a nod in the direction that, after a point, a commodity or a scientific object reaches a limit to their improvement. The issue exists in the niches of the wider philosophical debate between realism and those who oppose it and yet concede to it some ground. The jury is still out on this question among those who consider culture-nature relationship. One of the ways out of this debate among sociologists and feminist historians of science has been to conceptualize the existence of actor network - giving equivalence to humans and non-humans; or conceptualizing cyborgs to meld the human and the non-human existentially. This paper takes up the historical case study of indigo dye and its improvement during its long history within peasant societies, plantation systems, and modern science between the mid-seventeenth century and the era of the First World War. When did indigo become a valid object of improvement efforts? What did improvement mean? Who decided that a natural limit to improvement had been reached, and who dissented? This paper will answer the above questions to intervene in the debate over the precise parameters of the relationship between science and nature.

Transferring the Ether Concept in the USA: Herbert's E. Ives' Theory and His Opposition to Relativity

Roberto Lalli, Massachusetts Institute of Technology

Session: Circulating Theoretical Physics: Scientific Exchanges between Europe, US, and Latin America

Between 1937 and 1953, US highly respected industrial physicist Herbert E. Ives challenged the acceptance of Einstein's relativity with different strategies. One of these was to create an alternative theory which empirical consequences were the same as those predicted by special relativity theory. Ives based this theory on the real existence of a luminiferous ether and of absolute simultaneity, stating that his theory was an improvement of the theories that Lorentz and, above all, Larmor formulated between the 19th and 20th century. Even though the use Ives made of these European authoritative allies was also rhetorical, it highlights how the persistence of some concepts, as the ether and the absolute time, was transnational. However, in the development of his own theory Ives linked these concepts to bodies of knowledge coming from local practice (of his daily work as electro-optical researcher at Bell Laboratories) and national tradition (with the explicit reference to Bridgman's operationalism). Ives' theory did not produce an immediate debate within the community of physicists, but his criticisms of the

epistemological foundations of SRT were considered of interest by some philosophers of science and, later, used by a number of dissident physicists to reject Einstein's theories. In spite of this interest, historians didn't pay attention to Ives' theoretical opposition to relativity until now. My aim is to fulfill this shortcoming with the analysis of Ives' published papers and unpublished letters clarifying Ives' epistemological presuppositions and to what extent his references to universal knowledge came from local traditions.

“They Do It in a Different Way”: Personal Experiences of Transatlantic Cooperation in Science and Engineering in the Cold War

Thomas Lean, The British Library

Session: Science and the State in the Cold War

From the Tizard Mission and Manhattan Project, through varied Cold War joint committees, research programmes and technological developments, the Anglo-American relationship in science and technology has been a special, albeit sometimes fraught, one. Britain has been privy to sensitive information from American research and development, most famously in nuclear engineering and weaponry. America has benefited from privileged access to British innovation, experience and expertise. Whilst the overall framework of these collaborations has been established, the human relationships bound up in them have received little direct attention. In this paper I discuss individual reflections of British scientists and engineers on working with their American counterparts, drawing material from life story interviews recorded as part of the British Library's an Oral History of British Science project. From this material I explore the personal experience of collaboration in a variety of engineering and applied sciences across the Atlantic. I reveal day-to-day interactions through which knowledge was exchanged, rather than the policy level recorded in official minutes. I touch on how exposure to different engineering cultures and ways of working brought mutual benefits, and on the sometimes contentious issues of British 'reliance' on American know-how, and American exploitation of British inventions. Through this process I suggest a two way flow of ideas and experiences which was beneficial to both parties, and I provide a more nuanced understanding of the balance of power in a relationship in which Britain is frequently seen simply as hopelessly subordinate.

The Glory of the Corps of Roads and Bridges”: Augustin Fresnel and the Ethos of Civil Engineering in Restoration France

Theresa Levitt, University of Mississippi

Session: Scientific Ethos and Epistemology in the Long Nineteenth Century

Augustin Fresnel spent his career as a Ponts et Chaussées engineer, wresting time away from his road-building duties by convincing his director that his scientific work brought glory upon the civil engineering corps. The extensive negotiations surrounding Fresnel's duties, both scientific and mundane, reveal the many transformations of the engineering corps in the decades following the Napoleonic wars, as it absorbed an ethos both of scientific rigor and nationalist identity. The notion of glory becomes a particularly useful tool for examining the competing demands, as it fused in Fresnel a personal ambition and sense of patriotic duty. These issues came to a head in the last years of his life, as he gave up his original research in physics to concentrate on his engineering duties for the lighthouse commission. The French state touted his lighthouse work, both highly technical and undeniably useful, as exemplary of the peculiar genius of French engineering, mobilizing science both in the service of national rivalry and universal humanitarianism.

Contextualizing Creativity: Maria Martin, Natural History Illustrator

Debra Lindsay, University of New Brunswick

Session: Science and Art in the American South, 1750-1850

One of many illustrators whose work graced the pages of natural history publications, Maria Martin (1796–1863) drew plants, trees, and insects for *Birds of America*, as well as snakes for *North American Herpetology* (John Edwards Holbrook, 1836–1840). Although Audubon had other assistants, Martin was distinguished from them as her work was acknowledged formally. She was recognized (in print) twenty times, she identified botanicals in her own handwriting on the original paintings, and her contributions to numerous plates composed as the last volume went to press were alluded to in Audubon's companion text, the *Ornithological Biography*. Additionally, Maria Martin worked without remuneration, whereas earlier background artists were employees. Devoted to realizing Audubon's vision of producing *the* authoritative work on American ornithology, as well as working subsequently on a similar project on mammals, Maria Martin's life was transformed in 1831. Then thirty-five years old, Maria Martin had known little other than the pietistic and patriarchal world in which she lived as a Southern Lutheran, but in conjunction with Audubon's wife Lucy, his sons Victor and John, as well as with John Bachman—Audubon's friend and collaborator and her brother-in-law and husband—Maria Martin helped produce some of the finest natural history illustrations of the period. Through images from *Birds of America* and artefacts in private collections, this presentation will reconstruct a world in which science and art joined religion and family in one Charlestonian household.

France's European Empire and the Eclipse of Cosmopolitan Science

Elise Lipkowitz, University of Michigan

Session: "Scientific Ethos and Epistemology in the Long Nineteenth Century"

In May 1796, the-then French General Napoleon Bonaparte famously stated to the Milanese astronomer Barnaba Oriani that, "All men of genius, who have reached a distinguished rank within the Republic of Letters, are French, regardless of their country of origin." Read through the lens of Napoleon's subsequent patronage of science as First Consul and Emperor, this statement has been interpreted as an expression of Napoleon's bravado, nationalist pride, and respect for scientific learning. Yet this statement, made amid a military campaign that resulted in the French conquest of Northern Italy and the spoliation of that region's scientific and artistic treasures raises deeper questions about the status of the European transnational scientific community (as embodied in the Republic of Letters) in the 1790s. My paper addresses the fate of the cosmopolitan ideal in transnational science during the French Revolution by exploring how the new geopolitical dynamic of conqueror and conquered reshaped scientific relations among French, Dutch, and Italian savants. Drawing on both correspondence and institutional records, I argue that the geopolitical conditions profoundly altered transnational scientific relations as French savants became both the expropriators of fellow Europeans' scientific treasures, the principal conduits of scientific information from locales outside the French Empire, and the patrons and protectors of savants in the Empire. Indeed, from the perspective of some savants in the Empire, Napoleon's statement that all men of genius are French may have proved all too prescient.

Wilhelm Nussbaum and Franz Boas: Anthropometry in the 1930s

Veronika Lipphardt, Max Planck Institute for the History of Science

Session: Genetics, Race, and Anthropology

This paper argues that collecting anthropometric data allowed scientists to adapt to diverse ideological and epistemic communities. After 1933, Jewish anthropologists left Germany, and academic discussions on the "biology of the Jews" came to an end. However, in 1933, German-Jewish anthropologist and geneticist Wilhelm Nussbaum, a former student of Eugen Fischer and Otmar von Verschuer, set up an institution in Germany ("Working Group for Jewish Genetics and Eugenics") that investigated more than 1100 Jews (1933-1934). Nussbaum received considerable support from Jewish institutions and state authorities. Nussbaum's research design contained preprinted questionnaires and examination forms, pedigrees and report sheets. Measurements and photos were taken, collected and registered; hundreds of lists, charts, calculations, graphs, tables and diagrams were derived from them; manuscripts and papers

summarized findings and implications. Nussbaum's aim was to support German Jews in their desperate situation, but he also built up a unique data set that aimed at various purposes. Franz Boas helped Nussbaum to immigrate to the US and offered him to work in his team. Nussbaum thus continued his work in a very similar vein, and his German research data was used for comparisons with data he and others obtained under Boas' supervision. This case study allows to question whether the divide between physical and cultural anthropology was as clear cut as recent studies have claimed. Also, it helps to contextualize Franz Boas' conceptualization of anthropology as well as his life long active role in biological anthropology and human genetics.

Jewishness and the Inheritance of Acquired Characteristics in Interwar Vienna

Cheryl Logan, University of North Carolina-Greensboro

Session: Jewish Scientists in Interwar Vienna

In interwar Vienna Julius Tandler and Paul Kammerer independently promoted a new kind of eugenics in which environmental conditions, conditioning, and education could replace positive and negative selection as a method of biological improvement. Their ideas were based on a modernized notion of the inheritance of acquired characteristics in which hormones that were produced by the interstitial cells of the gonad reacted to environmental change flexibly in ways that "touched" and altered the germ cells. Tandler expressed outrage at the increasingly rigid view of heredity growing in genetics when, in 1928, he said: "In the deep shadows of resignation, we cannot leave the fate of our children to the combinatorial elements of the chromosomes alone." Kammerer used the concept to explicitly deny the rigidity of racial boundaries as he accused others of racism. Each man was of Jewish heritage and their views challenged the rigid hereditarianism that underlay the assumption of Nordic 'racial' superiority that increasingly dominated the eugenics movements in Germany and Austria. I explore the responses of their critics, various antisemitic attacks on them and their science by colleagues such as Otto Reche, Othenio Abel, and Fritz Lenz, and their quite different personal reactions to how their science became stigmatized as the product of misguided Jews who desperately wanted to become German. As critics labeled the inheritance of acquired characteristics a Jewish racial idea, their work was undermined in part by the very concept that their science challenged: race.

Problems Posed

Jemma Lorenat, Simon Fraser University

Session: In the Library

At the beginning of the nineteenth century mathematical publication shifted from books to single discipline journals. The decreasing cost and increasing speed of production enabled an active dialogue between editors, authors, and readers. In particular, posed problems proved an engaging medium for communication between these three overlapping publics. Unlike earlier puzzle journals, these new journals, such as J. D. Gergonne's *Annales des Mathématiques Pures et Appliquées* and A. L. Crelle's *Journal für die reine und angewandte Mathematik*, were primarily aimed at people with advanced mathematical training. The posed problems straddled the line between amateur amusements and research questions. They attracted a diverse array of contributors and fostered original roles of problem posers and solvers. However, increased specialization gradually led to a strict demarcation between profession and recreation. Consequently, fewer serious mathematical journals chose to include posed problems until the practice fell entirely outside the domain of academics. This paper considers the posed problems as a unique microcosm illustrating the changing goals and standards of early nineteenth century mathematics.

Inscribing Science and Specialized Activities in Socialist China: A Spatial Analysis of Science Buildings in China 1953-55

Christine Luk, Arizona State University

Session: Science, States, and Space

This paper intends to present a historical analysis of the socialist prescription for science buildings from 1953 to 1955. The overarching argument of this paper is that certain buildings for specialized activities in the early years of People's Republic of China (PRC) reflect a socialist logic of space and vision of science in alignment with the transition from New Democracy to socialism. I hope to show that a close examination of the spatial construction of science buildings can unveil a socialist constitution of specialized activities and the relations between public and the state. The overriding question that informs this paper is the ways in which a specific set of socialist principle of space is translated into the science buildings and its contribution to the socialist vision of science. Science buildings (rather than general public and liturgical facilities) are important to scrutinize because the spatial divisions in these arenas are implicative of the construction of the social authority and credibility of scientific investigation and pedagogy. Studying socialist laboratories and spaces for science-related activities are likely to cast light on the changing geopolitical ecologies in the spatial order and the relations between science and the state in the early years of PRC. I will examine exterior ecology and the division of interior space in several pictorial representations of science buildings contained in a series of anthologies published between 1953 to 1955 by Economic Information & Agency (經濟導報社) in Hong Kong.

The Quest for the 'West': Empire(s), Western Knowledge, and Korea

Eun Jeong Ma, Pohang University of Science and Technology

Session: Transmission of Science and Medicine in East Asia

In contemporary Korea, there exist two parallel medicine systems with distinct hospitals and medical schools: Western medicine (WM) and Oriental medicine (OM). WM was introduced into Korea, initially through Christian missionaries in the late nineteenth century and later through Japanese colonial agents. In this paper, I first gloss over Christian missionaries and Japanese colonial agents who served as conduits to transmit Western knowledge to Korea. Next, I investigate the contentious concepts of 'Western' and 'modern' by paying particular attention to the Oriental-Western medicine controversy. The Japanese colonial period (1910-1945) is associated with modernization wrapped up with loosely constructed 'Westernization.' The colonial government restructured Korean medicine and tried to marginalize OM, which had existed as the official and orthodox medicine until that time. The colonial authorities repressed traditional OM on the grounds that it was not modern and scientific. Concurrently, the colonial government encouraged WM by establishing both institutions for medical education and public hospitals at major cities. In the 1930s, when this colonial order was stable to a degree, proponents between OM and WM clashed over relative merits of each medicine. In doing so, they contested the nature of West and modernity.

A Long-Standing Antecedent of Laurent Joubert's *Erreurs populaires*

Vera Cecilia Machline, Pontifical Catholic University of São Paulo

Session: Science and Technology in History

After the publication of Natalie Zemon Davis' essays making up *Society and Culture in Early Modern France*, very little seems to be worth adding in respect to the *Erreurs populaires* conceived by the Montpellier physician Laurent Joubert (1529-1582). To be brief, according to Davis, Joubert's goal with the new kind of book he inaugurated with that title was to demonstrate the superior knowledge of the university-trained physician over all those intruding into the realm of medicine. Besides charlatans and other quacks, these comprised not only "empiric" practitioners such as surgeons, apothecaries, midwives, and attendants, but also anyone venturing a lay opinion on medical matters. Davis considers that

theological writings against religious misconceptions, headed by the *Tractatus de superstition* penned by the professor of the University of Cologne Henricus de Gorinchem (?-1431), clearly anticipated Joubert's *Erreurs populaires*, since the latter did not have Medieval antecedents in the area of medicine. Interestingly enough, as shall be discussed in this presentation, in the gynecological treatise of Soranus of Ephesus (*fl.* beginning of the 2nd century), which has come down to us in bad condition, there already are admonitions against superstitious beliefs held by midwives, as well as common people.

