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ABSTRACTS

Matthew Aberman
The Politics of Pure Speculation

This paper examines the scientific and political travails of the Search for Extraterrestrial Intelligence (SETI) between the late 1970s and the early 1980s. By the end of the 1970s, SETI had achieved a real measure of institutional legitimacy in the United States. Modest university programs existed at UC Berkeley and Ohio State, and brief searches had been conducted at radio telescopes such as the National Radio Astronomy Observatory at Green Bank, West Virginia, and at the National Astronomy and Ionosphere Center at Arecibo, Puerto Rico. The SETI concept had also been endorsed in the National Research Council's 1972 survey of American astronomy and astrophysics, and NASA had begun to sponsor preliminary studies such as the 1975-1976 SETI Workshops and the 1979 Life in the Universe conference. SETI scientists therefore had good reason to emphasize their respectability by 1980. But no sooner than SETI could point to such institutional accomplishments that it could also point to real enemies, both within the scientific community and within Congress. By the late 1970s, a handful of vigorous detractors—including Tulane physicist Frank Tipler, Harvard biologist Ernst Mayr, and Wisconsin Senator William Proxmire—began heavily criticizing the search for interstellar communications for a host of philosophical and political reasons. In response to the challenges, SETI scientists sought to demonstrate that their endeavor, although speculative, enjoyed broad-based support throughout the scientific community. But did SETI enjoy widespread support from the greater astronomical community, specifically? Can supporters of an ambitious SETI program be said to have constituted a majority of American astronomers at the time? The previously unexamined responses to a 1980 survey of prominent American astronomers, conducted by historian of science Spencer Weart of the American Institute of Physics, do not support this assertion. Indeed, the Weart survey reveals that both hostility and ambivalence overshadowed enthusiasm for SETI by wide margins. While many of the astronomers surveyed in 1980 may have believed that alien civilizations exist, there is little evidence to suggest that these scholars considered SETI to be a high priority within their field. This paper therefore seeks to complicate existing portrayals of SETI that suggest that the American astronomical community had already embraced the idea by the early 1980s.

Tara Abraham
Warren S. McCulloch's Mechanization of the Brain and Mind

It has been argued that there are strong conceptual and methodological connections between the cybernetics movement and developments that characterized the "cognitive revolution". A central goal of cyberneticians was to elaborate negative feedback mechanisms to account for purposeful behaviour in biological systems. Neurophysiologist Warren McCulloch's well-known approach to the problem of brain and mind was exemplary of this goal. For McCulloch, this problem had traditionally been difficult to deal with within a mechanistic framework, but by developing formal models of negative feedback mechanisms, McCulloch believed one could develop a respectable, scientific account of mental phenomena and behaviour. In light of the supposed links between cybernetics and cognitive science, this paper seeks to qualify the supposed novelty of McCulloch's arguments for a mechanistic approach to the problem of brain and mind. To use Allen's (2005) framework, McCulloch was invoking "mechanism" in both a philosophical sense and, in McCulloch's own view, an explanatory sense. In the first sense, McCulloch's views were not so novel, as his arguments (and the cybernetic project itself) reflect arguments about the unity of science that were commonplace in the US context during the 1940s and 1950s. In the second sense, McCulloch's ideas were at once novel and controversial, as they went against the grain of epistemological standards in traditional disciplines of neurophysiology and psychology. In contrast to the contemporary notion of mechanism in the life sciences, McCulloch's methodology was not grounded in experiment but rather was based on formal modeling. By comparing McCulloch's explanatory standards with those from traditional disciplines, this paper aims to get a more precise account of the ways in which McCulloch's standards were so novel, to situate McCulloch's project within the disciplinary landscape of mid-twentieth century brain and behaviour sciences, and to get a more nuanced account of the relationships between cybernetics and cognitive science.

Lloyd Ackert
Parallel Biography: Ferdinand Cohn Versus Louis Pasteur on Bacterial Speciation, 1850-1870

From the 1850s to the 1870s, the German bacteriologist Ferdinand Cohn and the French chemist Louis Pasteur quarreled over the nature of bacterial species. Although they shared a world view that microbes played specific roles in nature's 'cycle of life,' the subtle differences between their views reveal the varied theoretical and methodological commitments of their authors. For both, "life" was central, yet Pasteur's concept revolved around the movement of simple principles in chemical processes while Cohn's centered on the life cycles of organisms. Pasteur envisioned nature as a circulation of matter (chemicals) that provided living organisms their vital energy. Cohn, on the other hand, emphasized the morphology of single celled organisms rather than the general flow of chemical elements. Primarily a taxonomist, Cohn found Pasteur's statement that putrefaction was correlated "not to death, but to life" paradoxical" and he recommended abandoning chemistry for establishing the biological relationship of bacteria to putrefaction." Pasteur, on the other hand, considered putrefaction a chemical and physiological process-a slow combustion caused by a microbe's nutritional needs. To understand how these distinctions emerged and influenced the acerbic debates between Pasteur and Cohn in the mid-19th century, I employ the method of parallel biography. I will explore how their similarities (e.g. in professional trajectory, in being myopic, and in experimental objects) and their differences (e.g. in nationality, scientific training, and institutional settings) played out in their discussions of bacterial taxonomy and physiology.

Marianne Ainley
'Marginal' Landscapes of Science? Gender, Environments, and Colonial Encounters in Nineteenth-century Australia, Canada, and New Zealand

In this paper I will report on my current interdisciplinary research project concerning the transfer of indigenous knowledge of the environment from the margins of the British Empire to European centers of science. Although the expansion of Western science to all regions of the world has been well documented, we know relatively little about the influence of local knowledge on Western science. What can we learn about the various landscapes by re-reading and re-examining nineteenth-century material about Australia, Canada, and New Zealand and their original inhabitants' knowledge about, and their relationship with, the land? How can we re-interpret the impact of this knowledge on western science? To what extent and by what means was the knowledge provided by the original peoples of "marginal landscapes" incorporated into the "institutional landscapes" of westerns science? Using archival and published material and interviews I re-examine gender, environments, and colonial encounters in the nineteenth-century and discuss some of the reasons that led to the recognition of the importance of indigenous environmental knowledge in twentieth-century Australia, Canada, and New Zealand.

Peter Alagona
The Mojave Desert Tortoise Industry: From Wildlife Management to Conservation Biology in the New Southwest

In this paper I explore the history of wildlife science and conservation in the eastern Mojave Desert of California and Nevada. Between 1974 and 1994, efforts to protect the region's iconic wildlife species, the Mojave desert tortoise (Gopherus agassizii), shifted from the traditional wildlife management approach to the new conservation biology paradigm. This did not involve a fundamental change in scientific theory or data. However, it did result in a qualitative transformation in the scope, character, political stature, and economic scale of wildlife science and conservation throughout the region. This transformation unfolded with relative ease in the eastern Mojave Desert--and without the severe social consequences that have befallen other areas of the rural West with federally listed endangered species--because the region's economy proved well suited for a conservation biology approach to land and wildlife management. By the time the desert tortoise became endangered, most communities in the eastern Mojave no longer depended on a geographically dispersed, resource based economy. The region had already made its transition into a concentrated and urbanized post-industrial growth machine founded on technology, tourism, recreation, and real estate development. This story demonstrates that the implementation of conservation biology programs depends less on international research communities and scientific

knowledge, than on local and regional political economies. In the United States current conservation biology programs seem to thrive primarily in regional geographic contexts defined by unsustainable growth and land development.

Aaron Alcorn
Educating for the Air Age: Toys, Technology, and Textbooks

My paper explores the movement for air age education in the United States before the Second World War. Started in earnest by supporters of the aviation industry in the late 1920s, proponents of air age education promoted an industry friendly consumerist vision of a future America built around the airplane. Supporters of this vision singled allegiance by calling themselves "airminded," and soon discussions of the importance of an airminded education flooded promotion of boys' model airplane building into the next decade. Encouraged by these efforts and the heroic exploits of aviators such as Charles Lindbergh hundreds of thousands of boys built model airplanes to express a faith in aviation technology and, in the process, recast their role as consumers into a form of industrial education. These children, and the adults who encouraged them, came to believe that successful construction of model aircraft could be the first step to becoming pilots or engineers. Model airplane manufactures aided in the effort to remake boys' consumption into something more purposeful by readily infusing their products with lessons in the science of flight. So too did popular magazines, which routinely featured lessons in aerodynamics, articles on the work of engineers, or advice on building flying models or even constructing homemade wind tunnels for conducting airfoil experiments. Throughout, technoscience was presented as fun, accessible, and, mostly importantly, an all male activity. Attempts to formalize this airminded consumer culture, led to the publication of the "Air Age Education" textbook series, which proposed a radical reorientation of secondary school curriculum around a philosophy of air-mindedness. Existing courses in science, English, geography, industrial education, and others received air age retooling, but this textbook series, by retaining an emphasis on models as pedagogical tools as well as the consumerist visions of an airminded world, merely attempted to give structure to popular culture. While this movement was largely unsuccessful, this paper details an educational movement that anticipated developments to mobilize American youth during the Cold War and argues for the place of consumption in mobilizing youth for science.

Ken Alder
Technology as Performance: Of Atom Bombs and Lie Detectors

This paper examines the use of the lie detector during the early Cold War, particularly in conjunction with maintaining the secrecy of atomic bomb work, especially in the town of Oak Ridge, Tennessee. It examines the ethic of deterrence, intrinsic to both the operation of the polygraph, as well as the developing strategy of nuclear warfare. It suggests that the success of these very different "gadgets" depended, at least in part, on their commonality as placebo technologies; that is, they relied as much on illusion and deception, as on functionality narrowly defined.

Hanne Andersen
Philosophical Themes in The Cognitive Structure of Scientific Revolutions: A Response to Westman, Bechtel and Nersessian

Important philosophical themes from "The Cognitive Structure of Scientific Revolutions" include the nature of concepts, the role of anomalies of conceptual change, and a historical response to the philosophical issue of realism. This presentation will respond to the philosophical aspects of the papers by Robert Westman, William Bechtel and Nancy Nersessian, on behalf of the three authors of "The Cognitive Structure of Scientific Revolutions," Hanne Andersen, Peter Barker and Xiang Chen.

Wilbur Applebaum
Copernicanism, Precision and Causality at the Watershed of the Scientific Revolution

Several historians have considered the few years on either side of the year 1600 as a turning-point in the course of the Scientific Revolution. This paper will address the confluence of factors, both social and intellectual, that have not been

considered in explaining the significance of events in that brief period, Much has been written on the novel and enhanced roles of mathematics, experiment, matter, motion, and methodology during the Scientific Revolution. How was it that those concerned with those novel roles about 1600, such as Digges, Stevin, Gilbert, Harriot, Kepler, and Galileo, for example, were both innovators in the physical sciences and also among the very few Copernicans? Why, despite the fact that Copernicus had little to do with greater precision, experimentation, a new role for mathematics, and in only a limited way, questioned the traditional concepts of causality? Among the factors to be considered is the changing nature of disciplinary boundaries.

Paul Arpaia
Radium as a Cultural Phenomenon in late 19th-century Italy

The announcement that the Nobel Prize in Physics for 1903 had been awarded to Antoine Henri Becquerel and Pierre and Marie Curie sparked a curious debate in the Italian press over the first half of 1904. The participants, both Italian and foreign, represented a broad spectrum that included academicians, schoolteachers and independent scholars from across the disciplines, as well as formally trained and self-proclaimed scientists, political and cultural figures and laypersons from the reading public. The debate began as a consideration of what was known about radium's properties and then diverged widely. Participants discussed the status of scientific education in Italy and the need for state funding for scientific research. They argued over which political, social and cultural conclusions should be drawn from knowledge about radium's properties. This paper will consider what this debate suggests about scientific knowledge among the educated class in Italy at the end of the long nineteenth century (from 1789 to World War I). In particular, the author will discuss what an analysis of the debates reveals about (1) perceptions of scientific expertise, (2) contemporary conceptions of epistemology and the place of science in how knowledge was conceived, (3) the importance of dailies in disseminating and transforming scientific knowledge among the Italian educated classes, and (4) the dialectical relationship between scientific knowledge and political, cultural and social movements.

James Ashley
Contesting "The Universe Story": Theistic and Atheistic Interpretations of "Deep History" at the End of the Twentieth Century

A narrative construction of history as constituted by certain unrepeatable and uniquely constitutive events is a central feature of Judaism, Islam and Christianity. This construction has been challenged by the discovery of "deep time" or "deep history" by the historical sciences of geology and biology. However, in his recently published book, Martin Rudwick argues the inadequacy of a model of "geology versus Genesis." Instead, he makes it his goal to show "how religious and scientific practices and knowledge claims have interacted, in ways that have varied widely according to place, time, and, above all, social location." ("Bursting the Limits of Time: The Reconstruction of Geohistory in the Age of Revolution," p. 6). This presentation attempts a similar evaluation (albeit on a much more modest scale!) for the closing decades of the twentieth century. To what extent did the triumph of the Neo-Darwinian synthesis complicate the task for Christians who continued to wish to argue the consonance of scientific and theological narratives of the cosmos' history? How have those responded who do, indeed, wish to advocate a model of geology (and biology) versus Genesis? How do place, time and social location help to explain both their strategies and the degree and kind of success they have enjoyed? My thesis is that both sides of the debate end up surrendering more than they might wish to acknowledge in entering the debate, because the common ground of the debate is not well understood by either.

Michitake Aso
Race, Science, and Nationalism in Colonial and Post-Colonial Vietnam

My paper explores race, science, the French empire, and the subsequent fate of racial thought in post-colonial Vietnam. Focusing on métissage (miscegenation) and eugenics, I examine the creation and popular reception of the racial sciences, defined here as systematic knowledge about race, in French Indochina during the twentieth century. Both colonial and post-colonial political leaders attempted to legitimate and run their states through the use of science; for the French, this effort resulted in a racial colonial order while for the North and South Vietnamese, this effort resulted in multi-ethnic nations. My paper argues that the nationalists' decision to oppose the racial colonial order but retain the sciences that

were used to support it partly explains why the process of decolonization has been left incomplete and why questions about eugenics and métissage have been left unanswered in Vietnam.

Ana Avalos
Astrology and Other Occult Sciences in Seventeenth-Century New Spain

My current research on ''Astrology and the Inquisition in New Spain'' is concerned, on the one hand, with 'the true place of astrology' within the broader intellectual context of the viceroyalty during the seventeenth century; and, on the other hand, with the practice and social use of this particular field of knowledge. In this paper, I will present some conclusions based on my work with inquisitorial sources which may shed some light on the question of the relationship between astrology and other bodies of knowledge. I will mainly focus on the coexistence of and interaction between astrology and other so-called ''occult sciences,'' such as physiognomy, chiromancy, metoposcopy, and geomancy. While presenting my work on three different trials against astrologers before the Holy Tribunal in Mexico City between the years 1641 and 1655, I will aim to reflect on the problem of applying modern disciplinary boundaries, such as the distinction between normal science and occult or pseudo-science, to such a different intellectual context.

Ellen Bales
From Calamity Mesa to Boyertown, Pennsylvania: Risk, Radon, and Regulation in Cold War America

The inside of a 1950s uranium mine on the Colorado Plateau might seem literally and figuratively very far from a basement in a suburban home in 1980s Pennsylvania, and yet the two contexts became linked in dual crises about radon, risk, and regulation. My paper will explore related events at the beginning and the end of the Cold War that illustrate connections between conceptions of risk, contested scientific data, risk communication, and changing expectations of governance. In the uranium mining industry in the American Southwest during the postwar 1940s and 1950s, the highest priority for all involved was to fuel U.S. nuclear ambitions as rapidly as possible. The first casualty of this boom industry was occupational safety, and that lapse engendered a harsh legacy: roughly fifty percent of the miners developed lung cancer over the next ten to twenty years, apparently due to their excessive exposure to the decay products of radon gas emitted by the uranium ore. Several decades later, in the mid-1980s, radon returned to the realm of public health and public policy when high levels of radon gas found in private homes in Pennsylvania and New Jersey set off an indoor radon scare and compelled the Environmental Protection Agency (EPA) to set standards for residential environments. Significantly, the EPA used epidemiological studies of uranium miners, including those who worked in American mines during the 1940s, 1950s, and 1960s and were tracked over several decades by a U.S. Public Health Service study, as a fundamental data set. This paper will trace the multiple guises of this data from mine to regulatory office to suburban basement to demonstrate the ways in which risk perception and risk communication are intertwined with changing political, social, and scientific circumstances.

Sultana Banulescu
A Baltic Noblewoman and Italian Psychoanalysis

This paper deals with the personality and professional activity of Baroness Alexandra Wolff, alias Alessandra Tomasi di Palma, Princess Lampedusa (Nice, France, 1984-Palermo, Italy, 1982), one of Italy's pioneer psychoanalysts. The personality of the Princess is a landmark for the end of an era: the rich, fascinating, intriguing epoch of those scientists who were rooted in the 19th century Central/Eastern European space and who are to be thanked for many new beginnings. Alexandra Wolff, the daughter of Baron Wolff, a Latvian German who was State Councilor of the Imperial Court of Russia and of the Italian opera singer Alice Barbi, was educated privately in St. Petersburg and at the Stomersee family castle near Riga where she first became acquainted with the works of Sigmund Freud. Later she met Freud in Vienna, became initiated in the study of psychoanalysis at the Psychiatric Institute of Berlin, married an Italian aristocrat, and became one of Sicily's foremosts psychoanalysts.