"Proven Effectiveness": Evidence Based Medicine and the Rise of Cognitive Behaviour Therapies since 1950

Sarah Marks, University College London

Session: History of the Human Sciences

CBT has become the therapy of choice in many Western countries, and is now the primary mode of psychotherapeutic intervention in the British National Health Service with substantial government investment. How has it come to hold such a dominant position? Very little historical work has been done on the intellectual origins of CBT, and the social and institutional contexts in which it has come to attract such economic backing. This paper addresses this lacuna, using a range of published sources and oral history interviews to chart the intellectual development of behavioural and cognitive psychotherapies by psychiatrists, clinical psychologists and psychotherapists. Beginning with the invention of behavioural therapies at London's Maudsley Hospital in the 1950s, I will then explore the fusion of these techniques with the seemingly philosophically opposed 'cognitive' therapies in the 1970s across Britain and North America, and the subsequent quest to prove CBT's efficacy since the 1990s. At the heart of this story is the notion of evidence and the role it has come to play in healthcare, from the initial creation of treatments in an experimental setting, through to state-level policy making. It is perhaps no accident that the rise of CBT coincides with the development of a movement for 'scientific method' in medicine (see Bradford Hill, 1948; Cochrane, 1971). As such, the rise of CBT also serves as a lens through which we can historicize understandings of scientific method, evidence-based medicine and effectiveness in healthcare, within in the political and economic contexts of the post-WWII world.

Model Students and Ambassador Users: The Role of the Public for the Global Marketing and Distribution of Nineteenth-Century Anatomical Models

Anna Maerker, King's College London

Session: Science in Public Culture

Anatomical models have long played an important part for shaping both professional and popular images of the body. Using the case of the French modelling company Auzoux, this paper investigates the role of the public for distributing and popularizing standardized body images on a global scale in the nineteenth century. The paper develops two categories of users, the "model student" and the "ambassador user", to highlight users' contributions to the circulation of anatomical models. The investigation also highlights how model users articulated their own identity in this process. Thus, the analysis raises questions concerning the possibility of audience participation in contemporary public histories of science and medicine.

"Science in Pictures": Rudolf Modley, Pictorial Statistics, and Telefact

Erin McLeary, Independent Scholar

Session: Science in the Press

When Rudolf Modley became executive director of the company Pictorial Statistics in 1934, he was capitalizing on a burgeoning international interest in depicting information graphically. Modley (a former colleague of Vienna Museum director Otto Neurath, who pioneered the field of pictorial statistics in the 1920s) left his position at the Chicago Museum of Science and Industry to help move this innovative

graphic method out of the museum setting and into a wide variety of publications. Telefact, launched in 1938, was a daily pictograph produced by the company that promised to explain science, economics, and social statistics visually, by turning “statistics into symbols that explain themselves”; among its subscribers was the widely distributed Science News Letter. This paper explores how and why Modley and his colleagues sought to depict scientific facts graphically. Relying on new ideas about visual education developed by science and public health educators, Modley helped develop new visual conventions for statistical information. This simplified symbology would, he and others believed, enable ordinary people to visualize complex ideas easily, through simply looking—an idea central to the work of mid-century proselytizers for visual education. Although recently design historians have become interested in Modley’s visual language, his work in communicating complex scientific ideas in a simple, graphic form has been little explored by historians of science. Examining Modley’s work in the context of the history of science restores his work to the context in which it emerged, illuminating the challenges of communicating science to popular audiences in the interwar period.

Playing with the History of Science

Iwan Rhys Morus, Aberystwyth University

Session: Science in Public Culture

Let us start with an image. In December 1858, the *Illustrated London News* published its usual spread advertising the year's seasonal celebrations. It was illustrated with a drawing – 'Christmas Holidays at the Polytechnic' – showing a bearded gentleman dressed as a sailor clinging to the poles of an electrical machine as an appreciative crows eggs him on. The image reminds us of how corporeal and tactile science could be for Victorian audiences. Victorian scientific performers engaged their audiences by engaging their senses. This sort of science was public both because of where it was performed and through the way in which it invited sensational immersion on the part of its audience. If we want to produce public histories of science – and particularly ones that engage with this sort of material – then we might also want to borrow a few tricks from these Victorian scientific performers. In this paper I will discuss attempts to use digital interactive technologies to represent and engage with Victorian experimental culture. I will suggest that technologies like these provide historians with tools to interrogate experimental culture from new perspectives. They provide opportunities as well for allowing students and other users to experiment with fashioning their own understandings of Victorian (and other) experimental cultures.

Collective History as a Mechanism to Explain Genetic Risk of Breast Cancer among High-Risk Ashkenazi Jewish Women

Jessica Mozersky, University of Pennsylvania

Session: Seeing and Believing: The Importance of Mechanisms in Human and Medical Genetics

The origins of genetic disease often lie in the demographic and socio-cultural histories of particular populations. Ashkenazi Jews are one such population and they have the highest known population risk of carrying three specific founder mutations in the high-risk breast cancer genes, BRCA1 and BRCA2. Each of these three mutations, commonly referred to as the ‘Ashkenazi BRCA mutations’, have been correlated to specific time points and events in Jewish history. This paper examines the way in which high-risk Ashkenazi Jewish women in the UK understood one aspect of collective history – endogamy - and its role in the origins of genetic disease. In addition to being associated with disease, endogamy is also an important mechanism to ensure the survival of future generations of Jews. Qualitative interview data with 14 high-risk women illustrates how this history was understood as a mechanism that causes genetic disease, and the potential future reproductive consequences of this knowledge. A contradiction may arise between a pre-existing sense of responsibility to produce future generations of Jews with that of producing future breast cancer free children.

Philip Henry Gosse: English Naturalist-Artist in Alabama, 1838

Gary Mullen, Auburn University

Session: Science and Art in the American South, 1750-1850

Largely self-taught, Philip Henry Gosse (1810-1888) was a naturalist/scientist whose fieldwork in Newfoundland, Canada, and the American South was the basis of his later reputation as a zoologist in England and Europe. During his career, he published some forty books and more than 270 scientific papers and religious tracts, producing the first illustrated field guide, a series of university-level textbooks in zoology, and major scientific treatises on marine organisms. He also corresponded with Charles Darwin and was elected a Fellow of the Royal Society of London. In 1827, at the age of seventeen, he made his way to Newfoundland, where he spent eight years working as a clerk with the shipping firm of Garland & Sons. While there Gosse began collecting insects, illustrating his specimens in watercolor miniature, a technique learned from his father. In 1835, he moved to Lower Canada, where he lived on the farm he purchased in Sherbrooke County for three years prior to traveling to Mobile and Dallas County, Alabama. He continued to pursue his passion for entomology in Alabama while employed as a schoolmaster for the children of plantation owners, during which time he decided to devote his life to natural history. Consequently, Gosse produced two sketchbooks of insect watercolors—*Entomologia Terra Novae* and *Entomologia Alabamensis*—both containing exquisite illustrations. The latter was recently reproduced (Mullen and Littleton, Philip Henry Gosse: Science and Art in *Letters from Alabama* and *Entomologia Alabamensis*, 2010). This presentation will focus on the formative years of this extraordinary individual's life.

Half-Casts and Family Lines. Franz Boas' Anthropometric Studies 1890-1891

Staffan Müller-Wille, University of Exeter

Session: Genetics, Race, and Anthropology

I will argue that the critique of the race concept emerged within anthropology in the nineteenth century already, when physical and cultural anthropology were not yet separated. The source for this critique was the increasing use made of the analytical tools of genealogy, both in cultural and in physical anthropology. Though kinship, genealogy and race seem to be mutually supportive, they are actually not: representations of race follow the logic of evolutionary trees, while genealogies follow that of networks of exchange. To substantiate this claim I will look at the use of genealogical tools in Franz Boas' papers on biometry and physical anthropology. Boas carried out a range of anthropometric studies on American Indian populations in the 1890s, making observations that predisposed him to embrace Mendelism after 1900, and to reject some of the fundamental assumptions of Galtonian biometry. It was specifically Wilhelm Johannsen's work that had a lasting effect on Boas (*The Mind of Primitive Man*, 1911). However, physical anthropology lacked the possibility of creating pure lines and experimenting with them. When Boas embarked on his famous studies of American immigrant populations (*Changes in Bodily Form of Descendants of Immigrants*, 1912), he therefore sought refuge in an analytical tool borrowed from genealogy: "family" or "genetic lines", for which unity of descent could be empirically ascertained and which were represented, in each generation respectively, by the various fraternities a population is composed off. On account of this analysis, as Boas should later emphasize in his campaign against "race" as a viable, scientific category, races emerge as local, heterogeneous composites of family lines, not vice versa.

Collecting Slave Traders: James Petiver, Natural History, and Slavery in the British Atlantic

Kate Murphy, California Polytechnic Institute

Session: Botany and Natural History

As the crew of the slaver, *New Providence*, prepared the vessel for its voyage to West Africa in 1710, the ship's surgeon was making his own preparations. Robert Barcklay had promised the apothecary and

fellow of the Royal Society James Petiver that he would collect natural historical specimens during the voyage to Gambia and Jamaica. By recruiting slave ship surgeons to his wide network of correspondents, Petiver added rare West African specimens to his vast collection of natural curiosities. Yet men such as Barcklay are largely absent from accounts of early modern science. Although historians have observed that science often followed the routes of commerce, little attention has been paid to this convergence within the commerce that most defined the Atlantic World: the slave trade. Ship surgeons such as Barcklay were uniquely suited as professional itinerants to collect unknown natural wonders, to record indigenous natural knowledge in far-flung regions, and to recruit new colonial correspondents. As surgeons on slaving vessels, they spent months awaiting a full cargo of slaves before proceeding to American ports. Furthermore, surgeons aboard the South Sea Company's ships were some of the only Britons with training in natural history who were allowed in the Spanish mainland during the eighteenth century. As seagoing men circulated around the Atlantic World, they helped natural knowledge to complete its own circuits. Drawing upon naturalists' correspondence, natural histories, and the Trans-Atlantic Slave Trade Database, this paper explores the intersection of the trade in human cargo and the exchange of natural curiosities.

Channels of Communication: Martian Canals and the Meaning of Popular Science

Josh Nall, University of Cambridge

Session: Science in the Public Sphere

Much recent scholarship in our discipline concerns itself with the nature, role and significance of popular scientific material intended for mass audiences. These historical studies of scientific 'popularization' have greatly enhanced our understanding of the complex relationship between elite scientific cultures and the wider societies in which they operate. But the distinction between these two spheres, and the two types of publications they supposedly produce and consume, is neither as manifest nor as stable as such studies often imply. In this paper I use the case of astronomy at the turn of the twentieth century to argue against such clear distinctions, and through a re-analysis of the infamous 'Mars canal controversy', I propose a number of challenges to the 'popularization' framework as a model for understanding science in the public sphere. Three purportedly distinct careers—of the celebrity science author Richard Proctor, the aristocrat and supposed scientific "interloper" Percival Lowell, and the doyen of Progressive Era American science, Simon Newcomb—show how each engaged with the thorny Mars question using similarly diverse media and modes of scientific discourse, forging identities that resist categorization within modern concepts of 'high' science or 'popularization'. In particular, I will demonstrate the central importance of Newcomb's editorial and authorial work on the Encyclopaedia Britannica 11th edition to the development of his position as public critic of the scientific case for life on Mars.

A Father of Physical Chemistry: J.J. Thomson in Philadelphia

Jaume Navarro, Universidad del País Vasco, San Sebastian

Session: Circulating Theoretical Physics: Scientific Exchanges between Europe, US, and Latin America

In 1923, Joseph John Thomson was invited to give a series of lectures at the Franklin Institute in Philadelphia, which were immediately published as *The Electron in Chemistry*. The so-called "father of the electron" was, in the event, introduced also as one of the founding fathers of the new field of physical chemistry: the electron had been appropriated by the chemists and, with it, solved some of the puzzles of chemical bonding. But, to what extent was Thomson's later career related to the interests of chemists? In this paper I propose to explore the reasons behind Thomson's portrayal as a father-figure for some chemists in the US at a time when he was already regarded "as being on the shelf" by many contemporary British scientists. This case-study will also help to evaluate the extent to which Thomson's career can be better understood as a practitioner of the Physical Sciences, rather than as exclusively a physicist, as some historians have suggested.

Foundation Transmission & Reception: The Case of Bunsen's American Students

Christine Nawa, Universität Regensburg / Chemical Heritage Foundation

Session: Training and Transmission in Chemistry

In the second half of the 19th century, Germany became a stronghold for chemistry, thus attracting numerous students from abroad to learn about the latest apparatuses, methods and theories from the inventors themselves. Only a few meant to stay for good. Most of them hoped for advantages in the competition for jobs in their respective home countries. One of the students' favorite destinations was Robert Wilhelm Bunsen's laboratory in Heidelberg. Bunsen was expert in gas analytics, inventor of spectroscopy and "clearly one of the century's best lecturers on chemistry" (Rocke). Every semester his laboratory was attended by 50 to 60 practitioners, and according to an anonymous American student "half of the nations of the world were represented". Among them, the largest groups of foreign students came from Great Britain, Russia, and the United States. By focusing on the Americans, this paper ties the question of Bunsen's reception to the processes of migration and transformation of scientific knowledge between Germany and the United States, which was by then a rapidly developing country, both scientifically and economically. In the first part of my paper, I ask what motivated students to choose Bunsen's lab for their education, and I explore the knowledge and the style of teaching and research they got acquainted with when there. By analyzing the careers of the home-comers in academia and beyond, the second part of my paper investigates processes of transmission and adaption and sheds new light on different modes of reception.

Reassessing the Human Automatism Debate in the Late Nineteenth Century

Francis Neary, University of Cambridge

Session: Animal, Human, and Machine

The human automatism debate in the late nineteenth century was concerned with important questions of the efficacy of human consciousness. It has been mobilised by various historians to fit in with their grand narratives of this important period for the rise of the theory of natural selection, the professionalisation of science and the challenge to established social orders. Some historians have read the debate in the context of the publication Charles Darwin's *Descent of Man and Selection in Relation to Sex* (1871) and the attempts of supporters of the theory of natural selection to narrow the gulf between the mental and moral faculties of humans and animals. Others have seen wider political significance to the debate in the professionalisation of science by an elite group of 'Scientific Naturalists' and in supplanting the language of the immortal soul of the centralised political power of old Anglican social order with the democratic and neutral principles of the laws of nature by the aspiring middle classes. Through an analysis of specific exchanges as they unfolded, I argue that it is difficult to see how the debate can be simply reduced to be part and parcel of the wider concerns outlined above. The debate certainly had localised political significance at various stages. However, the sheer breadth of contributors and the diversity of their philosophical, religious and political views make it difficult to see the debate as having a particular polemical purpose or, indeed, as a debate about a single issue at all.

Mapping Human Metabolic Diversity: Racial Metabolism Studies in the 1920s-30s

Elizabeth Neswald, Brock University

Session: Genetics, Race, and Anthropology

In the mid 1920s Francis Gano Benedict, director of the Carnegie Nutrition Laboratory, began a project to study racial differences in metabolism. This project aimed to coordinate researchers in scattered locations to conduct metabolism measurements on representatives of non-Caucasian populations with the intent of identifying the relative effects of environment, diet and race on metabolic rates. The racial metabolism research program, which achieved only ambiguous results, was formulated at the intersection of several threads of human scientific research: Since the 1880s nutrition physiologists and their associates had

attempted to identify potential biological differences through the analysis of the diet of different ethnic groups. Secondly, in the early twentieth century, the CNL had, under Benedict's direction, undertaken a decades' long project to determine metabolic norms in the male and female sexes from birth to death. Although Benedict assumed that these were human norms, apparently anomalous results in a study of Chinese-American women led him to question whether they were merely "American standards", i.e. norms based on ethnically British and Western European individuals. Finally, in the late nineteenth century, sciences based on assumptions of racial difference took on a new form in the field of physical anthropology, which aimed at determining quantitative differences in human biology and physiology in racially defined populations. These three threads combined in the racial metabolism project, which, before the establishment of geographic genetic and serological mapping, aimed to create a metabolic map of human diversity.

Alchemy and Christianity in the Era of the Reformation

Tara Nummedal, Brown University

Session: Beyond Transmutation: The Goals of Early Modern Alchemy

In the past two decades, historians of science have successfully challenged an older image of alchemy as a largely symbolic, "occult" philosophy possessing more in common with esoteric magic than with science or medicine. In light of this work, it is now clear that late medieval and early modern European alchemy addressed not only intellectual problems, such as matter theory, but also practical concerns such as mining, commerce, and the limits of technology. Resituating alchemy in the history of science and medicine has been an essential part of explicating alchemy's broad significance in early modern culture. In the process of detaching alchemy from "the occult," however, many of us have minimized or failed to explore sufficiently alchemy as a religious engagement with the world. This paper will offer a broad overview of the various ways in which European alchemists used their work with nature to engage spiritual issues of paramount importance – including eschatology and demonology – primarily in the era of the Reformation.

Alexis Carrel's Tissue Culture: Cell Death, Experimental Failure, and Surgical Imperatives

Hyung Wook Park, Ulsan National Institute of Science and Technology

Session: Death under the Microscope: Histories and Mechanisms of Apoptosis Research

Failure in experiments has been a longstanding subject among historians and philosophers. Thomas Kuhn argued that what was considered failure was the case of research that did not fit with a paradigm. Social constructivists asserted that failure was socially configured through negotiations and debates among scientists. This paper sheds new light upon this subject by analyzing the work of Alexis Carrel, a Nobel laureate and a founder of tissue culture. While claiming that somatic tissues can be indefinitely cultivated in an ideal laboratory condition, he regarded tissue death as failure, caused by experimenter's negligence. This view in the 1910s dominated scientific communities for more than fifty years until Leonard Hayflick showed that somatic cells had a limited lifespan. After Hayflick, cell death was redefined as a normal phenomenon accompanying normal aging or what later scholars called apoptosis. Yet Carrel himself was not much concerned about aging and never knew anything about apoptosis. As a surgeon, Carrel was primarily interested in surgical situations in which cell death had to be controlled by all means. In this context, therefore, cell death was defined as a consequence of inadequate surgical expertise. My paper argues that this surgical imperative of Carrel's constructed a strong imagery in later researchers' minds that connected failure and death until it was reexamined in the 1960s. I thus answer Hannah Landecker's question of why Carrel's claim was not challenged for such a long time. This paper thus highlights an important factor involved in the construction of failure in science.

The Apocalyptic Politics of Early Modern Alchemy

Glyn Parry, Victoria University of Wellington

Session: Beyond Transmutation: The Goals of Early Modern Alchemy

Recent historiographical emphasis on transmutation has overlooked the apocalyptic political role of alchemy at early modern European courts. This paper examines this role by considering the alchemical-prophetic career of John Dee at the courts of Rudolf II at Prague and Elizabeth I in England. The paper will situate the alchemical craze at Elizabeth's Court in the 1560s and 1570s in the context of English appropriation from the Habsburgs of ancient prophecies of a Last World Emperor, who would magically reform the world before the Apocalypse, by means of the philosophers' stone. Leading courtiers such as Robert Dudley, Earl of Leicester, encouraged Dee's prophetic ideas to advance his policy of military support for the 'Protestant Cause' in the Netherlands Revolt. That would merely constitute the first stage of Elizabeth's advance to the leadership of all Christendom, and very soon the globe. For a time in the 1570s, Elizabeth herself believed that she would bring global peace as the Last World Empress, wielding the alchemical philosophers' stone that several contemporaries expected her to create in 1577. The political demise of Leicester's policy paralleled Dee's increasing belief in angelic and astrological prophecies of an imminent Apocalypse in Eastern Europe. He travelled to Prague to offer Rudolf II the role of Last World Emperor, who would defeat Antichrist and unite the globe using the philosopher's stone. He thus sought to restore alchemy to its ancient place as a tool of apocalyptic reform.

The Baconian Experiment as *Probatio*

Cesare Pastorino, University of Sussex

Session: Experimenting in the Baconian Style

In the past, relevant aspects of Francis Bacon's experimental program have been linked to the tradition of how-to books of secrets and technical recipes, or to the learned treatises on mechanical arts, and particularly to Agricola's popular text *De re metallica* (1556), which Bacon certainly knew. In general, these traditions have been often considered a likely source of inspiration for Bacon's ideas on experiment. Basing my conclusions on the epistemological features of Bacon's experimental accounts in his experimental histories, and specifically focusing on such historical narratives of experiments, I would like to suggest that this is not the case. The style of Francis Bacon's accounts of experiments in the histories strongly differs from the instructional style of technical recipes. Bacon is not describing established methods or procedures, but new experiments. In general, Bacon identifies the experiments described in the histories with the term "*probatio*." A *probatio* is a trial, or a test, and most of all an individual experiment the result of which is unprecedented and unknown, until the trial and test are conducted. This is a fundamental epistemic difference from the case of Agricola, or from the tradition of the books of secrets. In particular, William Eamon has perceptively discussed the conceptual characteristics of recipes as a form of technical record. Developing Eamon's analysis, I will show that Bacon's reports conceptually move away from the examples of technical recipes, and also from experimental description like the ones of Agricola's *De re metallica*.

Evolution in the Metaphysical Club: Wright and Fiske on Darwin and Spencer

Trevor Pearce, University of Wisconsin-Madison

Session: Rethinking Spencer: Science and Philosophy circa 1900

The "Metaphysical Club" of Cambridge, Massachusetts, which began meeting in the early 1870s, has been the topic of a great many discussions in the history of science and philosophy. Philip Wiener argued long ago that evolutionary ideas were an important influence on the club's members. The notion of evolution was most frequently associated at this time with two names—Charles Darwin and Herbert Spencer. Many of those who attended the club's meetings, however, were ferociously critical of Spencer even though they supported Darwin's ideas. In this talk, I will explore the reasons for this critical attitude

by contrasting the work of two club members, Chauncey Wright (a critic of Spencer) and John Fiske (a follower of Spencer). Both Wright and Fiske wrote reviews of Spencer and Darwin's books as they appeared; they disagreed in person and in print about the relative merits of the two British thinkers, but still praised one another's work. I will argue that their divergent attitudes toward Spencer stemmed from their different accounts of philosophy and its relation to natural science.

'Darwin Hates You': Owen, Mivart, and Spencer, Darwin's Failed Friendships in Theory and Practice

Alison Pearn, University of Cambridge

Session: Scientific Correspondents

Charles Darwin's career was built on co-operation and a finely honed ability to get on with those whose help and support he needed. Yet three relationships in particular, with Richard Owen, St George Jackson Mivart, and Samuel Butler, not only failed but failed spectacularly, publicly, and with consequences that lasted over decades, and even over generations. Darwin's science was situated in a remarkably domestic environment, with loving family and friends as the context within which he thought and wrote; exploring these failed friendships has particular potential to shed light on the relationship of public and private in the development of Darwin's theories on human nature. In the case of Richard Owen the souring of a student/mentor relationship can be seen as a rite of passage. The disputes with Mivart and Spencer however both belong to Darwin's mature years – specifically the period in which Darwin published *Descent of Man*, and was himself most closely focussed on issues of collaboration, mutual aid, and the moral sense. *Descent* was the lightning rod that attracted the passionate attention of two men whose subsequent apparent defection put them beyond the pale. And it was in *Descent* that Darwin struggled to reconcile the argument that morality in nature is not an absolute, with his belief that the social virtues that came very easily to him, in particular co-operation and mutual respect, are a natural state for evolved humankind.

From 'Inauspicious' to 'Suspicious' Death: Inquests in Turn-of-the-Twentieth-Century Bangkok

Quentin Pearson, Cornell University

Session: Science and Colonialism

Until the last decade of the nineteenth century, unnatural or 'bad' deaths in the Siamese capital were 'inauspicious deaths' (Thai: *tai hong*). Inauspicious deaths provoked a range of practices and meanings that were exercised within a context of local sovereignty. With the institution of the police inquest, however, the state removed the corpse and replaced vernacular understandings of death with 'suspicion,' the medico-juridical sphere of reason and action. The transition was facilitated by the almost perfect correspondence between the two taxonomies of 'unnatural' death: the inquest covered the entire spectrum of 'inauspicious' death. Using the archives of the Thai Ministry of Local Government, this paper explores the introduction of forensic science in treaty port Bangkok. It locates traces of vernacular practices and evidence of resistance to the new regime of 'suspicious' death in the very archival records of early inquests. For example, while police sought evidence of foul play in cases of suicide, witnesses were fixated on the type of tree branch used in the hanging; corpses retrieved by police from waterways in anticipation of an inquest were cut loose and entrusted to the river by villagers. But this transition was not a simple tale of the triumph of scientific knowledge and practice; extraterritoriality and foreign consular courts dictated the terms of forensic science in 'semi-colonial' Siam. This paper narrates the history of changing jurisdiction over death in turn of the century Bangkok, and attempts to answer the question of whose understanding of death became authoritative and why?

Descartes on the Heartbeat: The Leuven Controversy

Lucian Petrescu, University of Ghent

Session: Mechanism, Life, and Embodiment in Early Modern Science

I argue here that the main questions raised by Descartes's account of the heartbeat in late 1630s to early 1640s are theological in nature. On the one hand, a mechanical account of the origin of motion in the heart is read as paving the way for extending mechanical explanations to all the operations of the soul, including those of the rational soul. On the other hand, as defenders of the account will have it, Descartes's rejection of the Aristotelian sensitive soul is used as an apologetic argument for showing the separation between humans, endowed with a rationality of divine origin, and beasts, deprived of it. I follow the public dispute between Descartes and Vopiscus Fortunatus Plempius (1601–1671), a Catholic professor of medicine at Leuven. Plempius emerged in late 1630s as an opponent of Harvey's theory of the circulation. After an epistolary exchange with Descartes, he changes his mind on the matter of the circulation of the blood, but turns to promoting Harvey's account of the heartbeat against that of Descartes. Libertus Fromondus (1587–1653), professor of theology in Leuven, supports Plempius's attack in a controversy that culminated with the condemnation of Descartes's writings by the University of Leuven in 1662. The paper develops some of the suggestions offered by A. Georges Berthier's seminal article from volume 2 of *Isis* (1914), "Le Mécanisme cartésien et la physiologie."

Soldiers and Scholars: The Blackboard at West Point

Christopher J. Phillips, Harvard University

Session: Dusty Disciplines: Blackboards as Material and Culture in Science and Mathematics

Blackboards are crucial elements of the pedagogical and research practices of modern sciences, and particularly of the mathematical disciplines. It would be a mistake, however, to assume that the ways in which they represent, aid, or even augment mental processes have been consistent over time. This paper uses one specific, but important, site of the blackboard's development and deployment--the United States Military Academy at West Point--to explore how the blackboard came to be seen in the nineteenth century as a tool that made visible otherwise hidden intellectual, moral, and physical characteristics. This institution was important both for the propagation of nineteenth century math and science and for the dissemination of pedagogical materials and innovations. West Point was one of the earliest institutions which fully integrated the blackboard into pedagogical practices, eventually incorporating it into instruction in nearly every subject. In particular, this paper argues, the blackboard's most important role was not as an erasable surface but as an examination device, used in settings with elaborate rules and specific procedures. In this period, West Point's faculty positioned the blackboard as essential to the education of a physically, morally and intellectually well-disciplined soldier.

Writing the Wilderness in the Early-Modern English Atlantic

Keith Pluymers, University of Southern California

Session: "Improving" the Climate in the Early-Modern North Atlantic World

Irish pastures, wrote the scholar William Camden, were so full of grass "the same not only fresh and long, but sweet also withall, that the cattle may fill their bellies in a small piece of the day; and unless they be kept from grazing... their bellies will burst." According to the settler John Smith, Virginia offered "abundance of fish lying so thick with their heads above the water [that] we attempted to catch them with a frying pan." Settlers in Bermuda, he wrote, had two harvests each year "without plowing or much labour" and easily found "whatsoever else may be expected for the satisfaction either of curiosity, necessity or delight." Scholars have already demonstrated that colonial promoters marshaled discourses around ideal land use and climate to advocate for colonies across the Atlantic. My paper expands on these conclusions by taking an Atlantic perspective. I argue that English writers crafted similar descriptions for

different environments and climates in order to encourage settlers to use land according to the models set forth in husbandry guides.