Ana Barahona

The Rhetorical Construction of Eldredge and Gould's Article on the Theory of Punctuated Equilibria in 1972

In recent years several studies about the function of rhetoric in social, political and scientific discussions have been published, and the significance of rhetoric to scientific controversies is now widely recognized. Some texts that had an important impact on the scientific community have been analyzed from the perspective of its rhetoric construction and it has been shown how their authors made use of rhetoric in order to make their arguments more persuasive. But there are many important scientific texts that have not been analyzed yet under the light of the rhetoric utilized by their authors. One of them is the article were the theory of punctuated equilibria (PE) was first published. We consider that the analysis of the arguments and rhetoric tools used on that paper is especially relevant because the text had an important influence on the paleontological community and was the origin –a few years later–, of an important debate between the proponents of the theory of PE and the defenders of the modern evolutionary synthesis, a scientific controversy that lasted for more than twenty years. Therefore, we attempt to present in this paper how rhetoric tools played a central role in the persuasiveness of Niles Eldredge and Stepehn Jay Gould's seminal article on the theory of PE of 1972. We will also show how they presented their arguments in three steps, and how the authors made specific rhetorical choices (presenting some evidence rather than other) in each step.

Thierry Bardini

Bush and the Nexus: Towards the Hypertextual Interface

In this paper, I examine the legacy of Vannevar Bush's "As We May Think" vision with respect to the future of computing. I show how Douglas Engelbart and Ted Nelson took on his early representation of a hypertextual system (memex), and actualized it in a full grown new paradigm for computing. I also show how this vision, based on the notion of "mechanizing the associations of ideas" was contrasted with another vision, that of Benjamin Lee Whorf. Whorf opposed the notion of "connection" to the notion of "association" and insisted on the importance of the former when communication was concerned. Association and connection thus represent the two poles of a continuum that helped locate the nexus of future computing interfaces. It eventually came to describe its organizing principle both as far as content and relation were concerned. Personal and distributed computing, as this new paradigm was dubbed during the 1970s at Xerox PARC, thus progressively emerged as the attempt to find a balanced nexus, in between individual (association) and collective (connection) aspect of a computer interface turned communication tool (i.e. medium).

Peter Barker

Historical Themes in The Cognitive Structure of Scientific Revolutions: A Response to Westman, Bechtel and Nersessian

"The Cognitive Structure of Scientific Revolutions" includes detailed historical treatments of three episodes: the Copernican revolution, the discovery of nuclear fission and the changes in the taxonomy of ornithology caused by Darwin. This presentation will respond to the historical and historiographical aspects of the papers by Robert Westman, William Bechtel and Nancy Nersessian, on behalf of the three authors of "The Cognitive Structure of Scientific Revolutions" Hanne Andersen, Peter Barker and Xiang Chen.

Megan Barnhart

Selling the International Control of Atomic Energy: The Scientists' Movement, the Advertising Council, and the Public

One of the primary goals of the post-WWII scientists' movement was to educate the American public about the dangers of the new atomic age and to mobilize citizens in support of the international control of atomic energy. In the years following the end of the war, activist scientists published articles in popular magazines and newspapers, spoke before a variety of local citizens' groups across the country, and collaborated with the media to produce a number of radio shows and films on the subject of atomic energy. These scientists also sought the advice and assistance of another group of "experts," professionals in the fields of social science, advertising, and public relations. Perhaps the most intriguing example of this rather unusual collaboration between natural and social scientific "experts" was the 1946-1947 campaign

on atomic energy sponsored by the scientists' movement and conducted by the Advertising Council. This paper examines the collaboration between the scientists' movement and the Ad Council as an example of the general cooperation between scientists and public relations experts during the early years of the Cold War. Over the course of this partnership, scientists came to change their conception of the public and its capacity to understand the complex issues surrounding atomic energy. Influenced by current theories on public opinion promoted by PR experts, who saw the masses as easily manipulated rather than as an entity unschooled yet capable of learning, scientists' faith in the power of public opinion in a democratic society was deeply shaken.

Kai-Henrik Barth
Scientists, Clerics, and Nuclear Decision Making in Iran

Many analysts agree that Iran has pursued a nuclear weapons capability for decades, arguably for reasons of deterrence, domestic politics, and prestige. However, there is little agreement on who drove and controlled the program. While the Supreme Leader, at first Ayatollah Ruhollah Khomeini and since 1989 Ayatollah Ali Khamenei, made final decisions on nuclear matters, he relied on advisers, who held diverse views on the nuclear program. The author analyzes the history of the Iranian nuclear program from the Iranian Revolution in 1979 to the present and argues that scientists and engineers associated with the Atomic Energy Organization of Iran have driven the program at critical turning points. The talk focuses on the interactions between leading scientists, clerics, and other members of Iran's nuclear policy elite to highlight the complexity of nuclear decision making in Iran. Furthermore, it emphasizes the significance of the nuclear establishment as a driving force behind the country's nuclear aspirations. This case study is part of a larger project on the role of scientists and engineers as drivers of nuclear proliferation.

James Bartholomew
Uniqueness or Particularity in Modern Japanese Science: Two Examples

Particularity or uniqueness in science can refer to a scientist's behavior, the conceptual framework and methodology he employs, or to both. This paper presents an example of each case. The first is the research career of Katsusaburo Yamagiwa (1863-1930) in pathology; studies by Hideki Yukawa (1906-1981) in theoretical physics illustrate the second. Achievements by each marked a revolution in the particular specialty. During World War I Yamagiwa launched chemical carcinogenesis as an organized field of study by creating cancer artificially in the epithelial tissue of rabbits' ears. In the early 1930s Yukawa presented a radically new explanation for nuclear forces which forever changed the face of theoretical physics. Partly because of a samurai's confidence and almost infinite equanimity, Yamagiwa succeeded after several dozen European researchers had failed to create cancer artificially in the laboratory. (Western contemporaries invoked the idea of "Japanische geduld" [Japanese patience] to explain his success). Yukawa in his work drew on both his consummate skill as a mathematician but equally on a deep Buddhist imagination that was comfortable with the idea of flux in nature and untroubled by departure from the Western idea of fixed laws. While each faced major resistance for a time, both finally triumphed. I examine the two careers in this paper, concluding with an explanation for why Yukawa both deserved and received a Nobel Prize, while Yamagiwa deserved the accolade but never received it.

Francesca Bavuso
Figures in Obsolescence: Changes to Constellation Imagery in Nineteenth-Century Europe

This paper examines star charts, planispheres, and other astronomical images produced in western Europe during the nineteenth century. At that time, the development towards contemporary celestial cartography was increasingly rapid and dramatic. Traditional conventions for depicting the constellations pictorially as gods and beasts were waning, and cartographers increasingly portrayed asterisms as mathematical diagrams or austere, realistic images of the stars themselves. I will examine which aspects of traditional celestial cartography were maintained or abandoned, and what this reveals about the shifting techniques of observation, and broader developments in astronomy.

Alexander Bay

Beriberi, Barley, and Tools of Empire: Military Medicine in China and Korea

During the Meiji period, there were two great diseases of the people (kokuminbyo): TB and beriberi. In my paper, I argue that beriberi was not only a disease of the people, but also a disease of empire. When the Japanese army invaded Taiwan in 1895, it experienced a 90% incidence rate. During the Russo-Japanese War, this disease hospitalized approximately 250,000 soldiers and killed over 27,000 of them. In 1907, a military doctor wrote that, "During the Sino-Japanese and the Russo-Japanese Wars, our army's formidable enemy was not the unrestrained Qing army, nor was it the brave Russian army, but a disease that we did not plan for—Beriberi," reflecting the importance of disease prevention during times of war.>From the early Meiji period, Japan was medically pluralistic, that is, people could seek out cosmopolitan, western or indigenous, Chinese medicine for treatment. At the same time, doctors could and did draw off of both systems to treat affliction, especially beriberi. In the navy, physicians incorporated barley—a traditional remedy in Chinese medicine—as a prophylaxis with dramatic results. In 1880, beriberi afflicted 36% of the navy, but after the introduction of barley the incidence rate dropped to zero percent in 1886. This incorporation of Chinese medicine was highly contested and set off a twenty-plus year debate, the beriberi debate, between navy physicians on one side and doctors from the army and Tokyo University on the other. >Because of the damages caused by beriberi, and the subsequent debate over its control, I focus beriberi prevention during the Sino-Japanese and Russo-Japanese Wars, and ask "How did modern military doctors develop policies to combat this disease at a time when western medicine had yet to determine its cause?"

Jennifer Bazar

The Toronto Asylum as seen by Society

Twenty years after first being proposed in the House of Assembly and nine years after a temporary location was opened, the first purpose-built institution for the care of the so-called "insane" in Canada West opened its doors in Toronto under the name: "Provincial Lunatic Asylum". Past research on this development in Canadian history has focused primarily on the administration, the patients, or the physical building itself (see Brown, 1980; Mitchinson, 1987; Hudson, 2000; Johnston, 2000; Reaume, 1994, 2000). This paper will examine an often overlooked perspective: that of society. More specifically, the following questions will be examined in detail: (1) how was the opening of an institution of this kind originally perceived by citizens in Toronto and its surrounding regions; (2) how did families respond when one of their relations was admitted as a patient; and (3) did any of these perspectives change during the early years of the Toronto Asylum? Resources will be derived mainly from primary sources related to the Toronto Asylum: reports of the Legislative Assembly and the Medical Superintendents, a selection of patient records, as well as letters written to and from family members and friends of patients. Sources will also include editorials and articles from local Toronto publications of the time, primarily the "Globe"

Graeme Beale

One for the birds? The Tinbergen School's Presentation of Ornithology as the Behavioural Science of Ethology

It is a long way from windswept herring gull colonies on the Lancashire sand dunes to the drawing rooms of the literate public, and yet this divide was spanned repeatedly by the popular work of Niko Tinbergen in the 1950's and after. In spartan but evocative prose and coupled with extensive photographs and diagrams, Tinbergen, and later his students, sketched the social lives of birds, bees and other insects. At the heart of their research, and their vision for the science of behaviour, were their studies of birds, and this is reflected in Tinbergen's popular output which frequently focused on the behaviour of birds. This paper will explore particularly the changing mechanistic framework for understanding observations of bird behaviour that was being presented for consumption by the wider public. This framework began with an understanding of behaviour largely as a response to sign-stimuli responses, but over the course of the 1950's slowly shifted to include a new interest in evolutionary explanations of behaviour. I will argue that this public literature fulfilled a double purpose. Firstly it helped to push into the public consciousness the idea that the observation of bird behaviour could be an important scientific activity and a key part of the wider "professional" science of zoology, and more specifically the emerging discipline of ethology, rather than a mere hobby of weekend bird watchers as it may have appeared initially to the public. Secondly Tinbergen's public books helped to popularise mechanistic explanations for

behaviour grounded in evolutionary theory, which, whilst initially confined largely to birds, later became pervasive across many species, including, and most controversially humans, as was demonstrated in the work of his students Desmond Morris and Richard Dawkins.

William Bechtel
Concepts, Perceptual Symbols, and The Cognitive History of Science

Andersen, Barker, and Chen draw heavily on cognitive science research on concepts to provide a basis for explicating and further developing Kuhn's accounts of scientific revolutions. In particular, they draw substantially on the earlier research of Laurence Barsalou, especially his account of semantic frames. One of the consequences Barsalou drew from his research showing instability in conceptual representations was that concepts are grounded in something more basic and in his more recent work he has articulated such a grounding in what he terms perceptual symbols. I will explore a theme complementary to that developed by Andersen, Barker, and Chen by considering how this grounding of concepts in perceptual processing can further elucidate the cognitive character of scientific change.

Domenico Bertoloni Meli
Anatomists and Mathematicians

My essay analyzes the role and broader historical and historiographic significance of collaboration among anatomists and mathematicians in the two decades after Descartes' death in 1650, focusing on six instances where collaboration was acknowledged in print; they involve anatomists Pecquet, Malpighi, Bellini, Willis, Steno, and Lower, and mathematicians Roberval, Auzout, Borelli, Wren, Viviani, and Hooke. Collaboration and the exchange of views and techniques went much further, yet even the rather limited set of cases I examine calls for a fresh look at anatomical investigations and experiments and a more integrated approach to the intellectual transformations of the 17th century, one bringing together anatomy and anatomical experiments with the physico-mathematical disciplines, philosophy, and medicine.

Mario Biagioli
From Ciphers to Patents: Registering Priority Claims in Early Modern Europe

The development of a reliable system for registering priority claims concerned 17th-century mathematicians and natural philosophers. Prior to the establishment of scientific academies and the introduction of institutional registration systems for discoveries, priority claims were usually made through ciphers or publications, or both. Galileo disseminated his ciphers through letters, while Huygens used them both in letters and in reports he submitted to journals. In this paper I argue that we have failed to recognize an additional system of priority registration in early modern Europe: patents. Patents were typically used to claim property, but they could also be used to put a timestamp on a discovery, if such a discovery could be connected to a machine or an instrument. Prior to the development of registration systems within scientific academies, patents constituted perhaps the only institutional form of priority registration. A few episodes from Huygens' career provide a window on such a use of patents. Huygens shows that, with the appropriate connections, patents could be obtained in ten days, thus making them as speedy as (or speedier than) a publication. More importantly, patents carried the stamp of a prince's authority – an authority that a journal or a self-published book could not have. But a more intriguing element of the story is that, because of the very modest disclosure requirements in place at that time, patents could put an authoritative timestamp on a vaguely described claim. That could allow the discoverer to conveniently reinterpret the description of the claim at a later time so as to work around priority challenges posed by other discoverers. In this sense, a patent functioned very much like a cipher. I will conclude by comparing these two systems.

Charlotte Bigg
From the Belle-Époque to the Années Folles: What Was the Impact of the First World War on the French Physical Sciences?

Between the 1900s and the 1930s, the landscape of the physical sciences (physics, chemistry, physical chemistry) changed dramatically both in scientific and institutional terms. This paper will examine the role played by the First World War in these developments, focussing on the French context and in particular on the 'Arcouest' group (including Jean Perrin, Emile Borel, Marie Curie, Paul Langevin). For this generation of left-wing physical scientists who came of age at the time

of the Dreyfus affair, the war was a turning point in many respects. Though their faith in science and social progress went unabated, nonetheless their trajectories were markedly inflected by their involvement in the conflict, as many retreated from scientific research proper in the 1920s and turned to science policy and politics, thereby helping create a new institutional environment for scientific research and a new role for the scientist. This case supplies fruitful points of comparison with the emergence of modern physical science in the better-known German-speaking context.

Theodore Binnema

Peter Fidler and Enlightenment Science in the Hudson's Bay Company Territories, 1788-1822

Scholars have recently shed considerable new light on the history of scientific inquiry in the Hudson's Bay Company Territories. This paper will contribute to this trend by examining the significance of one of the most intriguing servants of the Hudson's Bay Company, Peter Fidler (1769-1822). Fidler kept perceptive and insightful journals in a variety of fields including cartography, meteorology, phenology, natural history, and ethnography. The paper will argue that Fidler, imbued with the values and aims of the science of his day, willingly endured physical hardships and dangers to experience, record, describe, analyze, and understand the little-known world of Rupert Land. But Fidler showed a similar interest in and respect for other ways of knowing, whether they be aboriginal forms of knowledge, or controversial European knowledge systems. Evidence will be drawn from extensive research in the Hudson's Bay Company Archives, and the Provincial Archives of Manitoba (including Fidler's large personal library of about 500 volumes).

Carla Bittel

The 'Sexual Science' of Mary Putnam Jacobi

In 1895, Mary Putnam Jacobi, physician from New York, reported a "Case of Absent Uterus" to the American Journal of Obstetrics. She treated a seventeen-year old girl, "B.M.", whose family had consulted her, worried that she had never menstruated. Upon examination, Jacobi discovered that the patient had neither uterus nor ovaries; B.M. was considered a "hermaphrodite." With this case, Jacobi joined a cadre of American and European physicians studying physical anomalies, genital "malformation," and sexual identity. Now in the third decade of her work as a practitioner, Jacobi had devoted much of her career to researching women's health issues. She employed scientific models of medicine to study menstruation, uterine and ovarian disease, anemia, and hysteria, among other matters. Jacobi explained health and illness through the concept of "nutrition," using experimental physiology to prove her theories and counter pathological constructions of the female body. In addition, she believed nutrition was also the key to understanding the biological differences between men and women. This paper analyzes Jacobi's "sexual science" by situating her treatment of hermaphroditism within the body of her work on women's health, and within the context of social and medical controversies over determining sexual identity. It will argue that she used this diagnosis to address broader problems of gender, and to illustrate both the differences and commonalities between men and women. She distinguished between normal combinations of masculine and feminine characteristics, and the abnormal "disassociation of sex attributes," as seen in "B.M." Men and women both possessed certain characteristics of the opposite sex, she argued, especially when it came to mental powers. She took this opportunity to challenge the strict gender dichotomies that governed late Victorian America, and to offer scientific evidence for the idea that women shared the same intellectual capacity as men. This paper will also demonstrate how Jacobi's work on sexual identity fit into a larger pattern of her political activism, as she continued to campaign for women's rights at the end of the century.

Jean-François Blanchette

From Enigma Machines to the Word Wide Web: Public-key Cryptography and the Promise of Electronic Authenticity

A much-belabored trope for ushering in the digital age has been that of escape from matter, of the paperless office, of cyberspace as the long-awaited emancipation of information from its physical substratum. In the 1970s, computer engineers envisioned a world of "dematerialized" information where control over desirable and undesirable properties of communication (e.g., confidentiality, authentication, anonymity) would proceed through that most immaterial of sciences, mathematics and, in particular, cryptography. A science historically associated with military goals, cryptography

reinvented itself in 1976 as "the science of information integrity" by offering a mechanism to emulate handwritten signatures. Founded on Diffie and Hellman's celebrated invention of public-key cryptography, digital signatures technologies spearheaded a reform of evidence law regimes across the globe during the late 1990s. In this paper, I retrace the path of digital signature technology through its encounters with American businessmen, European regulators, French notaries, Canadian archivists, and Tim Berners-Lee's semantic web. Such encounters illustrate the highly contested process of defining evidence, authenticity, and memory in the electronic age.