Apeman, Spaceman: 2001: A Space Odyssey and the Dawn of Man

Robert Poole, University of Cumbria

Session: Human, Animal, and Machine

Stanley Kubrick and Arthur C. Clarke's film *2001: A Space Odyssey* (1968) was one of the cultural landmarks of the space age. It sought to prepare the public for the prospect of early contact with extraterrestrial intelligence by offering a long-range view of human evolution from *australopithecus* to astronaut: dozens of scientists were interviewed in its preparation. Although most famous for its portrayal of space travel, it began with a wordless 20-minute sequence entitled 'The Dawn of Man' which ended with the famous 'jump cut' from flying bone weapon to orbiting nuclear bomb, suggesting that in two million years of evolution the human condition has not really changed. Research at the recently-opened Kubrick Archive shows how Kubrick and Clarke's ideas were based broadly on the Chicago 'man the hunter' theory, and specifically on the 'killer ape' variation popularised in Robert Ardrey's book 'African Genesis' (1961). *2001* was an evolutionary fable that tapped into deep anxieties about human progress in the age of the 'atomic crossroads': could mankind 'evolve' culturally to achieve world peace and colonise space, or would the original sin of aggression bring civilization to a premature end in nuclear war? Kubrick's vision of human origins matches his vision of the human future: both were ambiguous. The paper also reflects more generally on the appeal of the 'apeman, spaceman' theme of the period, also developed in the other big science fiction film of 1968, *Planet of the Apes*.

Bloody Analogical Reasoning. The Role of Analogical Reasoning in William Harvey's Discoveries

Dagmar Provijs, University of Ghent

Session: Mechanism, Life, and Embodiment in Early Modern Science

In this paper I will study William Harvey's use of analogies in the *Prelectiones Anatomiae Universalis* and the *Exercitatio anatomica de motu cordis et sanguinis in animalibus* in view of the discovery process of blood circulation. I will show that Harvey applied analogies in many different ways and that some contributed to the discovery of the characteristic 'action' of the heart and pulse and eventually to the discovery of blood circulation. The focus on constraints allows to see Harvey both as a 'modern' because of his use of experimental results and as an Aristotelian, strongly influenced by a 'natural philosophy interpretation' of anatomy and physiology, guiding his methods of observation and the conclusions to be drawn from them. The importance of the 'natural philosophy' constraints will be highlighted by comparing them to a Cartesian 'mechanistic' alternative to Harvey's *historia-actio-usus-utilitas* approach of the 'heart'.

Between McCarthy and the Modern Synthesis: Ashley Montagu's Problems with Darwinism

Gregory Radick, University of Leeds

Session: Egalitarianism and Popular Science: The American Anthropology of Ashley Montagu

In a remarkable but little remembered 1952 book on Darwin, the anthropologist Ashley Montagu urged readers to stop believing that Darwinian science had shown them to be competitive animals. For Montagu, animals were by nature cooperative, with Darwin's "fundamental error" in this matter arising from his immersion in Victorian imperialism and industrial capitalism. Although Montagu's book was well received, some commentators since have seen links between the leftwing stance expressed there and his departure from Rutgers University in 1955, when the country – Rutgers included – was in anti-Communist mood. In fact, neither the book nor the break with Rutgers had much to do with Communism. The book emerged out of Montagu's alliance with the Harvard sociologist Pitirim Sorokin, then

promoting work on the social promotion of altruism. And at Rutgers, it was, if anything, Montagu's reputation as a defender of the Darwinian "law of the jungle" that made for anxious administrators.

Latent Life: Intersections between Cryobiology and Human Genetics in the Mid-20th Century

Joanna Radin, University of Pennsylvania

Session: Tempo and Mode in Mid-20th Century Genetics

Basile Luyet was a Jesuit priest hailed by practitioners as the "Father of Cryobiology."

Cryobiology is the systematic study of the properties of life at low temperature. Working in the decades immediately prior to and after WWII, Luyet characterized his research program, an ambitious effort to transform the study of life, its origins, and functions, as centered on the examination of life in its "latent" form. Latency referred to the condition of life in a state of suspended animation. In a biological material, latency is a period in which, ideally, nothing is imagined to be happening. The idea of latency – that life processes can be suspended – also includes the assumption that this is but a phase; that the restoration of life is inevitable and useful.

A Mutual Divide: Experimental Anatomists vs. Speculative Cartesians in Seventeenth-Century Dutch Medicine

Evan Ragland, University of Alabama

Session: Method and Discovery: Connections between anatomy and philosophy in the Early Modern Period

From their first contact with Descartes' philosophical anatomy, prominent Dutch anatomists constructed a distinction between the experimental, laborious method of proper anatomists and the a priori speculations of Descartes and his followers. Strikingly, this distinction was embraced as salutary by some of Descartes' most vocal and trusted disciples. By analyzing the debate from both sides, from letters, tracts, disputations, and books, this paper reconstructs the development of the main features of this debate, and sheds light on early modern disciplinary boundaries, the fortunes of Cartesianism and Harvey's work, and the development of experimentalist cultures. The analysis in this paper also connects with recent discussions of the much more global distinction between experimental and speculative philosophy emergent in the later seventeenth century.

Between University and Polytechnic: Chemistry in Zürich, 1860-1872

Peter Ramberg, Truman State University

Session: Training and Transmission in Chemistry

The development of universities and technical schools in nineteenth century Switzerland is commonly assumed to be similar to the development of comparable schools in Germany. To a large extent this is true, but there are subtle differences in the founding and organization of Swiss institutions that are reflective of the Swiss national and local cantonal contexts. One significant difference lay in the relationship between the University of Zürich, formed in 1833, and the Swiss Federal Polytechnical Institute, formed in 1854. Unlike German universities and technical schools, many faculty in the natural sciences and humanities at the newly formed Polytechnic held dual appointments at the University and Polytechnic. The first professor of theoretical chemistry at the Polytechnic, Georg Städeler (1820-1870), and his successor Johannes Wislicenus (1835-1902), would both hold dual appointments at the University and the Polytechnic between 1855 and 1872. Furthermore, between 1855 and 1861, the Polytechnic and the University shared the same laboratory space for research and instruction in chemistry. This paper will outline the origins of the relationship between the university and Polytechnic, and use Wislicenus' career path in Zürich, from his appointment as Privatdozent in 1860 to his role as Director of the Polytechnic in 1871-1872 to illustrate the unique institutional context of chemistry in Zürich and how this context, including the roles of cantonal and federal support, the tensions between the ideals of scholarship and

practical application, and the physical constraints created by shared laboratory facilities, shaped chemical research and instruction.

Logics and Materialities of Air Resistance: Étienne-Jules Marey's Insect Automata

Enrique Ramirez, University of Texas, Austin

Session: Models and Materiality

The French physician, inventor, and chronophotographer Étienne-Jules Marey (1830-1904) is known to historians, art historians, and media scholars primarily for his innovative graphic methods and his contributions to the burgeoning field of cinema. Yet his small, mechanical insect, or “*appareil schematique*,” provides a new vantage point from which to consider his depth and breadth of his work. Featured in two versions of his *Memoire sur le vol des insectes et des oiseaux* published in 1868 and 1869, Marey's insect model was part of a career-long investigation into the relationship between air and the mechanical aspects of animal flight. This essay considers this early work in aeronautics as a kind of aerial communications medium, a device that uses air not only to mediate our own understandings of modernity, but also as a media in the most general sense of the word. This essay contends that Marey's mechanical insect not only utilized air as a medium for information, but that also transformed air *into* information, a development that relies on the very materiality of air as an instrumentality for transmitting data that mediate and stabilize our representations.

Medicine and the Pursuits of Alchemy

Jennifer Rampling, University of Cambridge

Session: Beyond Transmutation: The Goals of Early Modern Alchemy

Late medieval alchemists recognised that some things should be valued more than gold – particularly where health was concerned. For instance, in influential treatises attributed to Ramon Llull, the healing virtue of the *opus maius* (great work) was privileged over the transmutational *opus minus* (lesser work). Besides healing sickness and prolonging life, medicinal elixirs allowed healthy and pious practitioners to perform good works among the poor, although in practice this rhetoric was frequently directed towards winning patronage. As a further appeal to potential patrons, treatises often describe multiple applications: ‘mineral’ stones capable of transmutation and ‘vegetable’ stones for healing, in addition to ‘animal’, ‘mixed’ and even ‘angelical’ stones – multiple discourses that continued to flourish long into the seventeenth century. In the historiography of alchemy, however, such ‘multi-purpose’ applications have become increasingly separated out into their component aims. Thus, while the medical applications of alchemy have long been recognised by historians of science and medicine, they are most often discussed in relation to the advent of Paracelsian and Helmontian medical chemistry (*chymia*) in the later sixteenth and seventeenth centuries. This paper will both survey the historiography of alchemical medicine, and investigate how *chymia* itself developed out of an earlier, rich tradition in which medicine provided only one strand of a palette of alchemical pursuits: a tradition that continued to flourish long into the seventeenth century, both competing and interacting with later iatrochemical innovations.

Occupying Europe: How West German *Volkskundler* Claimed *Europäische Ethnologie*

Amanda Randall, University of Texas-Austin

Session: Genetics, Race, and Anthropology

One usually considers the rebirth of German science after World War II as a Kuhnian paradigm shift requiring the reorganization of laboratories, curricula, museums, etc. My ongoing historical research on German anthropology problematizes such received models, especially regarding the sciences' de-Nazification, by tracing the evolution of German anthropology post-World War II as part of a much longer series of transformations triggered by multifarious internal and external pressures. Post-war

German anthropology is structured in significantly different ways from other European anthropologies because it has continuously transacted a 250-year-old division between anthropologies focused on European and non-European cultures – designated as *Volkskunde* and *Völkerkunde*, respectively. That differentiation became politicized in World War II, and in the post-war period, the traditional disciplinary divisions splintered into a confusing multitude of field and institute names as the discipline actively sought to denazify. Yet these names are evidence less of a deepening classic or politically reactive disciplinary split than of attempts to claim crucial, tangible scientific resources: university positions, museum spaces, research funding, etc. To demonstrate how both pre- and post-war internal debates inform strategic disciplinary profiling today, I examine three specific cases concerning the status of “European ethnology” (*europäische Ethnologie*) and the stakes of “occupying” this name: a 1970 meeting of West German Europeanist anthropologists (*Volkskundler*), a 1982 meeting that raised stakes between subfields (*Volkskunde* and *Völkerkunde*), and the German Research Foundation's (*Deutsche Forschungsgemeinschaft*) re-categorization of the different cultural sciences for funding competition since 2000.

London and Los Angeles Smogs Revisited: Contrasting Origins, Actions and Controls

Peter Reed, Retired

Session: Scientists and the British State

Between 5 and 9 December 1952 ‘a heavy, motionless layer of smoky, dusty fumes from the region’s million or more coal stoves and local factories settled in the London basin’. It became known as the ‘Big Smoke’ because of its toll and the public reaction. Initial assessment of mortalities was between 3,000 and 4,000 deaths. However, in the following few months mortality rates were higher than normal and a Government report attributed these deaths to influenza but recent analysis has reassessed the influenza attribution. It was not the first time London (and other major towns in Britain) had experienced such debilitating smogs but the pea-soup of 1952 was to prove crucial, prompting Government action in an endeavour to prevent similar episodes occurring in the future. This talk will review the 1952 episode as well as earlier episodes in Britain, Government action following the 1952 episode, why such action was taken and its achievements. A comparison will be made with similar episodes in Los Angeles and other US cities.

Evolution, Mind, and Society: Human Agency in L. T. Hobhouse’s Spencerian Philosophy and Sociology

Chris Renwick, University of York, UK

Session: Rethinking Spencer: Science and Philosophy circa 1900

Building on recent work on the relationship between philosophy and psychology around 1900, this paper explores the intersection of philosophy and social science in late Victorian and early Edwardian Britain. The paper does so by focusing on L. T. Hobhouse (1864-1929): a thinker best known as a political theorist but who began his career as a philosopher with interests in the study of animal intelligence before his appointment in 1907 as the UK’s first—and during his lifetime only—professor of sociology. By exploring his wide-ranging philosophical and scientific system, including the critical responses it received from philosophers such as Bertrand Russell, the paper addresses two main issues. The first is what led Hobhouse and others like him to believe they needed to choose between philosophy and social science in early twentieth-century Britain. The second is the crucial role played in those discussions by the philosopher of evolution, Herbert Spencer. Indeed, and taking its lead from recent revisionist scholarship, this paper uses Hobhouse’s life and work to show how Spencer, perhaps unexpectedly, frequently inspired scientific thinkers to grapple with the potential for purposive human agency in evolution.

The Deaths of a Cell: How ‘Morphogenetic’ Cell Death Became ‘Altruistic Programmed Cell Suicide’

Andrew Reynolds, Cape Breton University

Session: Death under the Microscope: Histories and Mechanisms of Apoptosis Research

Apoptosis or regulated cell death occurs as a normal part of the development and maintenance of tissue and organ homeostasis in multicellular organisms. Due to its genetic regulation it is also known as ‘programmed’ cell death. Because it often involves the premature death of healthy cells and serves ‘utilitarian’ ends within the body it is commonly referred to as cell ‘suicide’ and described as an ‘altruistic’ act on the part of the cell. Mammalian cells appear to require the continuous reception of extra cellular ‘survival signals’ to prevent activation of their inherent ‘suicide program’. This provides the organism as a whole a form of ‘social control’ over its component cells. This paper explores the history, function and assumptions behind the metaphors used to conceptualize apoptosis, with special attention to the contributions of John Saunders, Richard Lockshin, and Martin Raff, developmental biologists largely responsible for introducing many of these key terms from the 1960s to the 1990s.

Starfish, International Law, and Human Rights

Linda Richards, Cape Breton University

Session: Toward a Global/International/Transnational History of Spaceflight

The public discourse during the Fukushima accident included repeated reassurances that levels of radiation “below background” were harmless and implied that those concerned were irrational. Using the history of high altitude nuclear test explosions, secondary sources, and archival research from Chemical Heritage Foundation, the American Philosophical Society, and the Oregon State University Ava Helen and Linus Pauling Special Collections this paper argues that radiation health history, consent, and human rights belong in nuclear history discourse. How nuclear history is told matters. It is not simply a successive series of controversies over nuclear power plants and fallout, but an epic human rights struggle that extends from Hiroshima and Nagasaki to today’s Navajo Nation’s resistance to uranium mining. During the fallout controversy, scientists and citizens destabilized the belief that government authorities could objectively determine atmospheric radiation safety. Central to this mass education effort by non-government scientists was molecular biologist Linus Pauling, and his wife, Ava Helen, who worked to raise the awareness of the cellular, molecular, and genetic effects of radiation. In particular, Pauling was lead plaintiff on the "fallout suits" from 1958 to 1964, an international effort to stop nuclear testing simultaneously in Britain, the US, and Russia. The 1964 case argued that the psychological and biological consequences of high altitude nuclear tests in space such as the Starfish 1.4 Megaton nuclear explosion of July 9, 1962 defied international law and the US Constitutional right to life, liberty, and the pursuit of happiness

Delineating a Rational Profession: Engineers and Draughtsmen as Visual Technicians in Early Nineteenth Century Britain

Frances Robertson, Glasgow School of Art

Session: Technical Drawing and the Political Context of Science and Technology in 19th-Century France and Britain

In parallel with public displays and exhibitions that created a meaning for machines in Britain, engineers and draughtsmen also worked to develop a visual discourse of mechanical representations on paper in the context of publications dedicated to the useful arts. In this self-reflective world, machine drawing was shaped quite literally through the invention and use of a range of drawing aids such as elliptographs and ruling machines. In publications such as the Transactions of the Society of Arts, contributors used drawing strategies to create authority for the productive ability of engineering and mechanical science. In their commentaries and in the images they made, engineers and instrument makers such as Joseph

Clement, John Farey, and Edmund Turrell announced that using mechanical aids was a professional skill, marking a clear separation from artistic and even design practice, where such aids would be called on only covertly. In combination with hands-on observation of historical drawing machines in use, I argue that mechanical drawing in Britain at around 1800 gained authority with viewers as the sign or marker of an often laborious embodied process. In considering drawing as visual expression, a material artefact, and embodied practice, inventors, instrument makers and draughtsmen used two strategies to promote this engagement; first, by conjuring the authority of self-registering technology, and second, by asserting the personal and tacit expertise of the skilled craft operator. These specialized inscriptions on paper functioned as an ambiguous promise to deliver the goods in the material world.

De-Mobbing British Oceanography; the Royal Navy and the establishment of National Institute of Oceanography

Sam Robinson, University of Manchester

Session: Science and the State in the Cold War

During the Second World War the British War machine made extensive use of oceanographic knowledge and resources. In 1944 the Hydrographer to the Royal Navy Admiral Edgell argued in a memo that there were significant deficiencies in British Oceanographic knowledge. According to Edgell these deficiencies were caused by a lack of Government funding, lack of an Oceanographic Institute and lack of scientific governance for oceanography in Britain. It was not until 1949 that an official Royal Charter was passed creating a British National Institute of Oceanography and it was not until 1953 that the 'Institute' gained its own premises and began to establish its international reputation. The period from 1944-53 was turbulent for British Oceanography and British Science more generally. It was by no means inevitable that an Institute would come into fruition, especially under the bleak economic conditions of post-war Britain. This paper will account for the creation of a National Institute of Oceanography, throwing light on to bureaucratic politics of post-war scientific governance in Britain, the science policies of the Admiralty, and the disputes within the oceanographic community. With so much conflict and division this paper will argue that the existing accounts of post-war British Oceanography, which see policy developments and the growth of oceanographic studies in Britain during the Second half of the twentieth century as an inevitable result of the science's growing significance within Cold War contexts, misrepresents the much more complex realities of scientific governance and policy in Attlee's Britain.

The National Science Foundation Confronts Segregation: Discrimination at the Teachers' Institutes

Marc Rothenberg, National Science Foundation

Session: Science and the State in the Cold War

In response to the perceived threat of the rise of the Soviet scientific and engineering communities in the 1950s, the US Congress appropriated unprecedented levels of funding for National Science Foundation (NSF) education programs. Among the most popular programs in the late 1950s and early 1960s was the summer institute program, which brought junior and senior high school mathematics and science teachers to college or university campuses for training to increase their knowledge of their fields and therefore to improve the quality of science and mathematics teaching in American schools. Facing intense pressure from powerful Southern politicians, such as Senator Strom Thurmond, and recognizing that the science and mathematics communities in the South were still, in the main, segregated, the NSF allowed, for the only time in its history, overt discrimination by grant recipients. Southern colleges and universities were allowed to exclude African-Americans from their institutes. This policy was reversed only after the NSF received pressure by President John F. Kennedy as part of Kennedy's 1962 campaign to end segregation when federal funds were involved. The U.S. Civil Rights Commission concluded that the NSF's policy played a role in the continuing underrepresentation of African-Americans in the American scientific and mathematical communities, an issue the NSF continues to confront to this day. This paper highlights the need of the NSF for political sensitivity.

Ars et Scientia: The Role of Apparatus and Devices in Della Porta's Natural Magic

Fumikazu Saito, Pontifical Catholic University of São Paulo

Session: Science and Technology in History

There are several studies about the relationship between science and technology as well as between science and magic. Such studies once based on different trends in historiography include issues and historical reflections concerning their interrelation in the origins of modern science. In a recent study we showed that Giambattista della Porta's natural magic was a kind of science (*scientia*) closely associated to *technee*, often translated as art (*ars*), but closer in meaning to "skill". However, the magicians (*magi*) were not mere skilled artisans. Renaissance *magi* as Della Porta embraced, bore the idea that nature could not be held easily for it was in constant changing flux. According to *magi*, nature enjoyed the movement of changing and disguising itself and it was precisely by watching and imitating nature metamorphosis that magicians acquired knowledge and practice of their art. However, mere observation and imitation were not enough to make nature reveals its secrets, it was also necessary to manipulate it in all of its aspects to finally deceive it. Della Porta then used specific devices and resources in order to produce *mirabilia*. The aim of this paper is to point out that the wonders produced by magicians were instances which enabled them to reveal secrets of nature. Through the use of certain kinds of apparatus and devices, Della Porta produced different sorts of effects which allowed him to work on and to uncover the secrets of nature.

Plutarchian Parallels in Research Lives of Cancer Viruses and Bacteriophages

Neeraja Sankaran, Yonsei University

Session: A Century of Viruses and Cancer

The concept of a virus was in a considerable state of flux in the scientific community for much of the early half of the twentieth century, although some features such as their extremely small size - ultramicroscopic and filterable - and exogenous source were agreed upon. During this period the confusion provided the backdrop for many debates about the identification of newly-discovered disease agents as viruses. When Peyton Rous in 1912 and Felix d'Herelle in 1917 attempted to attribute the causes - of a chicken sarcoma and a transmissible lysis of bacteria respectively - to filterable viruses, they met with considerable opposition to their ideas. In both cases opponents objected to the notion that an external infective agent could instigate these phenomena, and it was not until the 1950s when André Lwoff explained the phenomenon of lysogeny with the prophage hypothesis, that the issues were completely resolved. After this point, one of the reasons for rejecting these agents as viruses, namely their obligate parasitism, became one of the main defining properties of viruses in general. In my paper I borrow the Plutarchian device of pairing biographies, to examine the parallel lives of the cancer viruses and bacteriophages and illuminate the development of the virus concept and more broadly, the history of medical virology.

Of Mice and Children: Leukemia Viruses as Objects of Research and Policy, 1944-1964

Robin Scheffler, Yale University

Session: A Century of Viruses and Cancer

The 1950s were a decade of revival for the viral etiology of cancer. A marginal area of research within experimental cancer studies at the end of the Second World War, cancer viruses became the focus of intense inquiry and patronage. Studies aimed at elucidating the viral etiology of leukemia, in particular, played a central role in establishing the legitimacy of cancer viruses and the relevance of virus research to human disease. The first stage of this revival culminated in creation of the National Cancer Institute's Special Leukemia Virus Program (SLVP), an ambitious program to plan and accelerate the discovery of a human cancer virus and develop a vaccine. Current histories of this revival attribute its success to the experiments conducted on the transmission of leukemia in infant mice Ludwik Gross or to new

experimental techniques, such as electron microscopy and ultracentrifugation. While important, laboratory studies were only a part of how leukemia viruses emerged as objects for experimental and political intervention. In my paper I broaden the scope of factors relevant to the revival of leukemia virus research, calling attention to the critical cultural and experimental precedents offered by the polio vaccine and chemotherapy. After reviewing the progress and ambiguities of experimental research into leukemia viruses in the 1950s, I move to exploring how virus research advocates drew on polio and childhood leukemia to redefine cancer virus research as a question of not *if* but *when* a human cancer virus would be found and how to hasten this breakthrough.

The Dilemmas of the Biological Philosopher: Herbert Spencer Jennings and the Personae of Public Engagement

Judy Johns Schloegel, Independent Scholar

Session: Science in the Press

In 1918, in the wake of the Great War and Russian Revolution, the biologist and geneticist Herbert Spencer Jennings (1865-1947) began to weigh the competing demands on scientists to disseminate science to the public while simultaneously maintaining their research programs. Jennings' growing preoccupation with public engagement was rooted in his concern about the plight of democracy at that particularly tumultuous moment in world geopolitics. His contemplation of the dual obligations of social action and scientific research was itself framed by the philosophy of pragmatism. In extensive philosophical writings published over the preceding ten years, Jennings had worked out a pragmatist framework for the conduct of the biological sciences that had earned him the mantle of "biological philosopher." Up until this point, these writings had been primarily academic. Now, however, Jennings took his pragmatism to its next logical step when he began to speak and write for non-scientific audiences, including educators, social workers, community activists, and the broader lay public. As the debates over eugenics heated up in the 1920s, Jennings became both more deeply engaged in his critiques of the eugenics movement and more deeply conflicted over the dual roles of laboratory biologist and public intellectual that he felt obliged to play. This paper considers the resulting tensions Jennings faced in playing these competing roles and, relatedly, the personae he adopted to carry out each.

Mapping Out A Science: Joseph Needham's "A Chart to Illustrate the History of Biochemistry and Physiology" (Cambridge, c.1924)

Anna Kathryn Schoefert, University of Cambridge

Session: Historical Displays and Disciplinary Identity

In 1923–1924 a young English biochemist, Joseph Needham (1900–1995), drafted an unwieldy graphic, "A Chart to Illustrate the History of Biochemistry and Physiology". Stretching from 1400–1900, the Chart showed the life-lines of significant anatomists, physiologists, biochemists, philosophers and others, listed publications and discoveries, and summarised past research problems. Unlike disciplinary histories in book-form, the Chart constructed a dense canon of biographies, key works, and concepts visible at one glance, but its planar, synoptic, condensed form required viewers to engage its subject matter actively and intimately in order to make sense of its wealth of data. Visually a muddle and highly idiosyncratic in its selection of historical material, the Chart nonetheless circulated far beyond the lecture theatre of the University of Cambridge's newly opened Dunn Institute of Biochemistry, in which it was first displayed in 1924. While the Chart can be firmly placed in the rich visual culture of biological sciences in 1920s Cambridge, the contested emergence of biochemistry as a discipline, and concurrent developments of a history of science, it intrigues not only for its 1920s and 1930s use as disciplinary object. Equally important, later twentieth-century historians cited it as proof of Joseph Needham's longstanding dual interest in science and history, and his investment in philosophical problems of mind-body. In this paper, I draw from an analysis of the Chart's setting, form, and projected disciplinary future in order to discuss

the activist role of historical displays in constituting both personal and disciplinary identities in a university context.

What's in a Letter?: A Critical Examination of Victorian Letter Writing Practices

Efram Sera-Shriar, York University, Canada

Session: John Tyndall and his Correspondences

As historians we use letters all the time in our research. Taken together with books, periodicals, and other material objects, letters are an important resource for historical studies. They help us understand the way historical actors discussed key issues with their friends and correspondents, and contain information that historical figures felt was too private to express publicly. However, how often do we take into consideration the letter writing practices of our historical actors? As a member of the John Tyndall Correspondence Project for over five years, I spend many hours transcribing and editing the epistles of Tyndall and his correspondents. What has become clear is that there is very little historiography on the history of letter writing as a type of genre. This paper argues that historians should start developing more explicit methods of analysing epistles. Building on the work of Jonathan Topham (2000) and James Secord (2002) who have looked at the history of books and periodicals, including reading experiences, this paper will argue that letter writing – as with any type of genre – has its own set of rules and conventions, and that much can be learned by considering the physical structure of epistles. The reasons behind the deletion of words from a letter can be meaningful and indicate that the writer felt a particular sentence was overly aggressive, or the insertion of additional words can signify that the writer felt a need to further clarify his statement.

Shelving the Science-Religion Question: The Uses of Paley's Natural Theology in the Early American Republic

Adam R. Shapiro, University of British Columbia

Session: American Religion and Science: New Studies

Because of its role as a foil to Darwinian evolution, William Paley's Natural Theology has remained central to the understanding of American science-religion historiography. While it's obvious that readers prior to 1859 could not have situated the Natural Theology in a Darwinian context, what is less apparent is what the divergent readings of Paley say about the way American theologians, educators, and general readers thought about the emerging trope of "science and religion." This paper explores the way different audiences classified, taught, republished, and read the Natural Theology, and examines the hypothesis that American readings were largely different from their British counterparts in this era. This suggests that the Darwinian-foil reading of Paley was not a homegrown American reaction, but was imported along with Darwinism in the later nineteenth century.

Building Mathematics and Mathematics Buildings: The Built Environment of the Mathematical Institutes at Göttingen and NYU

Brittany Shields, University of Pennsylvania

Session: Dusty Disciplines: Blackboards as Material and Culture in Science and Mathematics

In this study of the cultural history of mathematics, I consider the architecture, built environment and material culture of two world class mathematical institutes developed under the leadership of Richard Courant – the first, in the late 1920s at the University of Göttingen (where he was exiled in 1933) and then in the 1960s at New York University. In both cases, the mathematical institutes were designed *by* and *for* the mathematicians who would inhabit them, with the intention of fostering a collaborative community of mathematicians. By examining these mathematicians' notions of the ideal built environment - including specific types of private workspaces, desks, and blackboards - situated in the right relationship to shared workspaces, a mathematics library, and other scientific disciplines - the

historian can gain insight into the cultural history of mathematics. The defining tool of both of these groups was the blackboard, a centerpiece in each office, classroom and common space. Ultimately, I hope to explore the physical environment of mathematical institutes to learn about the evolving work practices and social identities of mathematicians in Weimar Germany and the Cold War United States.