Daniela Bleichmar
Seeing, Owning, and Knowing: Training the Expert Eyes of Naturalists and Art Connoisseurs

This paper will discuss the role of visual expertise in eighteenth-century natural history and artistic connoisseurship, two visual practices centered on the importance of observation, representation, and accumulation. Collectors of naturalia and of art were both expert observers trained to identify objects accurately, distinguishing among very similar ones based on minuscule differences. I will examine the connections between the expert eye of the naturalist and the expert eye of the connoisseur by contrasting instructions drafted to indicate what traveling naturalists should observe and collect to guidelines aimed at teaching natural history and fine art collectors how to go about acquiring, judging, and organizing their holdings. I will analyze how the visual training of naturalists and artistic connoisseurs not only guided practice but also served to define communities of practitioners; the triangulation among images, specimens/artifacts in collections, and texts in order to guide the experience of seeing and to constitute the object of study; and the ways in which visuality contributed to the production and circulation of knowledge.

Stephen Bocking
Ecologists and the Transformation of Canadian Environmental and Resource Politics, 1950-1970

An essential theme in the recent history of ecological science has been the negotiation of the relation between the discipline and social concerns, particularly those that relate to environmental quality and the state of natural resources. Between 1950 and 1970 these concerns, in the Canadian context, were transformed: from a focus on efficient management of resources, to wider concerns regarding the impacts of industrialization, urban expansion, and resource extraction. Ecologists and scientists of other disciplines played a variety of roles in this. They encouraged this transformation, in part by drawing attention to the impacts of conventional resource exploitation. But this transformation was more than simply a consequence of dissemination of expert knowledge. Rather, the reception of this knowledge owed much to Canadians' evolving attitudes towards their environment, as expressed both in attitudes and behavior, including the emergence of mass nature tourism. In addition, the formation itself of this knowledge reflected the emergence of a more pluralistic array of research institutions that provided space for alternative perspectives on nature and its place in the Canadian economy and society. This account therefore demonstrates how, in Canada as elsewhere, the relations between ecology and society have been mediated by institutions, both for research, and for managing the environment and natural resources.

Talitha Bolton
Mapping British Institutions of Science: The Spatial Characteristics of the Common Cold Unit and Porton Down's Chemical Defence Experimental Establishment

As research facilities, Porton Down and the Common Cold Unit conducted programmes of experimental research on humans for a number of decades. Located eight miles apart in Salisbury, Wiltshire, much of Porton Down's military research was top-secret, especially during the 1950s when the research priority was the development of, and protection against, nerve gases, while the common cold research carried out at the Common Cold Unit courted extensive publicity as a kind of alternative holiday camp.>Thousands of volunteers were used by these institutions during the Cold War period and their spatial arrangements were affected by the extent to which the volunteers were passive or active in influencing the environment during their participation. Volunteers at Porton were drawn from the Armed Services and remained under

military control throughout their stay, and therefore continued to act within the hierarchy and subordination of military life. The Common Cold Unit's volunteers were recruited from the general public and the success of the trials, to a certain extent, depended upon the goodwill of the volunteers.>This paper will draw out the links between the physical aspects of the landscape of these institutions and the underlying issues of control, discipline and authority. These spaces of science reflected the nature of the research being conducted and this paper will explore how these institutions were mapped out in terms of physical boundaries, geographical location, and the situation of buildings, and thus how the cultural boundaries between subjects and scientists were drawn.

Cornelius Borck

The Posthumanism of the Avantgarde: Artistic Experiments in Prosthetic Vision

The history of prosthesis is so deeply interwoven with war and military history that its embeddedness in the larger cultural fabric gets easily overlooked. WW I marks, without question, a watershed in the history of visual prosthesis. Intensified work in this area was a response to the enormously increased demand because of the war and it exploited technologies of electronic amplification that were themselves the product of war-related efforts. In the following interwar period, however, others became actors in this field, for example the artistic avantgarde in Weimar Germany. The avantgarde of the 1920s, revolving around then-new media, envisioned the fusion of art and technology as a decisive step in the shaping of "new man," the human of the future, liberated from the constraints of nature and tradition. The work of Raoul Hausmann, mostly known for his leading role in Berlin Dada, provides a particularly rich case for analyzing the ambivalences of this utopian view of the relationship between body and technology, art and science. Hausmann engaged in a radical modernization of perception that questioned taken-for-granted distinctions between natural and artificial, the human and the technological. With his cyborgian photomontages and experimental employments of typography, Hausmann pushed beyond the limits of human sensory perception. The transgressive playfulness of this artistic experimentalism explored, during the 1920s, posthuman epistemologies of vision.

Francesca Bordogna

"Enchanted" Pragmatism: G. Papini and G. Prezzolini's Variety of Pragmatism, and Its Uses

Revisiting Weber's understanding of modernity as involving in fundamental ways a process of "disenchantment" and secularization, Alex Owen has argued that magic and occultism, far from being at odds with the modern outlook, were constitutive elements of modernity at the fin-de-siècle. This paper suggests that magic and mysticism lay at the root of one important strain of pragmatism – a type of thought considered by some to be among the most visible philosophical embodiments of modernity at the turn of the twentieth century. Focusing on the Italian pragmatists Giovanni Papini and Giuseppe Prezzolini, the paper contends that occult and religious disciplines shaped both their understanding of pragmatism and the uses they made of it. Papini's and Prezzolini's deep psychological and anthropological studies into magic practices, psychic phenomena, and spiritual exercises led them to develop pragmatism in unexpected directions. Like other pragmatists, they understood pragmatism as a "theory of action," but they interpreted that as a magic and practical "art of miracles." That art – to be premised on a study of the subliminal self and of the hidden powers of the mind - would disclose the inner spirituality of nature, and would ultimately enable human beings to attain divine status and to create new worlds, ones premised on entirely new physical and biological laws. The paper also argues that magic and occultism contributed to determine the ultimate goal of Papini and Prezzolini's pragmatism: the advent of the "kingdom of the spirit" and of universal peace. Thus the second part of the paper explores the ways in which the two Italian psychologist-philosophers – both of whom consciously worked in the geographical periphery of the international scientific and philosophical world, and acted as cultural intermediaries between Italy and other nations – used their "magic" pragmatism both as a tool to negotiate tense international relations, and as a means to promote Italian national interests.

Arianna Borrelli

Non-verbal Modes of Communication in Latin High Medieval Mathematics

The manuscripts containing the earliest Latin texts on the astrolabe (early 11th. c.) witness to the transfer of complex mathematical-astronomical knowledge from the Arabic-Islamic into the Latin culture. I analyse them under various aspects: (1) the single texts contained in the manuscripts, (2) the structure and choice of material in the earliest manuscripts, which are of an extremely composite nature, (3) the similarities and differences between texts dealing with the same subject in different words, (4) the labelled geometrical drawings present in some of the earliest manuscripts, (5) the differences in structure between earlier (11th/12th c.) and (late 12th to 14th c.) later manuscripts. On the basis of this analysis, I argue that the earliest manuscripts are the written traces of a process of knowledge transfer in which verbal and non-verbal, written and non-written modes of communication complemented each other (e.g. reading, oral teaching, imitation and internalisation of drawing procedures, mnemonic rhymes, codification of labels and drawings, note-taking).

Mark Borrello

Lessons from Nature? Conservation, overpopulation and a world out of balance

In the 1960's concerns about overpopulation and the mismanagement of natural resources were at a peak and scientists from multiple disciplines became involved in the examination and explanation of these issues. In this paper, I want to examine how a theory about the natural regulation of animal populations crossed over into the public discourse and was applied to the human population problem. In his 1962 book "Animal Dispersion in Relation to Social Behavior" V. C. Wynne-Edwards presented a theory of group selection in which he argued that animal populations were selected to maintain themselves at a level below the carrying capacity of the environment. This theory was the source of heated debate within the scientific community while it was simultaneously widely accepted in the popular press. This disjunct between the scientific and the popular reception of the idea had a number of interesting effects. I argue that the popularity and the intuitive appeal of the idea contributed to a particularly vehement reaction against the theory within the scientific community.

Dan Bouk

The Migrating Jersey Bird: The Study and Control of Salt Marsh Mosquitoes

As New Yorkers in the late nineteenth century moved out to the new suburbs of northern New Jersey, escaped to the resorts of the Jersey shore, and planned the industrial development of Jersey's salt marshes, they began to complain about mosquitoes. At the turn of the century scientists and community reformers in New York and New Jersey spurred on by proofs that mosquitoes were vectors for malaria and yellow fever started talking seriously about controlling these pests. John B. Smith, the state entomologist of New Jersey, became the primary advocate for a state-led anti-mosquito campaign carried out in cooperation with local public health officials. This paper shows how Smith based his case in favor of state control on the unexpected finding of his mosquito life histories that several varieties of mosquitoes breeding in the coastal salt marshes were migratory, moving inland across county lines searching for food in the affluent suburbs. The paper will discuss his methods for tracking the mosquitoes and examine the debates among professional entomologists over these methods and over the proper definition of migration. Smith's migratory theory eventually won support from other entomologists but was fiercely challenged by local mosquito control groups who objected to the implications of a migratory theory for the proper distribution of control responsibility between state and local interests. In the end, Smith succeeded in using his research on mosquito migrations to secure a spot for scientists and the state bureaucracy atop the expanding network of county mosquito extermination associations.

Christina Brandt

From Plant Breeding to the Laboratory: Clones, Pure Lines and Mass Production in Early 20th-century Botany and Protozoology

This paper analyses the transition of the clone concept from its origins in horticultural breeding into a laboratory research tool in the first decades of the 20th century. In 1903, Herbert J. Webber, a botanist from the Plant Breeding Laboratory of

the US Department of Agriculture, introduced the term "clone" to designate a group of plants that were asexually propagated from a single ancestor plant. Thus, the clone concept was first developed in the context of horticultural breeding and its demands for stability and uniformity of breeding products. Soon, however, the clone became a technical object of different experimental systems in the first two decades of the 20th century. It was in early genetics work on unicellular microorganisms – a field with similar requirements for uniformity of research objects – that clones (or "pure lines") of organisms began to be used as standardized research tools. Scientists such as H.S. Jennings and the German zoologist Victor Jollos started to apply the method of pure line breeding (developed by the botanist Wilhelm Johannsen) to research into unicellular organisms, especially protozoa. Their research on clones of Paramecium allowed the general investigation of genetic constitution and heredity as well as questions about the inheritance of acquired characteristics. Through an exploration of these developments, I will argue that the origin and transition of the clone concept has to be understood against the broader background of the rise of mass production and the quest for standardization in various scientific and non-scientific fields at the beginning of the 20th century.

Michelle Brattain

Redefining Race in the Post-World War II Era: Anthropology, Genetics, and the UNESCO Effort to Re-educate the Public on Race

This paper examines the scholarly debate about the meaning and significance of race in the immediate post-World War II era. It focuses on scientists' public education efforts, and particularly UNESCO's international project to re-educate the public on race. Beginning with the 1950 and1951 UNESCO-sponsored attempts to compile an authoritative "Statement On Race," it examines the debates which ultimately led the 1951 conference to abandon the 1950 conference's assertion that race was primarily a "social myth," to reemphasize the biological basis of race, and finally, to leave open the possibility that significant racial differences might exist. Historians have attributed the retreat from 1950 to 1951 to disciplinary differences between the social science orientation of the first group and the biological orientation of the second. This paper, based on research in the UNESCO papers and manuscripts of several key participants, argues that the debates were the first sign of a more elemental disagreement around the "null hypothesis" of racial difference. While many scholars accepted that old studies of racial differences in intelligence, for example, had failed to prove differences, many remained committed to the premise that differences might exist. The burden of proof fell not on those whose "evidence" of racial hierarchy had been discredited, but ironically on those who now claimed that racial hierarchy did not exist. More importantly, although UNESCO refined the definition of race as genetic and environmental, it left the concept of race itself in tact. These factors had significant implications for the public education effort and seriously compromised scientists' ability to present a unified anti-racist message to the public. Although the UNESCO statements have often been cited as evidence of just how influential the new universalist, anti-racist position had become in the life sciences, this essay suggests that postwar liberal anti-racist science played an important, if unintentional, role in facilitating the creation of a highly resistant form of racism.

Eric Brown

The Lab and the Field in 19th Century American Economic Geology

The authorizing language for the United States Geological Survey, attached to an appropriations bill in March 1879, was distinctly vague on the mission of the new bureau. Into that vacuum of specificity stepped Clarence King, first director of the Survey. He established a research program focused on economic geology through an examination of the structure and the exploitation of the major ore deposits of the western United States. This program pleased his Washington patrons interested in practical results, and satisfied his desire to move toward a new theory of the origin of ore deposits. This paper will focus on two of King's chief lieutenants, Samuel Emmons and George Becker, who were dispatched to Leadville, Colorado and Virginia City, Nevada respectively, to do the geology that would lead to a new and American understanding of ore genesis. The work of Emmons and Becker, undertaken between 1879 and 1886, will be case studies of geological practice, lenses to examine the epistemological status of the ore genesis theories they developed and the variety of methodologies they synthesized to produce geological knowledge. Interestingly, both men built 'frontier' laboratories for their analytical work and I will look closely at the interplay between lab work and fieldwork in their research.

David Brownstein

'Spasmodic Research as Executive Duties Permit': Practice and Authority in the British Columbia Forest Branch, 1912-1925

Amateur natural historians were uniquely placed to observe and document the environmental changes that their colonial society had brought to British Columbia. They advocated scientific forest management based on a knowledge of tree life-histories. In the nineteenth-century when Prussian forestry ideals were brought to North America, both government and business embraced the empirical theories of Forstwissenshaft but the forest botany necessary for its implementation did not survive the trip intact. Upon creation in 1912, the B.C. Forest Branch adopted natural history techniques to make sense of, and then manage, the provincial forests under its control. The natural historians and the foresters were joined by the causeway of ecology as it was then emerging in North America. It was over this ecological bridge that traffic flowed back and forth between the old scientific culture of the natural historians and the new North American forestry. These newly minted civil servants had the moral authority to shape forest policy, but the nascent foresters did not understand the processes of forest regeneration well enough to impose effective logging restrictions. As they sought to develop their expertise, research by Forest Branch staff was initially an inventory science similar to that of the amateur natural historians. Branch research was structured similarly, with responsibilities dispersed among an egalitarian fieldstaff. Over time, a lack of trust between staff in the field and their sceptical leadership forced an internal reorganization of research duties. Research practices were standardized and centralized around limited experiment stations run by a very few trusted individuals. These remarkable shifts can teach us a great deal about the emergence of 'mandated' disciplines and the sources of scrutiny faced by scientists engaged in creating public policy.

Juliet Burba

Discerning the Original Type: Race and American Indian Origins in the Early Twentieth Century

The early-twentieth-century critiques of static notions of race put forth by Franz Boas are well-known among historians of science. Less well-known is the contemporaneous work of Ales Hrdlicka, head of the U.S. National Museum Division of Physical Anthropology from 1903 until his retirement in 1941. Unlike Boas and his students, Hrdlicka continued to emphasize a typological concept of race in his work, and his research stressed racial difference and formation. Resolutely dedicated to the development of his discipline, Hrdlicka frequently sought public attention for his research and ceaselessly promoted the methods of physical anthropology among his fellow anthropologists. One such effort was aimed at the question of American Indian origins, a topic that received considerable attention from anthropologists and the public. Hrdlicka framed American Indian origins as a racial question, thereby promoting physical anthropology--specifically his vision for it – as the discipline uniquely suited for research on this topic, which previously had been addressed through the study of language, folklore, and material culture. Despite the variation that had arisen after their arrival in the New World, Hrdlicka believed the "old type" was still discernible in American Indians, and thus physical anthropology could peer into the past to uncover the ancient racial relationships that were the key to Native American origins. One essential component to this approach was the "unity of type" idea, which portrayed indigenous Americans as uniform, despite any apparent physical variation. This paper demonstrates how this notion, as well as other features of Hrdlicka's analysis, grew directly out of his application of a rigid, classificatory concept of race to the dynamic process of population migration.

Paul Burnett

Pregnant Men and Extra Breasts in Women!: Sexology and Sexology Magazine, 1933-60

This paper examines strategies of popularization of sex research in "Sexology," an American pulp magazine published by science-fiction patron Hugo Gernsback, from its debut in 1933 through the 1950s. Sandwiched between Comstock-era censors and the prurient eye of the newsstand customer, Gernsback and the editors of the magazine walked a tightrope between their appeals to public education and scientific gravitas on the one hand, and Gernsback's rhetorical and semiotic flair on the other. Article titles were reminiscent of the cries of a sideshow barker, while the color covers of the magazine, like Gernsback's other publications, such as the science-fiction magazine "Amazing Stories" were often sexually suggestive. But by suffusing the moral with the natural, the editors argued repeatedly that sex science in no way

contradicted moral codes, and even helped to forestall sexual perversion in the reading public by demystifying sex. "Sexology" highlights the tensions between a sexually conservative social order and efforts to publish the results of scientific research about human biology and sexual behavior in a popular format during the first half of the twentieth century.

Conor Burns

Ethnological Diversity in a New Light: Daniel Wilson's 1858 Critique of North American Ethnology

In 1853, Scottish antiquarian-turned-ethnologist Daniel Wilson relocated from Edinburgh to the provincial scholarly backwater of Toronto, Canada, where he took up the chair of history and literature at University College and intensified his broad ethnological studies of North American native peoples. Wilson is perhaps best known for his two-volume _Prehistoric Man_ of 1862, a work which anticipated by three years the sprawling developmental framework and use of comparative method found in John Lubbock's *Prehistoric Times*. Wilson was no straightforward evolutionist, however. In the five years after his arrival in Canada, he mounted an exceptional critique of the entire field of North American ethnology. Although his main target was polygenist Samuel Morton's cranial analyses, Wilson was unsparing in singling out many others—including arch-monogenist philologist Albert Gallatin—for having failed to recognize the existence of a vast range of diversity among North American ethnological data. In this paper, I will examine the basis for Wilson's critique in detail, and I will comment on what it tells us about the status of ethnology as a science in the mid-nineteenth century North American context.