Calling for the ‘New Prophet’: A Skeptical Scientist Argues for the Importance of Religion in the Cold War

Matthew Shindell, University of California, San Diego

Session: American Religion and Science: New Studies

In 1953, the nuclear chemist Harold C. Urey (1893-1981) began arguing in his public speeches for a new synthesis of science and religion. Science would replace the “poetry” of Genesis with a no-less inspiring view of the vast and ancient universe and mankind’s humble place within it. The traditional moral teachings of the Judeo-Christian religions would be maintained in this new synthesis. Without these teachings, Urey feared that no part of society or Western culture could survive – including science. Urey hoped that some “new prophet” would come who could combine science and religion into a new worldview for the Atomic Age. In part, this new synthesis was based upon Urey’s own religious upbringing in the German Baptist Brethren Church at the turn of the century. Although he characterized himself as an atheist, he nonetheless felt beholden to his pious upbringing for instilling in him a strong sense of right and wrong. But the synthesis was also heavily shaped and most likely prompted by the events of the Cold War. This talk examines Urey’s Cold War speeches on science and religion in the light of his religious and Cold War experiences in an attempt to better understand the complex relationship between science and religion in 20th century America.

Illustrations, Mechanical Explanations and Experiment in the Study of the Kidney in the Early Sixteenth Century

Allen Shotwell, Indiana University

Session: Method and Discovery: Connections between anatomy and philosophy in the Early Modern Period

In the first half of the sixteenth century, there were conflicting views about the structure of the kidney and how it performed its task of filtering urine from the blood. Galen had identified the faculty of the kidney as the cause of its filtering action, but by the sixteenth century, many anatomists believed that the kidney filtered the blood by means of an internal membrane that acted like a sieve. That position was not universally accepted however, and injection experiments, dissection procedures and illustrations were all employed to investigate the question or to assert the truth of one position or another. Interestingly the trends traditionally identified with similar debates later in the early modern period were largely absent in this case. The conflict between a mechanical explanation and Galen’s natural faculty was ignored, and all of the anatomists involved firmly believed the answer to the question lay in examining the kidney itself. The kidney controversy therefore not only provides us with a rich source of information about how early sixteenth-century anatomists addressed competing views about the body but also with information about larger questions concerning the role of experiment and mechanical explanations in the early modern understanding of the world.

Serotherapy in Lyon: The Local Reception of Innovation

Jonathan Simon, Université de Lyon

Session: Novelty in Medicine

Following the initial development of serum therapy for diphtheria by Behring, Aronson and Wernicke in Berlin between 1890 and 1894, Emile Roux and his collaborators at the Pasteur Institute introduced the innovative treatment into France. At the same time, 1894-1895, a number of regional centres started

producing serum across the country for local use. In this presentation, I will use the case of Lyon to explore the interconnection between medical innovation and the use of serum as an innovative therapeutic technology. Thus, I will consider what such novel products brought to the medical profession and the wider effects of this new therapy in a specific local context. Because of the large number of people, particularly young children, affected by diphtheria and the high levels of mortality associated with the disease, serotherapy opened up new horizons for promoting microbial diagnosis and treatment, possibilities that were exploited by a range of local actors. This historical analysis is articulated with a reflection on the philosophy of technology, notably the work of Andrew Feenberg, which enables me to theorise the issue of innovation in medical science in terms of the application of therapeutic technologies, rather than the more classic approach in terms of scientific innovation

Lepage like Paris: the Entangled Lives of Science, Technology and Art in France (1841-1900)

Josep Simon, Université Paris Ouest

Session: Technical Drawing and the Political Context of Science and Technology in 19th-Century France and Britain

In the nineteenth century the development of new visual languages to represent machines resulted from the negotiation of tensions among science, technology, and art. These involved a large number of actors (draftsmen, engravers, printers, instrument makers, textbook authors, journal editors, and painters), and work spaces that I aim to characterize in order to understand what it meant to be a visual technician dealing with machine representation in nineteenth-century Paris. This paper is a composite portrait of the visual representation, circulation, and appropriation of machines and instruments built through two distinct, although connected, biographical viewpoints: that of a draftsman active in nineteenth-century Paris, and that of the city itself, the urban space that Walter Benjamin viewed as the “capital of the nineteenth century” and that had previously been described by Louis-Sébastien Mercier as “a beast” that “sucks up money and people.” Paris was an international hub for the production and display of machines and their visual representations. These representations are “entangled objects” that embody the fruitful, but sometimes acrimonious, interactions between scientific, technological, and artistic practices and their political status in nineteenth-century culture. Charles-Edmond-Constant Lepage (1825-post. 1900) worked in Paris as a mechanic, draftsman, engraver, painter, and drawing teacher. He produced machine illustrations, performed industrial espionage at international exhibitions, and created paintings representing workshops. By the end of his life, he had secured a permanent position as a drawing teacher. However, his autobiographical portrait of machine representation in Paris was that of a socialist struggle for social and professional recognition.

Chemical Control in the Atlantic Sugar Trade

David Roth Singerman, Massachusetts Institute of Technology

Session: Transatlantic Reactions: Translating Chemistry between Continents

In 1900 the cane sugar trade was among the largest and most profitable in the world. That profit, however, required consistent chemical valuations among individuals, practices, and instruments in environments as diverse as a Cuban cane field and a Pennsylvania chocolate factory. Their cooperation had to be maintained despite the sugar itself crossing political, economic, and scientific borders. This paper examines three key sites in the sugar world to show how, in such a diffuse global network, chemical practice gained authority through its proximity to economic power. Chemists in Caribbean factories argued that calibrations and methods of faraway instrument-makers failed in the tropical heat and humidity and in the complex labor situation after slavery. But in New York, the refiners’ cartel claimed that its lavish Sugar Trade Laboratory produced more accurate and trustworthy values than unclean factories (or underfunded customs labs) ever could. Meanwhile, chemists and engineers in Glasgow, whose engineering firms built the increasingly chemically complex apparatus of sugar production, constructed miniature and idealized models of sugar factories, and argued that training with these models

provided a surer basis for maintaining “chemically controlled” sugar production than did experience in real factories themselves. The New York refiners’ monopsonistic purchasing power spread its laboratory’s moral and numerical values, while Caribbean factories’ dependence on Glasgow for machines made them ever more reliant upon its trained chemists for expertise. These sites exerted their influence over scientific practice and labor in distant factories by allying themselves with powerful institutions of commerce.

Climate Improvement and Cultivation in Colonial Canada, 1742-1867

Victoria Slonosky, Independent Scholar

Session: “Improving” the Climate in the Early-Modern North Atlantic World

The idea that improving the climate through cultivation and deforestation was present in the colonies of Canada since at least the mid-18th century. Jean-François Gaultier discussed the theory in 1745, attributing the idea to the inhabitants and elders of the colony of Québec. This belief continued in Canada after the British Conquest of 1756. In 1836, John Samuel McCord wrote that he “was impressed generally with the belief that the climate had improved...as it increased in...cultivation”. His search for historical and contemporary meteorological observations, to corroborate or refute this theory, led him to develop a collection of early weather records which now forms the core of historical weather data for Canada. McCord finally came to the conclusion that the climate had *not* changed during the preceding two centuries of colonization. A much more thorough critique of the climate warming due to cultivation theory was published by William Kelly in 1837. The idea continued to surface in Canadian meteorological writings until decisively dismissed by American John Disturnell. Gautier, as a correspondent of the Académie Royale, may have been aware of the theories of climate discussed by du Bos, and McCord translated works of Theodore Mann. Both men suggest, however, that the belief in the improvement of the climate by cultivation was a popular belief, rather than one emanating from the intellectual élite. Local 20th century studies suggest that clearing and cultivation would have cooled the local climate due to changes in the distribution of energy associated with the different environments.

Overbeck’s “Rejuvenator”: Marketing Electrotherapy Devices Beyond the Medical Profession in the Early Twentieth Century

James F. Stark, University of Leeds

Session: Ownership and Invention of Medical Technologies

Electrotherapy is an approach to treatment which still has a place in medical practice. Techniques such as deep brain stimulation and electro-convulsive therapy are two of the most highly medicalised applications of electrotherapy. Yet, as this paper argues, in the early twentieth century devices were marketed to the general public, bypassing the medical profession. One such electrotherapy device was the “Rejuvenator”. This was developed by Otto Overbeck, a German-born British chemist who made his name as Scientific Director of a brewing firm. Overbeck patented a number of modifications to brewing technologies during the first decade of the twentieth century, and later turned his attention elsewhere. He patented his Rejuvenator, which could be used to treat a vast variety of conditions, very widely from the 1920s onwards. The patents themselves were part of a broader marketing strategy, which included testimony from practitioners and users, appeals to Overbeck’s scientific credentials and claims of manufacturing integrity. Overbeck was able to pursue such strategies precisely because he was a chemist rather than a clinician, and therefore did not have to abide by professional codes of conduct which applied to other medical innovators.

This paper argues that patents lent credibility to the Rejuvenator. Overbeck’s goal was to legitimise his device, and to convince potential purchasers that it was a viable alternative to professional medical advice. Using the Rejuvenator as a case study, this paper shows that there was a complex relationship between the marketing of medical devices, patents and electrotherapy in the early twentieth century.

Cancer Virus and the 1964 Declaration of Helsinki: How NIH Prisoner Research Loosened International Research Ethics

Laura Stark, Wesleyan University

Session: A Century of Viruses and Cancer

Between 1954 and 1961 millions of Americans received polio vaccines made with SV40, a virus from monkeys that was known to cause cancer in animals but had no known effects on humans. In order to study possible links between SV-40 and human cancer, the NIH, headed by Dr. Vernon Knight, clinical director of NIH's National Institute of Allergy and Infectious Disease, began to conduct studies which used federal prisoners at the NIH hospital, who had been moved there from penitentiaries across the country for this purpose. Federal science administrators described these SV-40 studies as a priority in protecting US "public health," and prisoners were considered the only appropriate human subjects for such high-risk research. When the American delegation to the World Medical Association circulated to NIH leaders the proposed revisions to the Nuremberg Code, these scientists, strongly resisted the restrictions on prisoner research because they would have limited cancer-virus studies in particular. NIH scientists worked - ultimately successfully - to remove the prisoner restrictions in what came to be known in 1964 as the Declaration of Helsinki. By providing a comprehensive account of the NIH Prisoner Program, this paper not only helps to flesh out what scientists came to learn, overlook, and imagine about cancer viruses during this period, but also shows the ways in which international ethics can be crafted to match the contemporary research needs, scientific models, and methods of inquiry of political-scientific elites.

Catalogus bibliothecae historico-naturalis Josephi Banks: Joseph Banks as Book Collector and Corpus Creator

Jennifer Steenshorne, The Selected Papers of John Jay, Columbia University

Session: In the Library

Sir Joseph Banks (1743-1820) was as avid a collector of books and journals as he was specimens. Beginning in his student years, he amassed over 10,000 volumes on natural history and another 3,500 on other sciences. These works were acquired from bookshops, catalogs, publishers and printers, and as gifts from authors. Banks not only collected, but organized, employing Jonas Dryander (1748-1810), the Swedish botanist, to catalog his library. These catalogs were printed and circulated in pamphlet form, until finally appearing in a five volumes between 1800 and 1805, as an aid to scholars and collectors. The organization and publication of the catalogs created a corpus of scientific literature. Banks's library was not dispersed after his death, but left to the British Museum. They are now in the collection of the British Library. This bequest made the collection useful not only to an individual, but a resource to the general scientific community. This paper will examine Banks's collecting and collection, through his correspondence and the *Catalogus bibliothecae*, to investigate scientific publishing and the trade in such books in the 18th century. The wide breadth of the collection illustrates the scope of publishing, including both Latin and vernacular texts, "serious" works and popular items, and a wide variety of subjects.

An Imperial Epidemiology: Epidemiological Practices in Britain and Abroad, 1865-1914

Jacob Steere-Williams, University of Minnesota

Session: Science and Colonialism

In this paper I reinterpret our understanding of how scientific knowledge was produced between the laboratory and the field in British colonial networks in the late nineteenth and early twentieth century. I builds upon David Arnold's (1993) argument that we need to complicate a purely metropolitan view of colonial science, where public health practiced and taught in Britain was simply applied to colonial settings. By focusing on one of the most important public health tools of late Victorian and early Edwardian public health, epidemiology (Elyer, 1997, Hardy, 1993), this project aims to elucidate the

ways in which metropolitan science did not simply expand into colonial territories as a ‘tool of empire’, but rather was also locally produced and contested. I will examine the ways in which local socio-political and environmental conditions framed epidemiological investigations, and how epidemiologists communicated between center and periphery and among diverse colonies. My analysis focuses on communication between three imperial cities that were central to the British Empire, Melbourne, Pretoria, and Calcutta. By comparing the work of epidemiologists in Melbourne and Pretoria, both settler colonies, I will consider how epidemiologists were bound by a transnational Britishness, which could open communication between colonial locations, and an emergent local identity, which could disrupt or antagonize exchanges. Central to this project is an analysis of how epidemiological ideas were circulated throughout the British Empire. While epidemiological practices were local in character, I will demonstrate how they were made important through a complex network of communication

Drawing Mathematical Theories, Illustrating Points: The History of a Topological Atlas

Alma Steingart, Massachusetts Institute of Technology

Session: The Sense of Things: Perception as Practice in Educational Settings

In 1987, mathematician George Francis published a book entitled *A Topological Picturebook*, meant to serve as a drawing manual for mathematicians. In the introduction to the book, Francis writes that he was inspired to write the book after he spent a year studying the world nineteenth-century geometers. The illustrations and drawings, he explains, “captured a vivid record of the mathematics of their day.” Francis “resolved to try to do the same for the mathematics of my contemporaries..” Francis’s book is both a manual for how to draw various mathematical objects and an illustrated guide to several problems in topology. This paper asks: what roles did the figures and drawings play in Francis’ work and teaching? How crucial were they to the communication of mathematical ideas? And how is the practice of drawing related to the production of new mathematical knowledge? In an article published in 1983, Francis distinguished between his early days studying topology in the “era of Bourbaki,” when he “erred blindly in higher dimension,” and his later days dedicating himself to “the concrete, the particular, the visible topological analysis.” Indeed, Francis’ work exemplifies an historical shift in the late twentieth century toward a more visual approach to mathematic research and pedagogy. Francis’s *Topological Picturebook* is one place from which to examine mathematicians’ ongoing negotiation between abstract and concrete, and formal and visualizable, modes of knowledge.