Claire Calcagno

Sounding the Past: The Development of Sonar Surveying in Underwater Archaeology

Sonar has been used since the early twentieth century to probe and map the underwater environment. By detecting and interpreting the return of emitted or reflected sound pulses, scientists have been able to "see" through water and navigate a world which otherwise would be virtually opaque to normal vision. Acoustic waves can also penetrate sea floor sediments and provide data on sub-bottom morphologies. Sonar sensors have had huge impacts on the oceanographic sciences, including the exploration and mapping of submerged cultural resources. This paper discusses early developments in the application of sonar surveying methods to underwater archaeology, through the engineering contributions of Harold E. Edgerton. A serendipitous observation he made using an echo-sounder at an ancient Mediterranean shipwreck excavation in 1953, while working with Jacques-Yves Cousteau, triggered Edgerton's interest in developing underwater acoustic instruments--side-scan sonars and sub-bottom profilers--to detect cultural artifacts lying proud of the sea bed and buried under sediment. Edgerton carefully documented his experimentations and field-testing observations over the ensuing decades of close collaborations with pioneering archaeologists in the emerging sub-field of underwater archaeology. Archaeological standards of precision and field conditions (including economic constraints) provided particular challenges for designing effective sonar instrumentation, data recorders and processing equipment, and methods of data interpretation. Edgerton's experiences offer insights on scientific experimentation in the propagation, detection and interpretation of acoustic waves under water, as well as their interactions in and around materials of interest such as sediments and man-made objects.

Jane Camerini

Integration of Independent Scholars in the HSS

As a woman and an independent scholar I have found the History of Science Society to be a receptive professional forum for my research. There are significant lacunae in opportunities for unaffiliated scholars, but the HSS and large grant organizations have done a better job at addressing these gaps than have individual universities. I have not found gender discrimination to be an issue in twenty years of attending HSS meetings.
Please note: this submission is part of a workshop on women and people of color sponsored by the Women's Caucus.

Lino Camprubi
Transforming Regimes: Continuity of Scientific Institutions in Spain (1950-1980)

When General Francisco Franco died in 1975, Spanish's transition to democracy took place. In this paper, I want to address the controversial issue of the continuity of some important scientific institutions from one regime to the other. There is a widespread, though not at all universal, historiographical tendency to maintain that democracy in Spain brought scientific and technological interests for the first time. This historiography normally depicts Franco dictatorship as a "time for silence". I will discuss this tendency and present a more balanced version of essential years for economic, industrial and scientific development in Spain: 1950-1980. I intend to prove the institutional continuity between the two regimes, that allow us to talk about "transformation" of the scientific Spanish establishment rather than of "construction" or "revolution". Focusing especially in biological and medical sciences, the role of foreign countries and of ideology in this continuous process will receive special attention.

Kevin Chang
Balsamic Pills: The Alchemical Background and Commercial Value of the Stahlian Equivalent of Universal Medicine

Many alchemists dreamed of achieving transmutation as well as producing universal medicine that cured all diseases. For Georg Ernst Stahl, a believer of alchemy turned critic, though transmutation appeared almost impossible, an equivalent of the universal medicine was not only plausible, but was in fact made available for sale for his own profit. This paper studies the background for Stahl's balsamic pill, an equivalent of the alchemical universal medicine, analyzes his formulation of its medicinal effects in terms of his medical theory of tonic motion, and elucidates the significance of the profitable business of the manufacture and sales of versatile medicines that was pursued not only by Stahl, but also by a host of illustrious chemico-medical authors and institutions that included Johan Joachim Becher, Friedrich Hoffmann, and the pharmacy of the Halle Pietists' philanthropic institution, the "Weissenhaus."

Howard Chiang
Effecting Science, Affecting Medicine: Homosexuality, the Kinsey Reports, and the Contested Boundaries of Psychopathology in the United States, 1948-65

In 1952, with the American Psychiatric Association's publication of its first official listing of mental disorders, the *Diagnostic and Statistical Manual, Mental Disorders* (DSM-I), homosexuality was officially classified as a psychopathology in the United States. As mental health professionals gained increasing cultural authority in the post-war era, a majority of psychiatrists, particularly those with a psychoanalytic orientation, rigidly viewed homosexuality as a psychological disturbance that combined an inner masochistic tendency with a psycho-adaptational fear of the opposite sex. It was within this conservative socio-political context of mid-20th-century America fostered by the Cold War and anti-communist McCarthy campaigns that Alfred Kinsey and his collaborators published their *Sexual Behavior in the Human Male* (1948) and *Sexual Behavior in the Human Female* (1953). In both volumes, by providing statistical findings of the prevalence of homosexual behavior in American society, Kinsey explicitly challenged the mental health profession's description of homosexuality as a psychological illness. Given the context, many historians have correctly documented that among the critics of Kinsey's work, the most vociferous ones were the psychiatrists, especially the psychoanalytic group. Despite the intensive battle between Kinsey and American psychiatrists prior to the mid-1960s, this paper argues that Kinsey's work, in fact, played a significant role in transforming the mental health experts' view of homosexuality starting as far back as the late 1940s all the way through the mid-1960s. After analyzing how Kinsey's work might have compelled American psychiatrists to re-evaluate their understanding of homosexuality *indirectly* through the effort of clinical psychologists, I will then focus to a greater extent on examples that illustrate how the Kinsey reports *directly* affected certain members of the psychiatric community. In the conclusion, using a Foucauldian conception of "discourse," I propose that in order to approach the struggle around the pathological status of homosexuality in the 1950s and the 1960s, thinking in terms of a "politics of knowledge" is more promising than simply in terms of a "politics of diagnosis." Central to the struggle was not merely the matter of medical diagnosis, but larger issues regarding the

production of knowledge at an intersection of science and medicine where the parameters of psychopathology were disputed.

Mary Chicorelli
"The Pain Paradigm: John Bonica, Ronald Melzack and Patrick Wall's Quest to Conquer Chronic Pain"

This thesis explicated a specific theory within pain processes, and showed a dilemma not addressed in medical history literature. On a small scale, the paper described the Gate Control Theory and the approach doctors used to treat patients with chronic pain during the second half of the 20th Century. On a larger scale, the paper illuminated the paradox in the medical field and the relationship between academia and practitioners. It also highlighted the conflicting education that doctors used to treat chronic pain. The development of a journal, Pain, and an association, the International Association for the Study of Pain, were preceded by the first meeting, specializing in pain, in Issaquah, Washington in 1973. There were three key people who helped initiate this dramatic shift in the organization of the pain field: John Bonica, M.D., Ronald Melzack, Ph.D. and Patrick Wall, M.D. For over 20 years, Bonica's tireless efforts to gain support for more research and funding finally intertwined with Melzack and Wall's research in 1965 when they developed the Gate Control Theory. This new theory to explain pain processes inferred that there were multiple factors that caused and affected patients with chronic pain. The theory validated Bonica's ideological approach to treat patients with chronic pain and in reciprocation Bonica supported the Gate Control Theory in lectures and journal articles. In actuality, the pain paradigm was never created because the other theories developed in the late 19th and early 20th century continued to be applied to patients with chronic pain. The Gate Control Theory was influential, but did not pave the way to a new and enlightening understanding of pain processes. Even as late as 1999, Melzack published a new theory on pain processes. If the Gate Control Theory did not create its own paradigm, it did force the field in a new direction, towards a more organized level with the formation of the society and the journal.

Margaret Chmiel
When Science Became a Sputnik: The Crises and Criticism of Secondary Science Educators 1943-63

Between 1943-1963 research scientists, representatives from industry, and others outside the teaching field demanded that science education in the US: win World War II; instill a sense of democratic duty; stop venereal disease; prevent cancer; prevent young minds from becoming "emotionally unstable"; preserve high standards of living; guide students toward racial tolerance; as well as "intangible objectives." The only consistent message teachers did get was that they were failing to adequately teach science. Industry offered financial support and curricular materials geared toward specialized student training in applied science while scientists demanded elite students learn "basic" science. Teachers struggled to accommodate these demands, while attempting to teach "scientific literacy" to all students. By the late 1950's, industry and research science used the image of the Soviet sputniks as a symbol for science education's failure. This paper examines the role of the high school science teacher during a period of great mutual misunderstanding and fear between the scientific communities and the general public. Caught in the middle of this misunderstanding, the professional crises faced by many U.S science teachers can help us better understand what a public demands of science, and what scientists demand of their public.

Hyungsub Choi
Replicating the Transistor in Occupied Japan, 1948-1954

A trio of American physicists at the Bell Telephone Laboratories invented the transistor in 1947. The news arrived to the Japanese physicists during the tumultuous times of the Allied Occupation (1945-1952), making it difficult for them to gain access to information from the U.S. This paper traces the early transistor research programs undertaken at two Japanese government laboratories—the Electrotechnical Laboratory (ETL) and the Electrical Communications Laboratory (ECL). From 1948, Makoto Kikuchi of ETL attended the transistor "benkyokai" (study group) set up by his superiors, where he scrupulously combed through the Western technical literature, and conducted experiments using crude silicon and germanium obtained from steel manufacturers. Kikuchi continued to fail in replicating the transistor

effect as late as mid-1950, when Shingo Iwase of ECL succeeded in making the first Japanese experimental transistor. Although Iwase was not as well versed in transistor theory, he was a dexterous experimentalist, and later designed and built zone-refining equipment in order to make high-purity germanium. I will argue that the transistor moved to Japan only when the knowledge and practices associated with the artifact was successfully learned. Early work done by government physicists during the Occupation years laid the groundwork for Japanese electronics manufacturers (such as Hitachi and Toshiba) to quickly learn transistor manufacturing techniques from American companies (such as Western Electric and RCA). By 1959, Japanese transistor production capacity exceeded that of the U.S., leading the country into the famed economic "miracle."

John Cloud
'The Far Away Nearby': Situating Exoticism in 20th-century Ocean Exploration

The historiography of the literature of modern ocean exploration, both popular and scholarly, discloses a predilection for the deeply exotic and the exotically deep. This in part disguises the great component of 20th century oceanography that was, and is, driven by military constraints, particularly in the arena of submarines and anti-submarine warfare. Deep sea submersibles have discovered astonishing life forms at depths that challenge every extant scenario for the history of life on earth—but they were designed to find downed nuclear submarines, not giant tube worms. Tube worms and submarines are both, in turn, diversions from the main activities in realized ocean exploration in the 20th century, which were the prosaic seaward extensions of hydrographic charting, and the progressive assemblage of data on ocean currents, tidal patterns, and the fluxes in sea water temperature ands salinity. The patterns these revealed, and the baselines for detecting changes over time these constituted, were the most important achievements in ocean exploration in the century. This theme will be explored in the analysis of several historic episodes of hydrographic surveying by the US Coast and Geodetic Survey in the NE Pacific Ocean before WW II, and in the early Cold War. Hydrographic surveying of the continental shelves using Radio Acoustic Ranging led to the first theorization of the deep sound channel of the ocean. During post-war extensions into deep water bathymetric mapping, surveys combining acoustic soundings of depth, electronic positioning, and magnetic surveys of the ocean floor revealed dramatic patterns of magnetic reversals in oceanic basalt crust, the famous "zebra-stripe maps", which required the emerging theory of plate tectonics to explain.

Nathaniel Comfort
Biographies of the Living and Near-Living

The nature of biography changes when the historian can talk to the subject and to those who knew her. Unwritten memories can recover telling anecdotes, forgotten relationships, and elements of personal and intellectual style—precisely the sorts of details that make a biography rich and worth reading. Of course, historical sources that can fog a mirror present special problems as well. They can argue back. They can be unreliable in crafty ways. Oral sources can conflict with one another and consequently may modify one another's views, sometimes compromising, sometimes polarizing. Most importantly, unlike most historical sources, what oral sources say is partly determined by the historian. The resulting document—the transcript or recording—is a collaboration between researcher and source. Biography that uses oral history, then, has a particular intimacy. Further, and in a sense reciprocally, recent history that uses oral history tends to become more biographical. Individual voices rise toward the surface of the narrative. Those elements of relationships, intellectual style, and also motivation will easily find a prominent place in the story. I will illustrate these and other observations about biography, oral history, and recent science drawing on my experience interviewing and writing about geneticists, focusing on the Oral History of Human Genetics project, a new collaboration between Johns Hopkins and UCLA that is recording the memories of pioneering human geneticists, both medical and scientific. These interviews will be made available to scholars and will be databased, providing researchers with a new level of access to the kinds of biographical details that make the history of recent science unique.

Lesley Cormack
From De Sphera to De Globis: Mathematical Practice and Concepts of the Earth

In the sixteenth century, in the midst of much discussion about astronomy and the place of the earth in cosmoloy, a new genre appeared. Treatises describing the use and construction of globes began to vie for readers and practitioners with the older De Sphera tradition (which dated back to Sacrobosco). These new texts were designed to explain the use of the new mathematical instruments – terrestrial and celestial globes – which hit the marketplace in significant numbers beginning at mid-century. They differed significantly from the older cosmological texts, since they explicitly eschewed philosophy and emphasized practicality. Yet, these two traditions had significant connections and on occasion the two genres appeared in a single publication. Was this interaction and contrast related to the changing emphasis in natural philosophy and the mathematical sciences of this era? Does this demonstrate the increasing importance of mathematical practice in the studies of the natural world in the early modern period? This paper will trace the development of these two genres in the 16th and early 17th century, in order to determine their interconnections and divergences, to answer the question of the role of such treatises in the new emphasis on practice, utility, and instrumentation in the development of the 'new sciences' of this period.

Donald Cotter
Unconditional Surrender: The Herty/Smith Feud of 1917, and the Triumph of Nationalist Rhetoric in the American Chemical Society

In early 1917, as the United States approached its entry into World War I, a series of provocative editorials appeared in the *Journal of Industrial and Engineering Chemistry*. Bellicose and nationalistic, these pieces expressed the demands of the new editor, Charles Herty, for strong tariff protection for the American dye industry. When Alexander Smith, chemistry chair at Columbia University, challenged Herty's interpretation of a technical term ("indigoids"), Herty's vicious response transformed the controversy into a feud between the two men and their supporters. By the time of its national meeting in April, the American Chemical Society faced the prospect of an all-out brawl. Despite the evident chest-beating, the issues at stake were crucial ones in the development of American science as a professional and political force. Could a single scientific society achieve the geographical and professional breadth of the already-large ACS without fracturing? What forms of political expression would be acceptable by the Society, its Sections, and its individual members? How would chemical terms of art be interpreted in legislative contexts, and according to whose expertise? The dynamics of the Smith/Herty feud reduced these complex issues to an almost Manichaean simplicity. In its aftermath, the Society increasingly spoke with a single, centrally disciplined voice, and conducted its political affairs accordingly. The feud also made anti-German rhetoric respectable within the Society, in contexts well removed from the prosecution of the war, and thus helped to lay the groundwork for a punitive post-war tariff and patent policy. (This work is supported by a Professional Development Fellowship from the National Science Foundation, Award No. SES-0551046)

Matthew Crawford
The Case of Quina: Trans-Atlantic Institutions and Natural History in the Spanish Colonial Empire, 1737-1792

The history of quina, a botanical febrifuge discovered in the viceroyalty of Peru in the 1630s, is useful as a vantage point from which to investigate the shifting importance of different trans-Atlantic institutions involved in the production of natural knowledge in the eighteenth-century Spanish colonial empire. Prior to the 1770s, Madrid-based institutions of colonial science – the Royal Botanical Garden, the Royal Pharmacy and the Museum of Natural History – did not have the presence (neither politically nor materially) to support trans-Atlantic production and circulation of natural knowledge. Consequently, natural historical knowledge often emerged from the networks of other important colonial institutions - the Secretaria de Indias, which was the colonial arm of the Spanish government, and Catholic missionary orders, especially the Society of Jesus. This paper will examine the scientific activities around quina and in the overlapping fields of natural history and medical botany conducted by members of these institutions in Spain and the colonial viceroyalty of Peru. Analysis of the texts (mainly Jesuit natural histories and reports filed by colonial functionaries) and practices of these institutions and their members will provider a stronger framework for assessing the significance and

novelty of the strictly scientific institutions that became prominent in the last quarter of the eighteenth century. This paper will also explore the features of natural history in the colonial Spanish Atlantic as a point of comparison for assessing colonial science and its role in European colonial projects.

Paul Croce

Rejected Science: William James's Use of His Father's Beliefs

There is wide recognition that the elder Henry James (1811-82) had a large influence on his son, William James (1842-1910). The twin vocations of the elder James were the expounding of his idiosyncratic spirituality and the education of his five children. He took a particular interest in the eldest son, William, whose career did indeed include spiritual interests and religious studies. However, because William also had a scientific education, took up the disciplines of psychology and philosophy, and even approached spirituality with a "science of religion," it has been easy to see the father's influence as a foil, a set of ideas that the son rejected on the path toward secularization. While this is a legitimate narrative for many late nineteenth-century Western intellectuals, it misses important parts of William James's religion and even of his science, and it is not even true to spirituality of Henry James, Senior.

The philosophy of the elder James was rooted in the spirituality of Emanuel Swedenborg, an eighteenth-century Swedish mystic, with growing popularity especially in English and American intellectual circles during the elder James's early years. A distinctive quality of Swedenborg's mysticism was its physical setting, with his theory of correspondence between material and spiritual things, and his emphasis on use which portrayed the meaning and purpose of everyday things. This is what attracted the elder James, and it launched his own spiritual quest to understand the deeper meaning of the natural world, not by going beyond it into transcendental explanations, but by exploring its own depths. He called his explorations scientific. Of course, a claim to empirical inquiry was not a sufficient qualification, especially with his lack of scientific training, and most especially with his inquiry's lack of scientific methodology. However, as the supporters of science in the middle to late nineteenth century turned to philosophies of empiricism and materialism to explain and justify the authority of science, the elder James was in ironic kinship. He was eager to tout this connection, although clearly for him, naturalistic science was merely a step toward greater spiritual awareness.

Growing up with this forceful if eccentric message about science and religion, William James at first rebelled against his father's spirituality. He found the elder James's rejection of individual moral striving confining; he rejected the idealism of his theory of correspondence; and he found his positions too uncritical, too certain. These positions very much reflected his scientific education in chemistry, anatomy, physiology, medicine, and psychology in the 1860s. However, as he began to chafe at the positivist impulses of scientific psychology, especially the efforts to explain or even reduce mind to its physical constituents, he looked at his father's thought with new eyes. At first, he began to appreciate the elder James's anti-institutional fervor, and to apply it to his own resistance to convention and to professional standards. Then he found himself applying his father's appreciation of naturalistic inquiry as a vital first step, even if not the last word about the meaning of natural phenomena. And most important, when he had gotten through discarding all the spirituality that he could not endorse, William got down to a steely core of belief that he shared with his father: a way of looking at nature as more than material stuff, a setting that included the operation of immaterial factors.

While William James rarely made direct reference to his father's thought in his psychology, philosophy, and religious reflections, that core of shared belief served as a magnet for the son's inquiry into other ideas in science and religion. When he found or developed such ideas, he attached them to these core beliefs with the familiarity of recognition and affinity to his father's conviction that the spirit circulates within the natural. The elder Henry James's strand of idealistic science was rejected by the mainstream, and even rejected in complete form by William James himself, but it became a part of much of his work: it entered into his emphasis on the will in human psychology, his eagerness to punctuate the striving of the Will to Believe with sessions of comforting conviction, his readiness to find "'piecemeal' supernaturalism" in subliminal psychology, his incorporation of idealism into his radical empiricism, and his openness to psychical experience. Before these mature theoretical constructions, William also came to terms directly with his father, right after his death, when he collected his father's Literary Remains, and wrote a long introduction, in which he carefully distanced himself, but also acknowledged his debt to the man who gave him his "right to have a say about the deepest reasons of the universe."

Daniel Crosby
The Logician and the Cash Register: Alan Turing's Material Epistemology of Minds and Machines

British mathematician Alan M. Turing has been rightly praised for his contributions to theoretical mathematics and computer science, but where did his ideas about machines come from? His Turing machine, introduced in 1936, is a central concept in modern mathematical logic, and his 1950 Turing test is a standard, if controversial, instrument in discussing artificial intelligence, but neither idea sprang out of thin air. For Turing, machines were very real, physical objects that instantiated mathematics, but that could only be understood through hands-on experience. This paper will show that machines had a meaning and articulated ideas far more concretely than the abstruse nature of the 1936 paper, and its initial reception, might imply. He had a childhood fascination with inventions, and as an undergraduate, was actually trying to construct computing machines, alongside his theoretical investigations of the subject. This interest continued during and after the war, when he was not content to theorize about and design machines, for code breaking or general computing, but was directly involved with their manufacture, debugging, and programming. Even his misbehaving bicycle was subject to a combination of physical examination and mathematical theory. Turing's material interactions with the objects of his study contributed to his understanding both of machines and of mathematics, and convinced him that machines were not predictable and simple in the ways his contemporaries often saw as synonymous with "mechanical." It was partly due to this material understanding that Turing came to believe machines were capable of intelligence, perhaps on the same level as humans.

Hunter Crowther-Heyck
Patrons of the Revolution: Ideals and Institutions in Postwar Behavioral Science

This paper argues that shifts in patronage for the postwar behavioral and social sciences were linked intimately to both intellectual and institutional changes. This broad argument comprises two sub-arguments: first, that there were in fact two distinct, successive patronage systems for postwar social science, not one, as is commonly assumed; and second, that the first postwar patronage system played a major role in enabling a series of behavioral revolutions and interdisciplinary syntheses across the social sciences, while the second postwar patronage system encouraged the development of specialized concepts, techniques, and technologies within the disciplines. The specific focus of this paper will be on the roles of these two patronage systems in the cognitive revolution in postwar psychology. From the late 1940s to the mid-1960s, psychologists interested in developing a behavioral-functional psychology that would use tools and techniques from other fields, especially communications and computing technologies, as guides for constructing formal models of mental processes found support from a wide range of patrons (including several private foundations and many military research agencies) who wished to promote research that was mathematical, behavioral-functional, problem-centered, and interdisciplinary. In the 1960s, new civilian, federal patrons, notably the NSF and NIH, began to play an increasingly large role in sponsoring research in cognitive psychology; by the late 1970s, their support of cognitive psychology had helped transform this inter-discipline into the mainstream of the discipline, enabling rapid advance at the price of a more bounded conception of the field.

Julie Cruikshank
Melting Glaciers and Emerging Histories in America's Far Northwest

Memories of the Little Ice Age in northwestern North America (roughly 1550-1850 A.D.) remain vivid in oral histories transmitted in indigenous communities near the Alaska-Yukon border. During the 18th and 19th centuries, enlarged glaciers in the Saint Elias Range provided travel routes for Aboriginal traders crossing from the Gulf of Alaska coast to the interior Yukon Plateau. In the 20th century, both Canada and the United States designated National Parks in this region, displacing indigenous residents from these territories; those parks are now encompassed within a UNESCO World Heritage Site. Melting glaciers are now revealing material evidence that reinvigorates longstanding oral traditions about human history and environmental change, posing new questions for cross-cultural and interdisciplinary collaborations. The paper will discuss how recent discoveries and collaborations among Aboriginal peoples and scientists reinvigorate

discourses surrounding science and politics, concepts of 'nature' and 'culture,' and how local knowledge is co-produced in such encounters.

Alex Csiszar
Joseph Deniker and the Classification of Race and of the Sciences at the Fin de Siècle

Joseph Deniker was a Russian-born French anthropologist who was internationally known for his comprehensive classification of human races *Les races et les peuples de la terre*, 1900); he was also the chief librarian of the Muséum national d'histoire naturelle in Paris, and the secretary for France of the newly minted International Catalogue of Scientific Literature, based in London. Now best-remembered for having challenged a then-dominant hereditary conception of race (he introduced the concept of an "ethnic group", later picked up by Montagu for the UNESCO statements on race), this otherwise-forgotten figure stood at the intersection between two ostensibly distinct classification crises at the fin de siècle: One asking what it meant to classify humans into racial types; the other what should serve as the basis for an effective global classification system for scientific works. As the chief advocate for the Royal Society's International Catalogue on the continent, Deniker engaged in debates over the bibliographical classification, and how best to improve the channels of communication in an era of rampant disciplinary expansion and specialization. In Deniker's and his colleague's work, the troubled science(s) of race, cutting across so many emergent disciplines as well as geographical locations, provided an explicit conceptual resource, not to mention a kind of ideal test case for the new bibliographical schemes. Better means of organizing and disseminating information were seen as crucial to enabling a modern, properly scientific, classification of human types. Progress in international scientific communication and progress in a comprehensive science of race could thus be understood as dependent on the solution of overlapping sets of methodological problems. Deniker's approach was to advocate radically anti-hierarchical, conventional and contingent classification systems, in the one case ignoring hereditary genealogies, in the other ignoring supposedly consistent disciplinary and conceptual hierarchies, arguing finally that closed and permanent solutions to such problems were not only unavailable, but often undesirable.

Louise Curth
Astrological Medicine in Early Modern English Almanacs

The vast range of printed 'popular' medical literature that appeared in the sixteenth and seventeenth centuries has long been recognized as playing an important role in the way in which the public understood ideas about health and illness. This paper, however, will argue that almanacs had the most powerful impact on the way in which medical information and advice was disseminated in England. Based on the examination of over 2,000 almanacs printed between 1550 and 1700, it will show that almanacs helped to promote and maintain traditional, orthodox medical practices and beliefs well into the eighteenth century.

Dane Thor Daniel
Alchemical Aspects of Paracelsus' Theology

The famous and infamous natural philosopher, medical practitioner, and lay theologian Theophrastus Bombast von Hohenheim, or Paracelsus (1493/4-1541), often links science and religion in unique ways. One such example regards his use of the literature of medieval alchemy, particularly that of pseudo-Lull, in his teachings on cosmogony and soteriology. This link between alchemy and religion/ethics is a significant, if overlooked, example of his attempt to utilize alchemical theory in a practical manner. Discussing the creation of Adam, as well as the intimate connection between man (microcosm) and the world (macrocosm), Paracelsus writes that the human was made from a *stoff* namely the *limus terrae* of Genesis 2:7, and that this primordial ooze consisted of all essences of the universe: humans are thus composed of and contain all macrocosmic essences, from plants to planets. In his magnum opus, the *Astronomia Magna* (1537/38), Paracelsus refers to the *limus terrae* as a quintessence—This points to a first striking example of his familiarity with the author of the *Testamentum* which was attributed to the Catalan Ramon Lull. The author of the *Testamentum* writes that the quintessence had been created *ex nihilo*: God took this pure substance, in which the entirety of nature is contained, and divided it into three parts, each with a different level of purity. In what may be seen as an anticipation of Paracelsus'

thoughts on the subject, pseudo-Lull argues that the quintessence is that from which the human is made–it is an extract of the heavenly and elemental, possessing all things within. This is only one of several examples of convergence between Paracelsus' theories and those of the Lullist, with whose alchemical concepts and writings Paracelsus was well familiar. As I will show, the quintessence (in the sense of pseudo-Lull)—especially regarding human origins—is certainly fundamental to Paracelsus' theology and utilitarian ethics. But it is also noteworthy that both the Lullist and Paracelsus held to a 'spiritualist' account of the biblical conflagration, in which both all evil and all impure material, including the mortal human body, must be irrevocably annihilated. Paracelsus the alchemist could fervently envision the final purification of the universe and the subsequent life of Christians therein—saints in pure bodies floating in a new universe of the purest substance. In addition to highlighting Paracelsus' relation to pseudo-Lull I will show how this connection relates to Paracelsus' heretical theory of salvation and pious views on Christian morals.

Deepanwita Dasgupta

Doing Science from a Colony: S.N. Bose and His Communications with Einstein

In 1924, Satyen Bose, a theoretical physicist working in colonial British India, sent a paper to Einstein that derived Planck's co-efficient without using classical electrodynamics. Bose's paper eventually became the foundation of what is known as the Bose-Einstein statistics. Bose had sent his paper to Einstein out of desperation-- he had been unable to publish his paper in the Philosophical Magazine. For a scientist working from the colonies, Bose's chance of publishing a paper that called for a radical conceptual shift was in fact pretty slim. Bose thus decided to take his chance by relying on his very slim personal relationship with Einstein. Bose's story, which fortunately had a happy ending, reveals however, the tip of an iceberg, showing the curious relationship that exists between a colonial scientist and his metropolis, within whose parameters he carries on his professional work. The metropolis controls the institutional gateway and thus effectively determines the success (or failure) of such a scientist. In my paper I articulate the double-layered relationship between a colonial scientist and his metropolitan professional community and inquire why such a scientist is often obliged to fall back on personal ties in order to gain a foothold within that metropolis. My paper is thus an attempt to articulate how communication in sciences is shaped by the dynamics between a periphery and a metropolis.

Raf De Bont

Fighting on Two Fronts: Spiritualist Thinking and Evolutionary Theory in Fin de Siècle Belgium

In their studies on the relationship between religion and science in nineteenth century Europe, historians (like James R. Moore or Harry W. Paul) have tended to focus on the 'traditional' Catholic and Protestant denominations. Yet European religiosity was broader than that. Therefore, in the proposed paper I would like to study how a more broadly defined group of 'spiritualists' (i.e. people who believe in the existence of a soul, free will and some kind of supreme being) dealt with evolutionary theory in late-nineteenth century Belgium. Three specific groups will be taken into account. First, I will focus on a group of (more or less traditional) Catholic authors around the journal *Revue des Questions Scientifiques* (such as Ignace Carbonnelle, Victor van Tricht and Alphonse Proost), who selectively tried to rehabilitate evolutionist elements in a spiritualist framework. Second, I will deal with spiritualist liberals and freemasons (such as Guillaume Tiberghien, count Goblet d'Alviella and Charles Saroléa) who – opposed to the rising of positivist and materialist thought in their circles – tried to reconcile the existence of a 'divine power' with evolutionist ideas. Finally, I will pay attention to a group of symbolist artists (such as Maurice Maeterlinck, Iwan Gilkin and Jean Delville), whose vitalist interest in 'Life' led to a very particular kind of spiritualist evolutionism. Although ideologically diverse, these different groups clearly resembled each other in their rhetorical strategies, in their creation of new associative fields and in their selective appropriation of evolutionary theory. All three groups wanted to formulate an alternative for both biblical literalism and materialist darwinism. All three therefore had to fight on two fronts. It is the strategies used in this double fight that will be the focal point of my paper.

Soraya de Chadarevian

Biolgy under the Cloud: 'Unplanned' Experiments and Strategic Implications

Fallout from nuclear bomb explosions represented a military-strategic problem imposing "practical limits" to the deployment of nuclear weapons (one rather partial way of addressing the problem were attempts, from the early 1950s, to develop a "clean bomb," that is a nuclear bomb that would not produce fallout). At the same time fallout opened up unexpected opportunities for biological research, for which government funds were readily available. The tight connection between weapon-related developments and biological research can be gleaned from plans in the late 1950s to set up a series of test explosions just for biomedical research and from the fact that nuclear bomb test explosion sites were active places of biological research. Even before global nuclear fallout became a public issue in the mid-1950s, concerns about the hazards of radiations from nuclear energy generated a wide range of experimental investigations, notably in the field of genetics. The "large-scale unplanned exposure of the population"; to nuclear fallout from weapons tests offered new opportunities for research. In my paper I will review how, in the mid-1950s, concerns about genetic hazards were at least partly overshadowed by concerns about the accumulation of radioactive strontium from fallout in human bones and the biological research that shaped these debates. The discussion will shed light on the wide variety and broad ramifications of biological research undertaken as part of the development of nuclear energy for military and civilian uses and help clarify the place of biology in the nuclear age.

Alexis De Greiff

A Critical appraisal of the Historiography of the North-South Technoscientific Relations

In this paper we make a critique of a few examples of potential interest to those concerned with problems regarding technoscientific scientific exchange between North and South from the social studies of science and technology perspective. We identify specific subjects, conceptual questions, social agents, political contexts that current historiography of science and technology has ignored or underestimate. We present a review of the state of the art of those subjects we discuss, namely: science, technology and development theories; the Green Revolutions; and technoscience and the Cold War in the South. We argue that, in order to understand the role of technoscience, both in the South and the North, it is necessary to study the dynamics of the technoscientific exchanges between the so-called Third World and the industrialized countries.

Johan De Klerk

History of Mathematics and Technology as Motivational Tools in Teaching Mathematics

It can be argued that some subject fields – specifically Mathematics in the present case – could be viewed as a separate entity, divorced from anything else in reality. But it can also be argued that Mathematics could be viewed in a setting of ever expanding contextual frames, for example, those of history, science, society, nature and religion. As lecturer of Mathematics and Applied Mathematics, I adhere to this latter viewpoint and in this discussion attention will be paid in particular to the contextual frame of history. It is often argued in literature that it would be to the benefit of students in Mathematics if the history of Mathematics could be integrated as a tool in teaching Mathematics (and also, in a wider sense, the sciences). Unfortunately, there is also a negative aspect to this matter, namely the poor standing of History (as a subject field in its own right, as well as a general background tool to class discussions). Therefore, I have embarked in my Mathematics classes on a road of not only discussing historical aspects of Mathematics, but also of Technology. I have found that my students – many of whom are engineering students – are much more motivated when the history of Mathematics and Technology is related to the course material. In this presentation attention will be paid to some background and pedagogical matters as well as to reactions of students.

Mioara Deac

Sciences of the Mind, Automatic Drawing, and Feminism in Victorian England

The vogue of spirit drawing emerged in the early 1850s. It meant the production of artistic works allegedly without the conscious knowledge and will of the performer. Drawings were printed in books; automatic painting séances were being held; and a number of London galleries exhibited such artistic productions. Many Victorian women belonging to the

artistic and literary elite believed that automatic drawing was performed under the guidance of the spirits of the deceased. Contemporary psychiatrists also explored these kinds of paranormal phenomena related to the inner vision. But they routinely attributed the belief in the action of the spirits to either insanity or gullibility. I focus on three less known Victorian women who performed automatic drawing in mid-nineteenth-century England: Camilla Newton Crosland (1812-1895), Sophia DeMorgan (1821-1896), and Georgiana Houghton (1817-1888). For these women, the exploration of the sciences of the mind, art, and feminism were inseparable. My paper shows how these women used the language of science (i.e., the concept of the unconscious cerebration, the theory of the inconvertibility of forces in nature, and newly formulated theories of vision and imagination) in order to deconstruct the Victorian normative image of the feminine.

William deJong-Lambert

Szczepan Pieniazek: Polish Lysenkoist

This paper is an examination of the career of one of the foremost promoters of Lysenkoism in Poland, Szczepan Pieniazek. Pieniazek was an agronomist whose involvement in communist activities began before the Second World War. He was on a fellowship at Cornell University when Nazi Germany invaded Poland and he spent the war in the United States. With the establishment of the socialist regime after the war he returned to Poland and became a leading figure in the Michurinist movement, and headed an agricultural research institute which was the center of Michurinist research. His own account of his activities during this period is made of contradictory statements: On the one hand he says he "truly believed," but also said that promoting Lysenkoism was his "compromise with power." This paper uses Pieniazekas a case study to explore the choices individuals make in supporting scientific doctrines in response to various political rewards and methods of coercion. The information presented is the product of a year spent in Poland on a Fulbright-Hays grant, conducting research for a dissertation on the topic of Lysenkoism in Poland.