“Strictly Chemical from Beginning to End”: The Credibility of Chemistry in Treatises on Brewing across the Nineteenth Century

James Sumner, University of Manchester

Session: Science, States, and Space

Why claim scientific authority when addressing non-scientists? What are the pitfalls, and how can they be overcome? My paper addresses these major questions through an apparently minor case: appeals to chemistry in nineteenth-century books on the art of beer-brewing. Most authors affirmed that brewing was a chemical process; they disagreed sharply, however, on how relevant precise laboratory analysis, or general theories of matter, might be to the messy realities of brewhouse practice. Some authors with brewery backgrounds warned their readers against all chemical intervention, invoking spectres of gimcrack philosophers and nostrum-vendors against the unpretentious solidity of long service in the trade. Others, by contrast, saw the growth of public chemistry as the key to credibility, faithfully adorning their treatises with accounts of the caloric theory or the elemental composition of their materials. Such writings, however, were often faulted for irrelevance: more careful authors, from the 1830s onwards, credited the advice of professional chemists while largely excluding chemical language and data from their practical accounts. Such concerns faded from the 1860s, as the largest breweries began routinely to recruit trained analytical chemists. Their preferred publication formats were the journal article – which assumed the relevant disciplinary expertise – and the instructional textbook – which assumed the desire

for it. The “treatise on brewing” disappeared, and with it the techniques of self-justification which had hitherto been a key element of the literature. By retrieving these techniques, we gain a useful window onto contemporary perceptions and rhetorical uses of chemistry.

The View from Somewhere: 19th Century Western Scientific Practice as Seen from Greek Space
Kostas Tampakis, University of Princeton

Session: Science, States, and Space

In this presentation, I want to examine nineteenth century scientific practice by situating the historiographical vantage point in a specific space, that of the early modern Greek State. Modern Greece was the first new state to appear in European space during the ‘age of revolutions’, gaining its independence from the Ottoman Empire in 1828. Early on, it acquired a University, an Observatory, a Polytechnic School and various scientific museums and gardens. It was thus a topos where modern statecraft, scientific institutions and a national ideology appeared and were negotiated simultaneously. Accordingly, a small community of Greek science experts emerged. They had studied in prestigious universities and participated in western scientific practice, while enjoying a prestigious role within the Greek state. The goal of this project is to identify which were, from the point of view of a nineteenth century Greek observer, the famous scientific spaces of the era, which western scientists enjoyed prestige in Greece and what nations were seen as being at the cutting edge of scientific progress. To do so, three kinds of primary sources will be used, the public utterances of Greek scientists, the origin of western scientific textbooks and manuals appearing in Greece and the distribution of places Greek scientists themselves chose or were sent to study. In that way, a new element can be added to the ongoing discussion about considering science as ‘knowledge in transit’ and how a world history of science could be articulated.

"Have Miss Martin Do It": Women at Work in the Boston Society of Natural History and Harvard's Museum of Comparative Zoology, 1870-1910

Jenna Tonn, Harvard University

Session: Botany and Natural History

Following recent work on the role of women in laboratories, this paper examines the multitude of roles that female assistants played in natural history institutions in Boston between 1870 and 1910. At the Boston Society of Natural History (BSNH), Alpheus Hyatt, the longtime BSNH museum curator, consistently employed a handful of unmarried women at the society’s museum and collections. They were charged with organizing and identifying specimens, re-arranging synoptic collections, producing diagrams, labels, and museum guides, and keeping the museum displays scientifically accurate. Questions of the gendering of labor at the BSNH are embedded in a variety of contexts from the acceptance of women as BSNH members to the natural sciences training outreach programs the society ran for local female educators. Down the road at Harvard’s Museum of Comparative Zoology, Alexander Agassiz, the director of the institution, increasingly turned day-to-day decisions over to his longtime secretary, Miss Elizabeth H. Clark. Clark, who worked her way up through the ranks from museum specimen maintenance beginning in the 1870s, played a crucial role in overseeing all aspects of the MCZ’s development. Attention to gender of course rewrites women into the histories of these particular institutions, but also suggests the range of employment possibilities and intellectual and academic training opportunities that the natural sciences presented in Boston at the turn of the century.

Women's Secrets and Their Sources: Marie Meurdrac and André le Fournier Cosmetics

Lais Dos Santos Pinto Trindade, Pontifical Catholic University of São Paulo

Session: Science and Technology in History

“*Le spirit n’a point sex*” is the phrase that pushed Marie Meurdrac to publish, in 1666, her notes in a book totally devoted to women, entitled *La Chymie Charitable, en faveur des dames*. It is believed that considering the amount of editions and reprints the work was highly appreciated by a public, willing to learn more about this new science which promised to unveil the mysteries of nature, and to provide knowledge about medicines, including cosmetics. Although it looks like any other book from its period, it is not, as it is dedicated only for women, focusing on cosmetics and providing “rare secrets” considered necessary for the feminine world. However these secrets were a compilation of old recipes adapted by the authors who had copied and transmitted them. One of the possible sources transmitted in this compilation is the writing of André le Fournier, physician at the Paris University. He aimed at gathering together all the knowledge published on embellishment specific to women health care.

Therefore is our purpose to identify in which way Marie Meurdrac assimilated Fournier’s writings, as they hold profound different notions of matter, but by the same time shared connections with ancient and medieval traditions on the art of distillation.

“Science, Literature, and the ‘Mirror of Nature’: Metaphors of Knowing in the United States at the Turn of the Twentieth Century”

Robin Vandome, University of Nottingham

Session: Experiments of the Experiential: Valuing Subjectivity in the Modern Earth, Medical, and Physical Sciences

By 1900, scientific knowledge was widely perceived as the pre-eminent source of cognitive legitimacy in the United States; yet conflicting accounts of how scientific knowledge was both acquired and applied proliferated among scientists and intellectuals. This paper will recover and interrogate narratives and representations of scientific inquiry in the United States from the late nineteenth to the early twentieth century, in order to trace the historical development of a dominant epistemological trope employed by scientists: the metaphor of the mind as “mirror of nature.” Philosophically freighted conceptualizations of scientific knowledge such as this appeared not only in formal scientific publications and addresses, but also in fictional literature preoccupied with (and sometimes authored by) scientists. The major figures discussed will be: the pre-eminent American astronomer of his generation, Simon Newcomb, who enumerated the authority of scientific knowledge as a professional scientist, but also as the author of science fiction; the historian and novelist Henry Adams, who expressed his anxiety over the increased authority of science in fiction as well as his autobiography; and other leading scientists, such as geologist Thomas Chamberlin and anthropologist John Wesley Powell, who also contributed to the vibrant literature on science which straddled specialist and popular audiences. This paper will argue that the varied and sometimes contradictory models of cognition which these figures disseminated furnished American culture with an increasingly complicated image of the epistemic virtues (and vices) of scientific knowledge, and contributed significantly to the later twentieth-century destabilization of a unitary conception of scientific method.

Ida Noddack and the Fission Proposal : The Actor’s Perspective

Brigitte Van Tiggelen, Université Catholique de Louvain

Session: Recasting 20th Century Physics

When in 1934 Ida Noddack suggested the possibility of the nucleus breaking up in several large fragments during nuclear reactions, she was commenting Enrico Fermi’s claim he had produced elements 93 by bombarding Uranium with slow neutrons. Her criticisms and suggestion however went unnoticed. Five years later, in 1939, Otto Hahn and Fritz Strassmann published the experimental proof that lighter

nuclei were indeed produced, while Lise Meitner and Otto Frisch provided the theoretical framework for the new nuclear reaction they called fission. But Noddack's proposal wasn't mentioned in any of these papers. Eager to set the record straight, Noddack sent a short article reminding her 1934 paper and regretting it had never been cited. Asked by the journal editor to comment, Hahn and Strassman officially declined their right to answer, while downplaying Noddack's contribution. When in 1934 Ida Noddack suggested the possibility of the nucleus breaking up in several large fragments during nuclear reactions, she was commenting Enrico Fermi's claim he had produced elements 93 by bombarding Uranium with slow neutrons. Her criticisms and suggestion however went unnoticed. Five years later, in 1939, Otto Hahn and Fritz Strassmann published the experimental proof that lighter nuclei were indeed produced, while Lise Meitner and Otto Frisch provided the theoretical framework for the new nuclear reaction they called fission. But Noddack's proposal wasn't mentioned in any of these papers. Eager to set the record straight, Noddack sent a short article reminding her 1934 paper and regretting it had never been cited. Asked by the journal editor to comment, Hahn and Strassman officially declined their right to answer, while downplaying Noddack's contribution. The case only resurfaced in history of science several decades later and the fact Ida Noddack's proposal was ignored has been interpreted in a wide variety of frameworks: gender, politics, disciplinary boundaries between chemistry and physics, authority loss, prematurity in scientific discovery ... etc. Some of these interpretations have failed to provide the context and the expertise on which Ida Noddack relied when criticizing the way new elements were allegedly produced, yielding sometimes anachronistic claims she never made herself. In this paper we draw on previously unused archival material to provide the actors' perspective. Among others, we will contrast the views of Meitner and Noddack on matter, the periodic table, and the manufacture of missing elements.

Geology and Governance: Surveying the North Sea in the Cold War

Leucha Veneer, University of Manchester

Session: Scientists and the British State

Changing practices in British governance of (and through) science in general, and geology in particular, in the 1960s led to the formation of a new body, the Institute of Geological Sciences (IGS), which, as well as maintaining the other duties associated with what is now the British Geological Survey, was swiftly given responsibility for surveying and mapping the geology of the North Sea. This had become a matter of urgent necessity following the discovery of gas and oil under the North Sea in the late 1950s. The British Government had begun issuing commercial licences for the exploration and exploitation of this gas and oil in the mid-1960s. By 1967, however, officials in the Ministry of Power (which controlled the licensing process) were becoming aware that they needed much greater expertise in the geology of the North Sea than they currently had. Furthermore, since the first licences would expire in 1970, this knowledge needed to be gathered very quickly. The Ministry was already under external pressure to increase its technical arm, but officials considered that it would be too difficult to generate sufficient expertise internally, and therefore turned to the newly created IGS. This paper therefore considers, through a study of the early years of the IGS and its surveys of the North Sea, how matters of governance reshaped state geology in the Cold War, affecting the relationships between ministries and scientific experts and at the same time reconfiguring geological surveying.

Inquests into a Surgical Procedure: Creating Public and Professional Trust in Aural Surgery, 1830-1845

Jaipreet Viridi, University of Toronto

Session: Novelty in Medicine

During the late 1830s, a group of practitioners providing specialized treatments for ear diseases—known as aurists or aural surgeons—aimed to distance themselves from any ambivalence surrounding their profession and mark themselves as specialists. In particular, they found their profession threatened by the prominence of quacks who offered ill-advised remedies and undermined the surgical authority of aurists.

This authority became severely fragile in 1839 when Alexander Turnbull, a popular London-based aurist applied a common procedure, Eustachian tube catheterization, which led to the death of two patients within a week. While the first death barely registered in the community, the death of the second patient, 18 year old Joseph Hall, sent outrage throughout both public and professional fronts. This paper will narrate the responses following the coroner's inquest into Hall's death, particularly the operation performed on him. Although Eustachian tube catheterization was not widely used as a therapeutic application, many British aurists considered it a dangerous procedure if done improperly and left patients vulnerable to unskilled and itinerant practitioners. I argue that inquest into Halls death questioned the nature of the field's consensus on a surgical procedure and undermined the authority of aurists as skilled experts. Since aurists appealed to both the public and professional counterparts in defense of the procedure, I demonstrate how the Hall case provided aurists with a powerful impetus for overhauling their field, thus providing a sense of immediate urgency for establishing some surgical consensus necessary for founding a specialty.

“The Pisspot of Europe:” Rains, Mists, and Bogs in the Anglo-Irish Imagination

Brian Vogel, Independent Scholar

Session: “Improving” the Climate in the Early-Modern North Atlantic World

Ireland has always had a reputation for dampness. The Anglo-Irish members of the William Molyneux's (1656-1698) Dublin Philosophical Society made note of this characteristic climate in the 1680s. William King (1650-1729) presented a theory of the generation of Ireland's famous bogs as being the product of the laziness of the ethnic Irish. The plow would put an end to the nuisance. St George Ashe (1658-1718) presented a general theory of weather, along with an assessment of Dublin's deplorable conditions on accidents of geography that could nevertheless be ameliorated by the introduction of English agriculture, to make Dublin as pleasant as any of European capital. Molyneux would also study bogs. The definitive work on the natural history of Ireland was Dutchman Gerard Boate's (1604–1650), published in 1652, reporting on Ireland through the eyes of English settlers-- English settlements had more pleasant climate than the unimproved areas beyond the Pale. When Samuel Molyneux (1689-1728) began, in his teens, to revive his father's society and his attempts to create a new natural history of Ireland, he described the reputation of Ireland as being “the pisspot of Europe,” once again recommending extending English agricultural practice, through plantations, into the wastes of Irish territory, nice “English towns” replacing native squalor. The observations of Samuel and his uncle Thomas (1661-1733) would be voiced in a 1726 edition of Boate, perpetuating a criticism of local knowledge and practice which most closely resembled the promotional ideology used to justify the North American colonies across the North Atlantic.

Chinese mathematics in Vietnam: transmission and adaptation

Alexei Volkov, National Tsing-Hua University, Taiwan

Session: Transmission of Science and Medicine in East Asia

Transmission of mathematical knowledge from China to Vietnam started as early as Vietnam gained its independence in the 10th century AD; however, until recently no efforts have been made by Western or Asian scholars to investigate this case. My investigation of the history of transmission of Chinese mathematical knowledge to Vietnam in the 15th-20th centuries focuses on the following questions: What were the Chinese and Vietnamese social institutions in which scientific knowledge was generated, perpetuated, and eventually transmitted or received? What were the motives for the transmission or reception of the knowledge? What were the social positions and functions of the individuals involved and what were their political agendas? How the process of the transmission was implemented: was it sporadic or planned, continuous or not, performed via written texts or oral instructions? In order to answer these questions, I will present the results of my study of the extant Vietnamese mathematical treatises preserved in the Library of the Institute of Han Nom Studies and in the National Library of Vietnam (both Hanoi,

Vietnam), and in the library of the French School of Far East (EFEO, Paris, France). I will also present biographical information concerning Vietnamese mathematicians of the 15th-19th centuries found in various Vietnamese historical documents.