James Delbourgo

Collecting the World Under Water

How and why did Hans Sloane (1660-1753) collect? In discussing a well-known eighteenth-century ethnographic object, a historian of slavery recently noted that an Asante drum had "made its way into Sloane's collection in London." This is an interesting use of the passive tense, because it is physically impossible for inanimate objects to move themselves, as scholars of museology and ethnography have emphatically shown. This paper examines the origins of Sloane's collecting practices in his gathering of ethnographic and physical information about African slaves on his Jamaican voyage of 1687-1689. Best known as the "great collector" who posthumously founded the British Museum in 1753, Sloane traveled to Jamaica with the incoming governor, Christopher Monck, Duke of Albemarle, and remained on the island for fifteen months, working as a physician and naturalist. He collected 800 plant specimens, as well as sundry artifacts and even human remains, and ultimately published the Natural History of Jamaica (1707-1725), a 2-volume work regularly cited by historians as evidence of the conditions of Afro-Caribbean life on the cusp of Jamaica's turn to slavery in the late 17th century. Sloane himself married a Jamaican widow and inherited slaves, which brought him income from the sugar plantations, thus helping to fund his own encyclopaedic collection enterprise. Slavery itself formed a part of these collections: Sloane appears to have been one of the very first Europeans to have collected and publicly displayed slave artifacts such as manatee straps (whips) and weapons used in slave rebellions. Historians of early modern collecting have recently insisted on the relationship between collections and global commerce, but they have rarely connected the business of collecting to the institution of slavery. What do Sloane's entrepreneurial collection practices tell us about the relationship between early modern science, slavery, and empire in the Atlantic world? How is the history of metropolitan enlightenment also a history of colonial collecting?

David DeVorkin

Leo Goldberg and the Two Chinas

It is well known that the 1952 Immigration and Nationality Act (INA), the infamous McCarran-Walter Act, severely curtailed travel to America for foreigners from suspect countries, or those who were outspoken from friendly countries. It is also the case that this act, and the general reactionary political atmosphere of the day, resulted in numerous difficulties for American participation in international scientific activities. Astronomy was no exception. One of the major issues on

the agenda of the U.S. National Committee to the International Astronomical Union, as it planned for discussions at the upcoming General Assembly in Moscow, was to gain State Department clearance to invite the Union, the world body of astronomy, to hold its next General Assembly in the United States in 1961. A central player in this effort was the Michigan astronomer Leo Goldberg, then Chair of the U. S. National Committee. Here we discuss his experiences dealing with the State Department and with Wallace Brode, then science advisor to the Secretary of State. We will show how the State Department reacted to the knowledge that Red China was a member of the IAU and not Nationalist China, and how Goldberg and his colleagues dealt with Brode's demand that Nationalist China be invited and Red China excluded, even though the former did not have an active astronomical community and the latter certainly did.

Nicholas Dew

Baroque Metrology and the Travels of the Seconds Pendulum, 1672-1726

European savants of the late seventeenth century shared the dream of establishing a universal standard of measurement, valid across space and time. One candidate, popular in the 1660s and 1670s, was the length of a pendulum beating seconds. This paper follows the travels of this apparently simple experiment around various sites from Paris to London, and from Uraniborg to Bayonne. As part of its surveying and mapping project, the Paris Académie des Sciences sent observers to various parts of France to make astronomical observations, and these agents were also instructed to measure a seconds pendulum in order to test whether the length was indeed constant, as was hoped. Harmonizing the measurements was a complex task, partly because the experiment was hard to do, and partly because it was also implicated in larger natural-philosophical problems like the theory of weight. This paper offers a micro-analysis of the construction of this ill-fated metrological network by the French Académie, showing how various other scientific bodies, like the Copenhagen Observatoire and the Royal Society of London, were brought into agreement by the movement of skilled agents and objects. For example, the Royal Society insisted on a different figure for the pendulum's length in London, and it was only when Cassini sent Roemer to London to show the English how to do the experiment that they fell into line. The seconds pendulum is best known today for its later role in the Figure of the Earth debate: an anomalous reading from Cayenne in Guyana seemed initially to be an error, and was to be interpreted by Newton as a sign of the earth's equatorial bulge, and of the distinction between mass and weight. Looking at the period before the Newtonian controversy, however, reveals how the travels of the pendulum can be taken as a case study in scientific replication in the age of the Republic of Letters. At the same time, this approach allows us to understand Newton's use of the pendulum data, and the response of his contemporary critics, in a new light.

Dawn Digrius

Imag(in)ing Paleobotany:The Internal Structure Debates, 1868-1895

William Crawford Williamson, in his article to the journal of the Royal Microscopical Society (1869), strongly noted that "I have very little confidence in any determinations respecting fossil plants, excepting such as are based upon internal structure: all the modern classifications of living plants rest on this basis, and it is the only safe guide amongst fossil ones." His determinations on the Carboniferous Lepidodendroid and Sigillarian plants, that they should constitute one natural family and not be divided into two distinct groups, met with great debate during the period from 1868 until 1895. The internal structure debates promoted the use of the microscope and changed the nature of paleobotanical practice during the latter half of the nineteenth century. As the science of paleobotany moved toward the microscopic analyses of internal structure of fossil plants, classification facilitated the development of programs, either at the university or at the museum, by which interested individuals would be trained in paleobotanical techniques. This paper addresses the development of modern paleobotany through the microscopic observation and imaging of fossil plant specimens and their internal structural components.

Fokko Jan Dijksterhuis

The Visible World. Knowledge of Things Optical in the Dutch Republic

In 1678, Samuel van Hoogstraten (1627-1678) published *Inleyding tot de hooge schoole der schilderkonst, anders de zichtbaere werelt* (Introduction to the Art of Painting, or: the Visible World). Hoogstraten was a painter and a former pupil of Rembrandt and in this book he elaborated his esthetic theories. However, the *Inleyding* also reveals Hoogstraten's

profound expertise of light, vision and image formation that is rooted in his painter's practice on the one hand and his extensive reading of contemporary savant literature on the other hand. A book on esthetics is not an obvious place to look for seventeenth-century optical knowledge, in particular when the history of optics is approached with twentienth-century epistemic and disciplinary categories. In this paper I will trace various kinds of optical knowledge in a disparate array of seventeenth-century writings to see what this reveals about the nature, practice and historical embeddedness of insights in light, vision and images. The sources range from the artistic world of a Hoogstraten, via the medical market of ophthalmology and the business of instrument making, to the comtemplative studies of savants. The setting is the Dutch Republic of the seventeenth-century and besides discussing the optical content of this heterogeneous collection of writings, I will trace the historical connections between its writers. For example: Hoogstraten on the one hand read Descartes' Dioptrique and on the other hand knew Casper Calthoff, an instrument maker who also worked for Christiaan Huygens. In this way, I intend to gain insight in the way optical knowledge was produced in the heterogeneous network seventeenth century visual practices.

Paul Dimeo

The History of Science, Drugs and Sporting Performance, 1920-1960

The use of drugs in sport has provided a public focal point for ethical debates on the science of physiological enhancement. Broadly, this history is one of two counter-acting forces: the scientific development of drugs; and the policies designed to prevent their usage on the basis on health and sporting ethics issues. This paper surveys a period when scientists and athletes were more open about the development of drugs (the anti-doping movement did not emerge with any vigour until the mid-1960s). It is a period when exercise physiology became a new scientific discipline in its own right, with such institutions as the Harvard Fatigue Laboratory leading the way. In the USA and Germany in particular the modernising impulses and structural social aims brought together sport and science to rapidly push forward research into stimulants for performance. Clinical studies on amphetamines, cocaine, sodium phosphates and hormones provided the scientific context within with such drugs appeared in sport. This relationship between science, drugs and sport will be examined in the paper. It set the foundation for later developments in physiology, steroids, human growth hormone and blood doping. As such, an improved understanding of this period would underpin greater insight into the 'problem' of drug use in sport.

Mary Domski

Locke and Newton on the Mathematical Nature of Natural Philosophy

When talking about the rise of empirical natural philosophy in the seventeenth century, it has become standard place to mention John Locke and Isaac Newton in the same breath. It's a small wonder when we consider Voltaire's famous characterization of this coupling: on the one hand, we have the empiricist philosopher who challenged Cartesian metaphysics, and on the other hand, we have the empiricist natural philosopher who overturned Cartesian physics. Turning our sites away from the broader anti-Cartesian trends of the late seventeenth century, there's more substantial evidence that Locke and Newton shared a common empiricist worldview: both emphasized the use of observations and experiments, both rejected the use of hypotheses, and both heralded arguments based on induction as the only acceptable form of reasoning for natural philosophy. Moreover, in light of Newton's emphasis on experiment, observation, and induction, as well as his rejection of hypotheses and innate ideas, we could follow G.A. Rogers and promote a Lockian reading of Newton's philosophy of nature. However, before we make this leap, I think it's important to consider an aspect of Newton's work that seems to resist a Lockian reading, or even a straightforward empiricist reading for that matter: the intermingling of experiment, observation, and mathematics that Newton employed to "deduce" the law of universal gravitation. Taking seriously the role that mathematics plays in Newton's "deduction" of gravity enriches our view of Newton's empiricism, and also illustrates his innovation over the methods espoused by his empiricist contemporaries. Thus, if any connection between Locke and Newton be drawn at all, I hope to show that it's more appropriate to see Newton's mathematical-empirical method as an extension of the method Locke promotes in his Essay rather than an exemplification of it.

Matthias Dorries

Responding to Natural Hazards: Krakatau

The explosive eruption of the volcano Krakatau in late August 1883 in the Netherlands East Indies immediately put scientists on alert, not at least because of its exceptional character. The mining engineer R.D.M. Verbeek (1847-1928), already stationed in the Netherlands East Indies, was commissioned by the Dutch government on the 4 October 1884 to lead an investigation on what had happened. His preliminary report appeared six months after the eruption, followed a year later by a detailed monograph on the history of Krakatau and the 1883 event and the eruption's regional impact. This report was assembled from some 600 sources (eye witnesses, interviews, newspapers, field trips, etc.) that reflect the network of colonial power. What motivated this kind of research? Was it just another scientific report in response to political demands? Was there an expectation of a better understanding of the danger that nature posed to the colonial enterprise? Or was it simply curiosity about nature's wonders? While Verbeek had first conceived his work as "purely geological," he was soon led to broaden his investigation, as reports from Europe pointed to the global scale of this eruption, "the most remarkable that humanity has witnessed." Ultimately his report was compiled in the "interest of humanity," meaning the interest of the colonial powers, which desired both to reinforce their control and to minimize the consequences of future natural hazards to their possessions.

Felix Driver

Disaster in the Tropics: The Wreck and Salvage of HMS Thetis, 1830-1854

In 1830, the British frigate HMS Thetis was wrecked at Cabo Frio, on the Brazilian coast. A British naval force was subsequently dispatched to undertake a major salvage operation which lasted for well over a year. The substantial textual and visual archive associated with the case of the Thetis raises wider questions about the entanglement of naval, scientific, artistic, financial, and legal concerns in an age of British maritime expansion. If the loss of such a ship brought into a questions capacity of the British to act at a distance, it also provided an opportunity to mend and strengthen the networks of power and knowledge. The sources of error exposed by the accident were to be subject to investigation by numerous authorities, including hydrographers keen to refine their charts and sailing directions ad Fellows of the Royal Society seeking to advance the claims of science, as well as the Admiralty itself, in the judicial setting of a court martial. We focus especially on narratives of the wreck and the salvage of the Thetis, and the significance of their repeated tellings of the story after the event; and on the evidential and representational status of the visual images of the Science, in sketches, maps, charts, diagrams, engravings, and paintings.

Sarah Dry

Saving Lives Everyday: Disaster Prevention in mid-Victorian Britain

This paper seeks to analyze the 'everyday' quality of disasters in the mid-Victorian period when railway crashes, shipwrecks, boiler explosions and mining accidents were commonplace. While exceptional events such as the Royal Charter storm of 1859 and the Tay Bridge Disaster of 1879 had important effects on safety policy, in this paper I examine the routines of life-saving. I look at the daily activities of voluntary organizations (such as the Royal National Lifeboat Institution and the Royal Humane Society), common civic displays of life-saving technology such as life-boats and ship's distress signals, and the daily publication of accident and rescue statistics in newspapers. A close examination of these practices reveals that anxiety about disasters often took the form of anxiety about safety interventions.

Warren Dym

The Enlightenment Underground: Dowsing and the Freiberg Mining Academy

Historians of earth science and mining have emphasized the modernizing influence of the Freiberg Mining Academy (f.1765). The school was central in advancing the study of rock formations, and it marked a new age of engineering in mining. However, age-old miner beliefs and new science could combine in practice at Freiberg. In particular, scholars and mining officials had little alternative to the prospecting knowledge of miners, and long-standing mining books filled with mining lore and digging knowledge, including dowsing, remained authoritative. In addition, theories of animal magnetism, galvanism, and electricity all suggested a new science of dowsing, or rather Romantic science based on the

'Naturphilosophie.' The famous Freiberg physicist, Ferdinand Reich, rejected dowsing, but he was nonetheless asked to examine a local dowser in the 1840s who experienced 'galvanic excitement.'

Bruce Eastwood
From Computus to Astronomy in the Carolingian Renaissance

In the ninth century in northwestern Europe clerical studies supported by both king and church underwent a remarkable expansion. Computus had provided for at least two centuries the field for study and sharp debate about the courses of the sun and moon, the placing of the vernal equinox, and the date of Easter. What computus did not include was the study of the planets and their more obviously variable motions. Computus, for example, had no explanation for retrograde motion. In the course of the ninth century the revival and study of Roman scientific books concerning planets opened to Carolingians new understandings of celestial motions. Two examples included in computus and the new astronomy, the changing lengths of daylight through the year and the different lengths of the four seasons, show directly how ninth-century scholars were led from arithmetical, computistical accounts of these phenomena towards geometrical, astronomical accounts. These new understandings were important conceptual foundations for later investigations of the "new" Greco-Arabic astronomy.

Taner Edis & Amy Bix
Islamic Creationism in Turkey: Historical and Intellectual Perspectives

While creationism and "creation-science" attract attention as a conservative Christian reaction to modern science in countries such as the United States, Muslim countries have been even less hospitable to Darwinian evolution. In Turkey, evolution has been promoted by secularists starting in the 19th and early 20th centuries, and fiercely resisted first by traditional religious scholars and then by more modern religious movements. The "Nur movement," for example, has been noted for both its pro-technology and pro-capitalist attitudes and its involvement with creationism and other apologetic distortions of modern science. Starting the 1980s, creationism in Turkey found official approval and also started borrowing heavily from Protestant creationism based in the US. In the 1990s, Turkish creationism continued its development, acquiring a significant media presence. Today, from the popular creation-science promoted by Harun Yahya to echoes of the "intelligent design" movement, Turkey has become a center for Islamic creationism.

Matthew Eddy
Symbolic Specimens. Or, Teaching University Students to Be Collectors, 1770-1800

How did eighteenth-century universities teach students to be collectors? In 1786 Somerville Wilson set off to become a surgeon for the East India Company in Madras (Chennai). Keen to collect useful objects, he visited his former teacher Rev Dr John Walker (1731-1803) and asked him for advice. Walker was Edinburgh's Professor of Natural History. He had amassed the largest natural history collection in Scotland and over his career he taught over 1000 students whose travels spanned the breadth of the British Empire. Walker duly wrote a collection guide and Wilson then took it to Madras. Like the other professors of the Medical School, Walker taught his students to see the world via a symbolic language of utility that normalised natural objects into classification characters that were relevant to the codes of classification employed by the Royal Society of Physicians and the Royal Society of Edinburgh. Drawing from the vast Walkerian collection housed in Edinburgh, this paper shows how he instilled a symbolic language of utility that then motivated and guided the collection habits of students like Wilson when they left Scotland. In particular, I will show how he integrated the practices of 'reading' (set textbooks) and 'writing' (notes and essays) with 'collecting' (museum specimens). This tripartite process taught his students to collect objects that they felt were relevant to their chosen profession or the perceived gaps in Edinburgh's natural history collection. Although historians have touched upon the general utilitarian motivations that under-girded collecting in Enlightenment Edinburgh and elsewhere, the local processes of symbolic inculcation remain unexplored. How did Walker's teachings affect Scottish collectors who visited India, Australia and Africa? Does his approach call for more studies on how local practices throughout Europe guided the collecting of international travelers?

Dmitry Efremenko

Societal and Historical Background of V. I. Vernadsky's Theory of Noosphere

The paper discusses societal aspects of activity and theoretical heritage of Russian geochemist and mineralogist V. I. Vernadsky (1863-1945). Since 1905 Vernadsky took an active part in Russian liberal movement as a member of the 'Kadet' Party. Under the communist rule Vernadsky faced dilemma to combine his non-acceptance of Marxist ideology, and collaboration with the Soviet regime in the field of scientific research. The theory of noosphere developed by Vernadsky fully reflects this dilemma. According Vernadsky, the human faces a question of reorganization of biosphere in the interests of freely conceiving mankind as a single whole. This new condition of biosphere to which we, not noticing it, are coming nearer is "noosphere". Means of transformation of biosphere in noosphere is the production and application of scientific knowledge. It was characteristic of Vernadsky's understanding of features of transition to noosphere that he coordinated this process both with the major events of political history of the 20th century, and with the freedom of scientific communication. In fact, the "noosphere" theory was a sort of non-Marxist discourse which contested official Soviet ideology.

Yulia Egorova

Science and Culture: Conversations with Geneticists

Recently the question of the impact of culture on science turned into one of the central issues in the history and social studies of science with some scientists having become involved in the debate defending the special status of scientific knowledge and admitting the possibility of culture affecting science only to a limited degree. How widespread are such views among 'regular' scientists? This paper is based on interviews with geneticists from the UK, the USA, Russia and France and explores their responses to questions about the impact of culture on their work and generally on genetics, a science which figures prominently in the public discourse. It will be demonstrated that the geneticists' responses far from being monolithic in terms of the perspectives on the epistemological effect of culture on science that they reflect contained a wide range of attitudes on the issue and can be best understood in the context of the history of genetics in the countries where the respondents work.

Ziv Eisenberg

Old Ideas, New Science: Mental Health and the Medical Care of Pregnant Women in Mid-Twentieth-Century America

My paper explores how the study, diagnosis, and treatment of pregnant women's psyche became one of the fundamentals of prenatal care in the United States, from the late 1930s to the early 1960s. The convergence of old obstetrical and gynecological concepts with contemporary mental health theories produced a discursive hybrid, which defined the American woman as childish and emotionally unstable, and assumed a pregnant woman's mental problems affected the fetus, leading to death or mental defects. Thus, the discourse's proponents served to place pregnant women under medical surveillance and subject them to mental treatment. The paper argues that four different mental health camps contributed to the construction of this new hybrid: mental hygiene, with its emphasis on the prevention of mental illness; ego psychology, which concentrated on the adverse influence mothers have on their children; psychosomatic medicine, which merged psychoanalysis with biological medical sciences such as neurology and endocrinology; and biopsychiatry, whose aim was to identify the somatic origins of mental illness. In addition, the new discourse was shaped by the ideology termed by Rima Apple "scientific motherhood," that is, "the insistence that women require expert scientific and medical advice to raise their children healthfully." One of my goals is to complicate Apple's argument, by showing that mothers were expected to seek advice and follow it even before they gave birth, in order to improve their mental faculties and protect their future children. What began as an intellectual interest in pregnant women's psyche by such eminent mental health professionals as Helene Deutsch, Karl and William Menninger, developed into a practice advocated by leading obstetricians and gynecologists. During the post-war era and the Baby Boom, the discourse I explore shaped the service many of the period's women received in doctors' offices and prenatal clinics. My paper fills a void in the literature on the history of pregnancy, which often focuses on questions of fertility, abortion, and contraception, as well as of power struggles between mothers and health care providers on the management of childbirth. The relation between prenatal

care and mental health has been largely overlooked, and I offer a fresh examination of the power and status of mental health in the United States after World War II. Although such scholars as Gerald Grob, Mari Jo Buhle, and Ruth Feldstein have examined the enormous prestige enjoyed by mental health in this period, not enough has been said on the influence mental health had on other, seemingly unrelated, medical sciences. Here I argue that mental health profoundly shaped the service offered to non-mental patients, in this case pregnant women.

Aant Elzinga
Einstein's Nobel Prize. Some New Light on an Old Question

In 1922, after a dramatic turn in the deliberations of the Nobel Committee for Physics, Albert Einstein was awarded the Nobel prize inhibited the previous year; Niels Bohr got the one for 1922. From 1910-1921 the Committee had continually dismissed Einstein's work on relativity theory, Brownian motion and the photoelectric effect as unworthy, despite a vast number of nominations. When it came the prize was for "the law of the photoelectric effect". The Nobel diploma explicitly stated that relativity theory did not count. The turning point came when two Nobel Committee members passed away and a new member (C.W. Oseen) came on board in 1922. In an internal polemic against an earlier assessment he coupled Einstein-Bohr. Pais has chronicled the Nobel Committee's decisions, and nominations, but until now there is no detailed examination of the archival record. Using argumentational and network analysis in a study of documents in the Nobel archives in Stockholm the paper provides a frequency mapping of works cited in nominations (divided into three major periods between 1910-1922). It is noted how links between nominators and Einstein went beyond German-speaking centres only after the 1919 solar eclipse expedition and Einstein's active internationalism during the Cold War in science after 1918. The dramatic turn from rejection to acceptance of Einstein, here highlighted by analyzing the Nobel Committtee's argumentation in social and historical context, is detailed in a forthcoming book "Einstein's Nobel prize. A Glimpse Behind Closed Doors - the Archival Evidence".

Ted Everson
Genome Research Funding and the Construction of Genetic Disease

Since the 1960s the field of medical genetics has expanded in scope beyond its focus on rare genetic diseases, to assert its relevance to a broad range of human illnesses. In the wake of the Human Genome Project in particular, the genetic approach to common illnesses has become increasingly popular in policy circles, and the notion that all disease is fundamentally genetic has become increasingly accepted. This claim has also been controversial, and criticized as reductionist, individualist, and neglecting the social context of disease. In this paper I examine lobby efforts to obtain federal funding for the establishment of two genome research funding agencies in Canada, the Canadian Genome Analysis and Technology Program (CGAT, 1994-1997) and Genome Canada (2000-). Using interviews, public policy documents, and media reports, I describe how a genetic model of illness has expanded in parallel with the importance of genomics and biotechnology as a macroeconomic policy initiative. I argue, therefore, that conceptualizing illness as genetic is, in this case study, closely connected to state macroeconomic interests in genome research.

Paul Farber
Science and Race-mixing in 20th Century America

Accounts of the decline of scientific racism in twentieth-century America generally cite the rise of cultural anthropology and the reaction to Nazi racial hygiene. Missing from these accounts is the role that science, particularly the Modern Synthesis, played in altering ideas about the biological significance of race, and race mixing. This paper will discuss Dobzhanzky's role in the debate over the biological meaning of race, and its implications for race-mixing.

Maurice Finocchiaro
Critiques of the Biblical Argument Against Copernicanism: Ingoli, Foscarini, Galileo, Campanella

In his "Disputation" (1616), Ingoli argued that Copernicanism is false because it is contrary to the literal meaning and patristic interpretation of scriptural passages (such as Joshua 10:12-13), and so it is contrary to Scripture. In his *Letter on the Earth's Motion* (1615), Foscarini advanced a theological criticism of the premise that Copernicanism is contrary to

Scripture. In his *Apologia pro Galileo* (written in 1616 and first published in 1622), Campanella formulated a theological criticism of the assumption that Scripture is a scientific authority. In his "Letter to the Grand Duchess Christina" (1615), Galileo proposed a methodological criticism of this assumption; scientific and textual criticism of this premise; and an epistemological criticism of the relationship between this premise and the conclusion. Expressed positively, Foscarini, Campanella, and Galileo provided good theological and philosophical arguments why Copernicanism is not contrary to Scripture and Scripture is not a scientific authority. From such a critical interpretation, three more general conclusions may be suggested. First, this episode is one where a significant development in natural philosophy or science (the Galilean telescopic discoveries and re-assessment of Copernicanism) produced a significant development in scriptural hermeneutics. Second, this case represents one of the greatest ironies in the history of the interaction between scriptural interpretation and natural science since this great achievement at the intellectual level was also accompanied by one of the greatest tragedies at the practical-institutional level (the Index's prohibition of Copernicanism in 1616 and the Inquisition's condemnation of Galileo in 1616). Third, the correct historical explanation of the 1616 tragedy is that Copernicanism appeared to contradict the literal meaning and patristic interpretation of Scripture, and Church officials were unwilling or unable to disregard such literal or patristic interpretation because of the Counter-Reformation struggles and because of the personal influence of cardinal Bellarmine, who held an especially conservative version of biblical literalism or fundamentalism; this explanation (which is not to say justification) may be gleaned from a recent essay by McMullin (2005) and an older book by Soccorsi (1947).

Suzanne Fischer

Selling Scientific Medicine: 'For Men Only' Advertising Medical Institutes, Immigrants and Scientific Popularization in Early Twentieth-Century Chicago

The bacteriological revolution was popularized in the press and by zealous physicians and scientists, but irregular physicians and their advertising also played a role. Advertising medical institutes, museum/clinic hybrids ubiquitous in late 19th/early 20th century cities, made scientific medicine, specifically the curing of 'diseases of men,' chronic and venereal diseases, into big business. In 1910s Chicago, the proprietors of dozens of institutes advertised their expertise in the new medical sciences, including the use of vaccines, serums and antitoxins, instrumentation such as microscopes and syringes, and laboratory techniques such as urinaylsis and Wassermann tests. In doing so, advertising medical institutes not only appropriated scientific discoveries to advance their businesses, but also served as a commercial location for scientific popularization. Their advertising was targeted to working class men, especially immigrants: pamphlets such as Dr. Bernard Ross' "How to Regain Health" were published in as many as sixteen foreign languages. This practice of advertising to immigrants was seized by institute opponents--the *Chicago Tribune,* public health officials and politicians--as harmful and dangerous, because, they claimed, immigrants were extremely gullible. Grand scientific claims, they argued, should only be targeted to native-born populations with appropriate skepticism. Urban medical clinics were an important site for the popularization of scientific medicine, but the appropriate audience for this new science was contested.

Maura Flannery

The Work of Art: Agnes Arber as Biologist/Illustrator

Agnes Arber (1879-1960) was a distinguished plant morphologist, the third woman elected to the Royal Society. From an early age, she was given art lessons by her father, a professional landscape painter. She created almost all the illustrations for her articles and books on the morphology of grasses and other monocots. In this presentation, I will examine what it means for a biologist to also be an artist. Realistic drawing is a time-consuming and painstaking process, which I have become more aware of since taking courses in botanical illustration. The art historian, James Elkins, argues that those in this field should have some training in art, since doing art gives a deeper appreciation of art objects. I would agree and will discuss how my perspective on Arber and other biologist/artists as changed since I myself have begun drawing seriously. I now appreciate Robert Root-Bernstein's argument that scientists with interests in the arts gain a great deal from having a broader perspective and another set of skills, and also Goethe's comment that we only really see something when we have drawn it. But there are other considerations as well in looking at the work of a biologist/illustrator: how

much time must be devoted to drawing; what is the difference between drawing to record observations and drawing for publication; does the scientific work of a biologist/artist differ from that of biologists who leave the drawing to others?

Ab Flipse

'Not a Bastion of Unbelief': Dutch Calvinist and Roman Catholic Scientists About Science-Religion Issues in the Early Twentieth Century

In the nineteenth century orthodox Calvinists and Roman Catholics in the Netherlands contributed little to the sciences. By the end of the century a process of emancipation had started and in the early twentieth century both groups increasingly participated in modern culture. This was partly realized by means of the foundation of private, denominational, organizations, such as the Calvinist 'Free University' in 1880, and a Roman Catholic University in 1923 (both starting with faculties of Theology, Law and Arts). In the meantime a growing number of religious young men studied Science at one of the State Universities and these scientists also formed confessional organizations with their fellow-believers. Despite an increased participation in academic life, in orthodox Christian circles there continued to exist a certain suspicion of the natural sciences, which were associated with materialism and unbelief. In this paper the attitudes towards the sciences of Calvinist and Roman Catholic scientists are discussed: Did their religious beliefs influence their scientific opinions? What was the aim of the foundation of confessional organizations? What issues were discussed in their meetings and journals? What role was played by the religious scientists in the process of emancipation?

Rayvon Fouche

"Facing the Challenge of a New Age": Martin Luther King, Jr., Science, and Morality

Martin Luther King, Jr., in his posthumously published book *Where Do We Go From Here: Chaos or Community?* began to critically examine what he considered to be the deepening divide between morality, religion, science and technology. King expressed his concern about the ways he saw modern science and technology and freedom revolutions shaping the emerging global community. He saw a great deal of change, but he was also unsure if we had the capacity to embrace each other as equal human beings, break the tradition of human exploitation, and use science and technology to bring communities together rather than destroy them. King would write, "[w]e must work passionately…to bridge the gulf between scientific progress and our moral progress. One of the great problems of mankind is that we suffer from a poverty of spirit which stands in glaring contrast to our scientific and technological abundance." He signaled his concern that "[t]he richer we have become materially, the poorer we have become morally and spiritually" and cautioned "[w]hen scientific power outruns moral power, we end up with guided missiles and misguided men." King pressed for a revolution in values not only cultural but also scientific and technological. He argued that science advancement and technological development did not have to be oppositional to a global moral vision. He was also troubled by what he saw as the potential for science and technology, if used inhumanly, to exploit individuals, communities, and societies. King, was calling for "a shift from a 'thing'-oriented society to a 'person'-oriented society," and declared that "[w]hen machines and computers, profit motives and property rights are considered more important than people, the giant triplets of racism, materialism, and militarism are incapable of being conquered." This paper aims to situate King and his writing within the context of sixties era protest and the demand to reassess the expanding military industrial complex. Furthermore, this paper will examine the writings of King and his critique of science and technology, in order to begin to understand and think about the roles of black intellectuals within public debates about the place of science and technology in American society.

Robert Friedman

Geophysical Science for Tough Guys: Polar Heroics and Norwegian Auroral Research

In trying to solve the age-old riddle of the aurora borealis, Kristian Birkeland played upon growing nationalist sentiment in Norway, to establish in 1897 a mountain top observatory in northernmost-Norway. Fridtjof Nansen's recent Arctic expeditions galvanized Norwegian determination for greater independence from Sweden. Polar heroics were equated with national-racial fitness for autonomy. Although the precise height of the aurora was as yet still uncertain, Birkeland ignored contrary evidence to convince himself, the Norwegian parliament, and public on the necessity of a mountain observatory. A team of Norwegian men working on a hostile sub-Arctic mountain-top was to bring the nation honor by

resolving the nature of the northern light. Although in the end there was no scientific reason for building a mountain observatory, the cultural resonances of a virile masculinity made it possible to establish an active geophysical research school that outlived the observatory. Scientific and domestic life at the observatory proved surprising in all respects.

Joseph Gabriel

Contagious Habit: Drugs, Addiction, and Metaphors of Infection, 1870-1910

Habitual narcotic consumption first became an important area of scientific, social, and political concern in the United States between roughly 1870 and 1910. While opiates and a number of other drugs that are today tightly regulated were freely available and commonly used throughout much of the nineteenth century, by the beginning of World War I a broad consensus had emerged that their habitual use posed a grave danger to the health and well-being of individuals and society. In this paper, I argue that infection served as a metaphor for understanding the spread of narcotic consumption within both medical and popular discourses. Much of this concern focused on urban areas, where increasing population density, changing patterns of social behavior, immigration, and other factors prompted widespread concern among physicians and other observers about the health and morals of the populace. I argue that there were at least three components to this concern. First, physicians and pharmacists were seen by themselves and others as infecting their patients with the disease of addiction by distributing narcotics too freely, especially in disreputable neighborhoods. Second, narcotic users were seen as potentially contagious to those around them, with their behavior threatening to spread beyond relatively isolated sections of the city and contaminate society as a whole. And third, as state and federal laws began to drive much of the non-medical use of narcotics underground, small dealers in urban areas came to be seen as something akin to infectious agents, supposedly contaminating those around them through the process of buying and selling drugs. In each case, the dangerous possibility that habitual narcotic use might spread to new sections of the population indicated the need for heightened levels of state intervention in the market and the development of bureaucratic mechanisms dedicated to the project of social control. Metaphors of contagion thus played an important role in the development of the modern regulatory state.

Brian Gaines

A Critical Period in the History of the World Wide Web

The study reported examines in detail the critical period from 1992 to 1995 in the history of the Internet when the World Wide Web (the web) went from being one of several technologies being used to support public information services to being the dominant technology doing so. It is based on two primary archives of information for that period: the records of Internet traffic maintained by Merit, the Internet backbone provider in that era; and the archives of the WWW-TALK mailing list that was used to coordinate the development of the web. From these sources it is possible to reconstruct a detailed account of the significant innovations that enabled the web to support the range of services that it does today, including the sources of innovation and their dates. The debate through the list enables the conceptual frameworks of those involved to be modeled, including the way in which the analogy to paper documents was used to inform many design considerations. The serendipitous nature of the innovation that went beyond document technology to enable the web to support highly interactive computer services is also identified, and its sources are tracked and dated. It is noted that the many popular and biographical accounts of this period do not accurately record the events reported, and that the mailing list archives which are an important primary source were only fortuitously preserved.

Lisa Gannett

Theodosius Dobzhansky, the Typological-Population Distinction, and the Question of Race

The typological-population distinction has its genesis in the distinction between "races as types" and "races as populations" made by Theodosius Dobzhansky in a paper delivered at a 1950 Cold Spring Harbor symposium that sought to embrace physical anthropology and human genetics within the modern evolutionary synthesis. While developments in Dobzhansky's field of population genetics rendered the concept of "races as types" obsolete, his redefinition of "races as populations" remains to be fully understood, both historically and philosophically. This paper explores the question of race – especially the question of the reality of race – in Dobzhansky's work. Dobzhansky's views are compared with those of his and our contemporaries and critically assessed. Particular attention is paid to tensions arising in his joint appeal to

an object ontology and a process ontology. On the one hand, a race is considered to be a genetically distinct Mendelian population, "which exists regardless of whether a classifier describes it or not." On the other hand, "what is [considered] essential about races is not their state of being but that of becoming."

Margaret Garber

Terror and Fantasy: Generating facts of "Monstrous" Births in the Journal of the Academy of the Investigators of Nature (1670-1700)

In the late 17th century, members of an early modern society of physicians in the German territories attempted to differentiate their interpretations of what they called "monstrous births" from the often politically destabilizing meanings ascribed to these infants by lay ("vulgar") persons. Their efforts are recorded in the society's journal, the *Miscellanea curiosa*. Whereas the Academy of the Investigators of Nature modeled themselves upon the Royal Society and produced a number of observations on plants, animals, minerals, disease etiology and the efficacy of patient treatments, they drew special attention to abnormalities of nature. Their correspondence affords a view of how the journal functioned to create "facts" about oddities and to arrive at consensus about the causes of such births across diverse regions of Central Europe and the German territories and across urban and rural divides. By examining the physicians' attempts to arrive at an agreement with respect to etiology, and within the context of their broader writings on women's bodies, this paper examines how learned audiences viewed maternal fantasies and behaviors as sufficiently deviant to create monsters.

Mónica García

Finitism and Medical Knowledge: Reconfiguration of French Theories of Fevers in Colombia, 1860-1900

During the 1860s, Colombian physicians constructed the notion fiebres del Magdalena to deal with the most feared pathologies of the warm lowlands that were being colonized. Although medical practitioners used French medical geography and pathology to frame these fevers, the fiebres del Magdalena incorporated a causal relationship between the export oriented production of tobacco in the Magdalena valley and the miasmas causing fevers. French medical geography and pathology provided exemplars such as 'intermittent fevers' and 'remittent fevers'. But, as the finitist account in the Sociology of Scientific Knowledge explains, the application of concepts to new realities -in this case the application of French classification of fevers to the fevers of the Magdalena valley- is not predetermined; the cognitive decisions are contingent to particular circumstances. In the case of fevers in Colombia, the boom of tobacco export during the 1840s and 1850s and the process of legitimising the medical profession by studying local pathologies, were some of the main reasons why Colombian physicians built the fiebres del Magdalena notion. Changes in these circumstances explain also that once tobacco export decreased dramatically from the 1870s onwards, the interest in the Magdalena fevers slowed down. However, during the 1880s there was a revival of the notion but under a new conceptual net: the Pasteurian germ theory. Physicians ceased associating tobacco production to fiebres del Magdalena. The cognitive decisions in favour of the French germ theory or the established medical geography and pathology are to be found neither in 'nature' nor in the 'theory' itself but in the contingent judgement of the medical work, following the finitist account argument. The tension between the emphasis on 'locality' attached to the medical geography, and that of 'universalism' attached to the germ theory fitted the conflictive professional interests of the Colombian medical profession at the end of the nineteenth century.