‘Current’ Events: Galvanism and the Functions of Scientific News in Britain c. 1800

Iain Watts, Princeton University

Session: Science in the Press

This paper looks towards refining our picture of the ways scientific knowledge moved in British society as the relationship between science and its wider audiences shifted in the decades around 1800. Recent work has understood the making of ‘popular science’, as a discursive form, to be largely a later, Victorian, development; turning these insights back on the preceding period, I take up one characteristic mode of print communication that was simultaneously valuable, often in different ways, to both scientific devotees and laypeople: scientific news. I focus on the novel, fast-moving science of Galvanism, addressing how it shaped and was shaped by the processes of scientific news-making and news-reading in commercial scientific journals, general readership periodicals, and daily newspapers. Galvanism captured the imagination of Britons in the first decade of the nineteenth century, offering spectacular electrical demonstrations and suggesting deep connections between electricity, life, and inert matter. I display the intricate relationships between print objects of scientific news (pertaining to both Britain and Continental Europe), elite science, and wider public culture, with a particular emphasis on daily newspapers and their unusual role mediating the transmission of scientific information between Britain and Continental Europe during the Napoleonic Wars. Detailed pictures of scientific news in action are provided by analysis of the news events surrounding two contrasting figures: Giovanni Aldini, the Italian visitor to Britain whose experiments on animal and human bodies in London in 1803 propelled Galvanism to public notice and notoriety, and the celebrated British chemist Humphry Davy.

Laboratory Instruction in American Land-Grant Colleges: A German Import in a New World (1870-1914)

Stephen J. Weininger, Worcester Polytechnic Institute

Session: Transatlantic Reactions: Translating Chemistry between Continents

Liebig’s innovative program of chemical laboratory instruction reached the US in the mid-nineteenth century. This critical event involved translation of German laboratory manuals and, more significantly, translocation of the German laboratory ethos to a politically and socially different milieu. The adjustments were most marked when the receiving institutions were the newly minted mid-western land-grant colleges. In 1862 the US government gave large tracts of land to the states for establishing colleges (so-called land-grant institutions), “to teach such branches of learning as are related to agriculture and the mechanic arts ... in order to promote the liberal and practical education of the industrial classes” Initially, most of these colleges lacked the material and human resources to reach university standards. Unlike their European counterparts, however, most were coeducational when founded or soon thereafter. Their strong emphasis on science meant that female and male students studied science together, at least in their beginning years. This talk will illustrate the transformation of the Liebig program under conditions prevailing in the pre-WW I American Midwest, particularly after college enrollments began to soar. A second focus will be the experiences of the female students and alumnae. Most were steered toward degree programs like Domestic Science, intended to prepare them for highly gender-specific occupations. While many graduates of these programs did follow those occupations, others entered fields such as medicine and journalism; some even established scientific careers. Whether fields such as Domestic Science advanced or retarded the participation of American women in science will be examined.

How the Oldest Museum in the Netherlands became a Museum for the History of Science

Martin Weiss, Leiden University

Session: Material Culture

When the German civil servant and junior minister Kaspar Heinrich von Sierstorpf visited the Teyler Museum in Haarlem in the Netherlands in 1803, he praised the collection of fine art, minerals and fossils, and scientific instruments this 20-year old institution had already acquired in its short history. He was particularly struck by the immense value of the instrument collection, exclaiming that “[...] the entire collection will someday only serve as testimony of a history of physics.” This proved to be prophetic. Although the primary concern of all of the successive curators of the museum’s physics department until well into the 20th century was their own research, and the museum’s well-equipped laboratory facilities repeatedly attracted eminent Dutch physicists to this post (such as the Nobel prize laureate Hendrik Antoon Lorentz), as from the 1840s the instrument collection’s historical value was increasingly appreciated too. As a result, the museum’s collections have remained largely intact until this day. What’s more, they have been preserved in their original setting, as the museum buildings were never refurbished. The museum has therefore become like a time machine for the history of science. This paper will chart the transition of the Teyler Museum from a research centre to a museum for the history of science, focusing on key events concerning the museum’s collection of scientific instruments. The question of how the changing status and public perception of the instrument collection compares with that of the collections of fine art and geological specimens will be addressed as well.

Digitizing Bibliography: On the Impact of Electronic Media on Classification in the History of Science

Stephen Weldon, University of Oklahoma

Session: Correspondence, Manuscripts, and Digitalization

The Isis Bibliography, now nearing the century mark, was established as part of a mission by George Sarton to build a universal classification system for all knowledge. The Belgian intellectual Paul Otlet, who developed the Universal Decimal Classification was an early colleague of Sarton’s in this work. The thinking about classification helped Sarton build a system well developed for small annual print bibliographies, and he tinkered with this system frequently over the several decades that he edited the bibliography. The result was anything but universal. The Isis bibliography was a personal creation with many idiosyncratic elements, quite different from the universalistic vision he had started with. Since Sarton’s time, the Isis bibliography became much more structured, and arguably more universal in its application, primarily as a result of the work of Magda Whitrow, who introduced a much more rigid and detailed faceted system of classification. Her work at the cusp of the change to digital media, helped usher in a new world for history of science research. The transition from print to digital media has dramatic ramifications for the future of the bibliography in the history of science. The history of that shift to digital media is explored in this paper.

From Fertilization to Birth: Representing Twentieth Century

Karen Wellner, Arizona State University

Session: Textbooks

Biology textbooks are everybody’s business. In accepting the view that texts are created with specific social goals in mind, I examined 127 twentieth-century high school biology textbooks for representations of animal development. Paragraphs and visual representations were coded and placed in one of four scientific literacy categories: descriptive, investigative, nature of science, and human embryos, technology, and society (HETS). I then interpreted how embryos and fetuses have been socially constructed for students. Certain events coincided with changes in how embryos were presented: (a) the growth of the American Medical Association (AMA) and an increase in birth rates (1950s); (b) the

Biological Sciences Curriculum Study (BSCS) and public acceptance of birth control methods (1960s); (c) Roe vs. Wade (1973); (d) in vitro fertilization and Lennart Nilsson's photographs (1970s); (e) prenatal technology and fetocentrism (1980s); and (f) genetic engineering and Science-Technology-Society (STS) curriculum (1980s and 1990s). By the end of the twentieth century, changing conceptions, research practices, and technologies all combined to transform the nature of biological development. Human embryos went from a highly descriptive, static, and private object to that of sometimes contentious public figure. I contend that an ignored source for helping move embryos into the public realm is schoolbooks. Throughout the 1900s, authors and publishers accomplished this by placing biology textbook embryos and fetuses in several different contexts—biological, technological, experimental, moral, social, and legal.

The Projectile Power of the Mind: Babbage, Foresight & Insurance

Daniel C. S. Wilson, EHESS-CNRS, Paris/University of Cambridge

Session: History of the Human Sciences

Although known to historians of science as the 'irascible genius' who invented the computer a century before his time, Charles Babbage's interest in insurance and risk has escaped close attention. Despite his reputation for high rationalism, Babbage was intrigued by games; perhaps because they offered a safe arena for observing the interaction of skill, chance and fate - unpredictable elements which plagued his family, as well as his finances. The project of quantifying uncertainty was one of Babbage's lesser known preoccupations. He was a harsh critic of the nineteenth-century insurance industry; an arena which served to dramatise the fraught relation between the individual and the collective. It was precisely to help negotiate this relation that Babbage wrote his 1826 polemic, *A Comparative View of the Various Institutions for the Assurance of Lives*, and so it was ironic that after a spell working as an actuary, Babbage would lose his own father, his wife and son. The spectres of such personal catastrophe have been a spur to collective preparedness but, under capitalism, also to profit. The aim of this paper will be to explore the encounter between Charles Babbage and the nascent life insurance industry as it underwent an unprecedented financial boom and then bust. Babbage's 1826 book provides the focus of a study which aims to illuminate a little-known aspect of his life, while providing new insights into more the general concerns within nineteenth-century financial capitalism about the proper relation between risk and profit, knowledge, foresight and expertise.

Private to Public: The Apollo-Soyuz Test Project and the Changing Character of American Scientific Diplomacy

Audra Wolfe, Smithsonian Institution

Session: Toward a Global/International/Transnational History of Spaceflight

The Apollo-Soyuz Test Project (ASTP) is widely recognized as the most dramatic moment of scientific cooperation between the United States and the Soviet Union during the Cold War. Yet even by the time the two nation's spacecraft docked in 1975, dreams of détente had already begun to give way to political tensions. The ASTP nevertheless represented a decided shift in American scientific diplomacy. Until the 1972 Nixon-Kosygin accord that committed NASA to a partnership with the Soviet Academy of Sciences, postwar US foreign policy had stressed scientific cooperation through the actions of nominally private individuals. Since 1959, the US and the Soviet Union had exchanged scientists, but the US was insistent that its scientists—in contrast to Soviet researchers—traveled abroad as free representatives of the international community of science rather than as emissaries of the American government. Such rhetoric pervaded not only the statements and reports of the National Academy of Science's Office of the Foreign Secretary from the late 1950s to at least the early 1970s, but also documents produced by the US Department of State, the National Science Foundation, US-driven international aid programs, and, to a certain extent, NASA. This paper therefore attempts to situate the ASTP within this wider context of Cold War scientific diplomacy first, by establishing the individualist cast of American scientific

internationalism prior to détente, and second, by examining the changing circumstances that made a more official partnership attractive to the American foreign policy establishment in the early 1970s.

Teleomechanism Redux? The Conceptual Hybridity of Living Machines in Early Modern Natural Philosophy

Charles T. Wolfe, University of Ghent

Session: Mechanism, Life, and Embodiment in Early Modern Science

We have been accustomed at least since Kant and mainstream history of philosophy to distinguish between the ‘mechanical’ and the ‘teleological’; between a fully mechanistic, quantitative science of Nature exemplified by Newton (or Galileo, or Descartes) and a teleological, qualitative approach to living beings ultimately expressed in the concept of ‘organism’ – a purposive entity, or at least an entity possessed of functions. The beauty of this distinction is that it seems to make intuitive sense and to map onto historical and conceptual constellations in medicine, physiology and the related natural-philosophical discussions on the status of the body versus that of the machine. In this paper I argue that the distinction between mechanism and teleology is imprecise and flawed, on the basis of a series of examples: the presence of ‘functional’ or ‘purposive’ features even in Cartesian physiology; work such as that of Richard Lower’s on animal respiration; the fact that the model of the ‘body-machine’ is not at all a mechanistic reduction of organismic properties to basic physical properties but on the contrary a way of emphasizing the uniqueness of organic life; and the concept of ‘animal economy’ in vitalist medical theory, which I present as a kind of ‘teleo-mechanistic’ concept of organism (borrowing a term of Timothy Lenoir’s which he used to discuss 19th-century embryology) – neither mechanical nor teleological.

Making – and Breaking – Scientific Specimens in 21st-Century Paleontology Laboratories

Caitlin Donahue Wylie, University of Cambridge

Session: Material Culture

Fossils are a rare and valuable source of information about extinct life. How then are these fragile natural objects made into robust scientific specimens that are useful for research and display? Based on interviews and ethnographic observations of workers in paleontology laboratories, I examine the people and processes that shape fossil specimens and the resulting knowledge about extinct organisms. Groups of workers – namely, fossil preparators, researchers, collections managers, and conservators – do separate but interdependent tasks, thereby constructing an implicit hierarchy of roles based on distinct bodies of expertise. However, when a lab community’s shared goal of *making* fossils fails and instead fossils *break*, groups’ statuses and expertises are made suddenly explicit. Considering the social and technical decisions that workers made in two situations of disastrously broken fossils reveals the different groups’ skills and priorities, as well as the social conventions of the community’s division of labor. These episodes suggest that groups of workers are considered responsible for specific tasks, and that their social statuses are constructed based on the relative value of their tasks in each situation. Thus status and power continually shifts among workers, according to their perceived expertise. In addition, each group of workers closely guards their expertise from other groups’ interference, despite – or perhaps because of – the relatedness of these bodies of skills and knowledge. These episodes shed light on the social conventions that shape both 21st-century scientific communities and the specimens they make.

Evolution and Religion in China: 1870s-1930s

Haiyan Yang, Peking University

Session: Transmission of Science and Medicine in East Asia

The Chinese experience with the introduction and appropriation of evolution is of great historical interest. My paper will explore the relation of evolution and religion in Chinese settings, mainly during 1870s -

1930s. Previous historical narratives on this issue in China are quite caricatured, overemphasizing the anti-religious climate. They rarely pay attention to the nuances of different knowledge communities, and instead offer a highly polarized picture of right vs. wrong. The evolutionary discussions among Christian missionaries, Chinese converts and secular intellectuals show, however, that, the relation between science, religion and philosophy was far more complicated than it is usually thought, involving appeals to theistic evolution, and efforts to construct an evolutionary theory congenial to local beliefs, against a background of the movement toward independence and indigenization by Chinese churches from the beginning of the 1920s. The so-called Monkey Trial, which took place from 10 to 21 July in the U. S. state of Tennessee, had reverberations in China, not only drawing attention to the dichotomy existing between fundamentalists and liberals, but also giving rise to the philosophical reflections on the moral and epistemological boundaries between science and religion. This investigation will offer a chance to move beyond a traditional and problematic image - religion and science inevitably at war with each other, and to present a richer understanding of their interactions in China in a transnational comparative framework.

The Organized Search for the Oncogene: Cancer Viruses and Robert Huebner's Hidden Enemies Within, 1958-1973

Doogab Yi, Chemical Heritage Foundation

Session: A Century of Viruses and Cancer

From the early 1960s to the late 1970s, the Special Virus Cancer Program mounted largescale, goal-oriented contract research and development programs to find a human cancer virus and to develop immunological means of prevention. The Program was guided by the bacterial vision of infectious disease – it boldly assumed that a human cancer might be caused by a single factor, a virus, and that the removal of this primary cause would cure cancer. The National Cancer Institute, the biggest institute of the National Institutes of Health, managed this national program. This talk will focus on one of the major research segments of the Program, Robert Huebner's human virus detection program. This talk will analyze how Huebner's research program evolved from a large-scale epidemiological survey to a molecular survey of animal cells for identifying oncogenes of viral origin. I show how Huebner's articulation of the hidden enemies within – oncogenes of viral origin – in turn 'translated' to the medical aspirations of the 1970s that led to Nixon's War on Cancer into his oncogene theory, enabling him to mobilize a large-scale national research program. At another level, my investigation of Huebner's organized efforts to find the human oncogene, especially his 'private' way of doing and managing a large-scale 'public' scientific project, provides a useful vantage point for analyzing the history of biomedical research in the 1970s, especially cancer research and the emergence of large-scale, target-oriented biomedical research.