Gustavo Garza

The Objective Preservation of Subjective Expression: The Use of the Phonograph in Ethnographic Fieldwork at the Turn of the 20th Century

The debate at the turn of the 20th century in anthropology between the evolutionary/comparative method and the diffusion method of Franz Boas found a particular expression through the use of the phonograph in ethnographic fieldwork. Introduced into American fieldwork during the 1890s, the phonograph, for some of its practitioners, revealed the shortcomings of traditional transcription methods of non-Western language and music based purely on the interpretation of the human observer. The phonograph's capacity to be both a musical and scientific instrument enabled it to accurately record and reproduce the affective/emotional qualities of Native American linguistic and musical expressions, elements that traditional methods of transcription failed to capture. This paper will examine the contestation

over the use and meaning of the phonograph in anthropological fieldwork at the turn of the 20th century. More specifically, it will explore how the phonograph, as a self-recording mechanism, was not necessarily seen as an instrument whose sole function was to record the bare "facts" of nature, in this case the words, notes, and rhythms of Native Americans. Rather, the aim of several ethnographers to preserve the subjective expressiveness inherent in Native American culture was realized, even enhanced through their use of the phonograph, which captured qualitative elements of language and music. An examination of the fieldwork practices of several anthropologists and ethnomusicologists will demonstrate how the phonograph's preservation of the expressive qualities in non-Western language and music strengthened the Boasian orientation of American anthropology.

Jean-Francois Gauvin
Expérience, Luxury, and Natural Philosophy: Du Châtelet and Scientific Instruments at Cirey

The château de Cirey, organized around the marquise du Châtelet and her lover, Voltaire, was "an universal Academy of science and *bel esprit*". Poetry, theater, religion, metaphysics, mathematics, natural philosophy, all knowledge became a guest of honor. Though historians have studied extensively the various activities going on at Cirey, they have usually disregarded an object of value—intellectual as well as monetary. I am talking about the cabinet de physique, the large collection of scientific instruments bought by Voltaire, made for the most part by abbé Nollet, and exhibited at the château. To Voltaire, this cabinet epitomized the experimental epistemology of Newtonian natural philosophy. For du Châtelet, however, even though she fully recognized that *expérience* was a "grand master" of natural philosophy, scientific instruments played a rather minor role toward her epistemological (and metaphysical) underpinning of natural philosophy. Du Châtelet was certainly not afraid to advertise the cabinet de physique in trying to lure back Maupertuis to Cirey (to study mathematics). Yet in the end, it is my contention that this collection (and scientific instruments in general) had neither direct nor significant impact on du Châtelet's natural philosophy.

Anna Geltzer
Penicillin as an Emerging Technology

The story of penicillin has been told so often in the past sixty years that in many circles it has been relegated to the status of a foundational myth. A quick search of the internet will quickly yield the standard narrative—Fleming's serendipitous discovery, Florey's quest to enlist US resources in finding an efficient production method, and the ultimate emergence of "the magic bullet." It is easy to see why this story lends itself so easily to mythological functions. There is the element of serendipity in Fleming's discovery, the drama of Florey's self-sacrificing quest, the emotional resonance of the War and the uplifting portrayal of the heroic group effort. Of course, this is only one of many possible stories, all of them both misleading and illuminating in their own way. This paper will problematize the standard narrative, and recast the story of penicillin from a foundational myth into the story of an emerging technology. Doing so will, I hope, contribute to a better understanding of both the history of penicillin and the phenomenon of emerging technology, which is currently being articulated in the field of science and technology studies.

Frederick Gibbs
The Natural Philosophy of Poison: New Theoretical Approaches to the Study of Toxins in the Latin West

Beginning in the early fourteenth century, Latin treatises on poison coalesced into a new distinct genre of medical literature. These treatises departed from the ancient tradition of literature that focused on poison remedies and instead focused on poison itself. Especially after a tract on poison by Pietro d'Abano (d.1316), medico-philosophers endeavored not only to define and to categorize poison, but also to understand the causes and methods of poison's action on the human body. In this paper I introduce the hitherto unexamined genre of Latin poison literature in which Aristotelian and Galenic natural philosophy fuses with a traditionally pharmacological topic. Based on the poison treatises of the fourteenth through sixteenth centuries, I argue that physicians shifted their efforts from categorizing a bewildering array of substances that acted in diverse ways to explaining the natural forces that governed a general category of substances. Efforts to understand the nature of poison gave rise to a constellation of debates such as how it spreads throughout its

victims, and whether poison could nourish the human body or if it always destroyed it. Physicians also debated the extent to which poison harmed through its complexion (balance of hot, cold, wet, and dry) or by its specific form—that is, through some invisible, occult quality that was not fully understandable in theoretical terms. These new ways of conceptualizing poison on philosophical grounds played a significant role in helping medico-philosophers of the later sixteenth century formulate material mechanisms for contagion and disease, and also laid crucial groundwork for later developments in the more formalized disciplines of toxicology and forensics.

Yaakov Zik & Giora Hon

Laying Bare the Sources of Errors: Kepler's Optical Part of Astronomy

In Kepler's *Astronomiae pars optica* of 1604 we read,>"Considerable difficulties stand between us and the prediction of eclipses and to an exact reconstruction of the moon's motion. It is my hope in these pages to remove these difficulties by a straightforward demonstration of the theorem, and by laying bare the sources of the errors [et apertis errorum fontibus], which displayed themselves to me through a careful observation of the solar eclipse that occurred in 1600" (Chapter 2: 48).>Kepler argues that inherent to the medium between the eye and the stars are certain effects that disturb the results of astronomical observations. One of Kepler's chief purposes in this study was to examine astronomical instruments at the theoretical level and then to realize his ideas in reliable instruments which take account of the disturbing effects. He knew further that flaws in design and manufacturing techniques as well as improper usage made instruments subject to more errors. It was therefore important to understand the extent to which astronomical instruments introduce deception into the study of motion of the heavenly bodies, and the degree to which the sense of sight itself is beset by errors.>With his novel understanding of the problem of error, Kepler considered not only errors that pertain to the act of observation, but also errors that may arise in the theoretical background and material means. The way Kepler "lays bare the sources of error" forms a telling historical argument. We argue that Kepler was aware of the fact that theoretical results crucially depend on observational practices and the instruments that facilitate them. Put succinctly, errors in the design and construction of optical instruments, the deployment of these instruments in astronomical observations and the interpretation of the recorded data required close scrutiny in order to obtain reliable astronomical knowledge. This argument suggests strongly a much closer interaction between science and technology, at least with respect to optics and astronomy, in the early 17th century.

Michael Gordin

Serial Biography: The Life and Death of a Journal and the Birth of National Styles

Biography is the most anthropocentric of historical genres (although all history is necessarily anthropocentric in the sense that it relies on written or constructed artifacts, and thus on human agency). Perhaps because of this single-minded focus on an individual or (small) set of individuals, biography often proves a singularly effective tool for a historian to probe broader cultural trends and contexts by exploring the interaction of these larger forces with the everyday lives of individuals. Prosopography attempts to generate similar insights by treating the collective biographies of a large set of persons. This paper attempts to use the life course of a specific German chemical journal — the *Zeitschrift für Chemie und Pharmacie,* which existed under various names from 1858 to 1871, when it folded, and was based first in Heidelberg and then in Göttingen — to explore the construction of the notion of "national styles of science" in the 1860s. The *Zeitschrift*, from early in its existence, morphed from a review journal designed to bridge the various physical sciences to become an often polemical vehicle for a theoretical reform program in chemistry. At the same time, it served, through two of its editors (first Emil Erlenmeyer and then Friedrich Konrad Beilstein) as a conduit for Russian chemists to publish their results in German, and thus achieve necessary European exposure – including priority claims. The transformations that took place in the life of the journal offer the potential to explore how the German and Russian chemical communities evolved through sometimes antagonistic, sometimes cooperative communication into groups that argued for the existence and importance of national styles of chemical thought.

Melinda Gormley

Undermining Scientific Racism: Politics and Science at Columbia University

Geneticist L.C. Dunn of Columbia University wrote several publications geared to non-scientific readers in an effort to undermine prevalent racial views and scientific racism during the mid-twentieth century. Dunn's interest in studies on race, heredity, and evolution prompted him to undertake his own field research on human populations in the 1950s. His previous political work during the 1930s and 1940s informed him of the social views promoted by anthropologists Franz Boas and Ruth Benedict, who were also at Columbia University. Combining his personal opinions and scientific knowledge, Dunn bolstered his anti-racist views with genetic information. His efforts can be seen as building on the ideas and tactics of Boas and Benedict while also contributing new scientific perspective.

David Gossman

The Scientist and the Craftsmen Traditions in the Twentieth Century: George Ellery Hale and George W. Ritchey at Mount Wilson Observatory

For over two decades at the Kenwood, Yerkes and Mount Wilson Observatories, George W. Ritchey was the primary optician, instrument maker and astrophotographer for George Ellery Hale. Ritchey's mechanical and optical skills were essential to the development of large, precision reflector telescopes, and he brought the optical and mechanical refinements developed by his mid-to-late nineteenth century predecessors to its highest degree of precision by the early-twentieth century. Yet, Ritchey and Hale's close collaboration disintegrated during the period 1910-1919, ending when Hale dismissed Ritchey from Mount Wilson Observatory. This paper analyzes the deterioration of the Hale and Ritchey collaboration as a professional conflict between the scientist and craftsman traditions. During the final decade that he worked with Hale, Ritchey's salary and status within the observatory declined relative to that of the college-trained astronomers, and Ritchey resented his diminishing influence. Although astrophysicists and observatory directors such as Hale were dependent upon equipment produced by opticians and instrument makers, they ensured that the work of the craftsmen would be subordinate to and under the supervision of the college-educated astronomers.

Frédéric Graber

Knowledge as a Decision-Making Tool - Levelling in France at the Turn of the Nineteenth Century

Levelling, the measure of the difference of level between two points, was one of the most important techniques in engineering in the eighteenth and nineteenth century, especially for public works. In the eighteenth century, levelling was entirely a field practice. When a canal was planned in a given area, engineers chose the line of the canal in the field, using both their broad visual knowledge about the local topography and the instrument, the level. I argue that this was not a measure in the classical sense (evaluating the size of things) but rather a decision-making tool. Around 1800, some French engineers (and scientists involved in geography, hypsometry or geodesy) attempted to displace the activity of drawing, of choosing the right line, from the field into the cabinet, by gathering field-data on a large scale. The production of such global knowledge would allow engineers to capture the field in a panoptical view, to submit it to calculations and therefore to choose the best solution, and to prove it mathematically. The paper focuses on one of the first cases of so-called "general-levellings", the levelling of Paris during the French Empire. I reflect on the transition in levelling techniques from the eighteenth to the nineteenth century, and on the specificities of knowledge used for decision-making purposes.

Monica Green

The Whole Enchilada: On the Virtues of Teaching Aristotle to AIDS

In this talk, I will describe how I decided to revamp my course on the History of Women in Science and Medicine, and why I came to the conclusion that the longue durée (Aristotle to AIDS) still offers us important perspectives for understanding women's place in the History of Science and Medicine, both as participants in those enterprises and as objects of their analytical gaze.

Christopher Green

The Historical Impact for Experimental Psychology of Johns Hopkins U. Choosing G. S. Hall Rather than C. S. Peirce for Its Philosophy Professorship in 1883

Normally, a single appointment at a single school cannot be said to have a dramatic impact on the history of an entire discipline. At particular junctures, however -- especially when a discipline is very young -- the decision in favor one individual who ultimately had a formative impact over another who could be argued to have had a significantly different formative impact can be seen to set a whole discipine on one path rather than another. In the early 1880s, Daniel Coit Gilman, president of Johns Hopkins University, was selecting a professor of philosophy from among his two instructors -- Charles Sanders Peirce and George Sylvester Morris. Peirce, being far more scientifically sophisticated than Morris, seemed to have the "inside track," especially given that JHU was America's first science-oriented university. Then, at the last minute, Gilman hired a third instrutor, Granville Stanley Hall, and ultimately selected him for the professorship. Morris soon left JHU for the University of Michigan, taking with him his protege, John Dewey. Peirce, who had just published the first original research in experimental psychology in America with his student, Jospeph Jastrow, was soon dismissed from his instructorship and never again held an academic appointment. He soon moved to rural Pennsylvania where he lived out his life in relative obscurity. By contrast, Hall went on to found the *American Journal of Psychology* (the US's first journal in this area), then to abandon his JHU professorship for the presidency of Clark University, where he founded the American Psychological Association and proceded to bill himself America's leading psychologist. In this paper I review these events, and then turn to examine what might have happened had Peirce won the JHU professorship. First, Hall would have had no platform from which to launch the *AJP*, nor to win the Clark presidency nor to found the APA. American psychology's first journal and national organization would have had to be organized by others, but by whom and where? Peirce, by contrast, would have (at long last) had a permanent academic position from which to extend his already impressive range of achievements and to influence a generation of students. He would also have immediately been recognized as one of the leading experimental psychologists in a field that was just getting under way. How might his particular skils -- in general much more mathematically and philosophically sophisticated than those of other American psychologists of the day -- have influenced the discipline's early development? And, finally, how might Peirce's visible presence on the American philosophical scene have affected the perception of his long-time friend, William James (who, of course, borrowed his philosophical pragmatism from some of Peirce's early work at Cambridge, MA).

Sarah Grossman

Extending the Area of Freedom: Catagorical Differentiation,Topographical Analysis, and the New Mexico Territory

This paper focuses on Senate reports submitted by two men who surveyed and "explored" Northern Mexico immediately prior to and during the Mexican War (1846-48), in an effort to elucidate the racially-based mechanics of nation building. Lt. James Abert traveled through the region as an official representative of the United States government, an officer in the Army Corps of Topographical Engineers. Adolph Wislizenus was a medical doctor who traveled to the southwest of his own accord on the Santa Fe Trail. Wislizenus' *Memoir of a Tour to Northern Mexico* was published as a Senate document and hailed by Senator Thomas Hart Benton as an exemplary study of the western landscape and people; it served, among other purposes, to validate his status as an American at a time when immigration from Europe was becoming a topic of general concern and conversation. The paper discusses in depth the reports each of these men published for the United States Senate, as well as the private journal Lt. Abert kept during his expedition of 1845. Abert and Wislizenus both used their skills and training as rational scientific men to conduct unauthorized quasi-anthropological studies of the region, which were submitted to the Senate along with their official geographic surveys. By considering the similarity between the analytical methods used by Abert and Wislizenus, and the profoundly different narratives each man constructed, the complex relationships between science, identity, mapping, and nationality will be analyzed.

Anita Guerrini

Anatomy as Natural History: Perrault, Duverney, and the 'Histoire des animaux'

The exploration of animal and human anatomy was among the first projects proposed by the fledgling Paris Academy of Sciences. It quickly devolved into two, on humans and on exotic animals. Claude Perrault referred to the latter project as

a "natural history" but in its emphasis on dissection (much of it performed by Joseph-Guichard Duverney, the Academy's chief dissector) it differed from most other natural histories of the era. I will look at some of these works as well as Perrault's *Memoires pour servir a l'histoire naturelle des animaux* to attempt to untangle the relationship between natural history, natural philosophy, and anatomy at the end of the seventeenth and the beginning of the eighteenth century.

Orit Halpern

Screen-Memories: Temporality, Perception and the Archive in Cybernetic Thought

This paper charts a relationship between contemporary theories of archiving and interactivity in digital systems to previous modernist concerns with perception, representation, and memory. I trace out how early engineers and architects of human-machine interaction, such as Norbert Wiener and Warren McCulloch, were informed by and reformulated different theoretical and technical practices from within 19th and early 20th century film, psychology, psychoanalysis, and philosophy. Using cybernetics and communication science as a starting point, this work begins charting an archeology of our contemporary relationship to the interface, the databank, and the network.

Jacob Hamblin

The Other Atomic Scientists: Oceanographers and Radioactive Waste in the Fifties

The phrase "atomic scientists" calls to mind theoretical and experimental physicists interested in the workings of the atomic nucleus. However, earth scientists tried in the 1950s to stake a claim on atomic science, suggesting that the era of physicists' dominance had come to an end. The prospects of more nuclear tests in the Pacific and radioactive waste disposal at sea, they claimed, required more involvement by marine scientists. Widespread concerns about the environmental effects of global nuclear activities, they argued, should necessitate a shift in scientific status to oceanographers, geophysicists, meteorologists, and geologists. This paper examines the frustrations and activities of American oceanographers who tried to move from the periphery to the center of atomic science. It examines the array of expectations, such as further patronage for oceanography, greater role in policymaking, and enhanced national stature. Specifically, this paper explores the actions of scientists from American oceanographic institutions who took part in bomb tests and the National Academy of Sciences' 1956 study on the biological effects of atomic radiation. This paper is part of a book project on scientists and the global controversies about radioactive waste disposal at sea. It portrays a crucial moment when American oceanographers negotiated the future of the ocean, tied it to nuclear weapons and power, and attempted to redefine their place in the perceived scientific hierarchy in Cold War America.

Ralph Hamerla

The Historian of Science and Political Realities

Religious and political groups have seized upon something first recognized by historians of science in the 1960s and 70s: the malleable nature of science. Unfortunately, these groups readily take advantage of this understanding as they define polemic messages toward objective legitimacy by capitalizing on science's privileged place in society. The maneuvering between and within these competing institutions plays out in the academic setting, leaving the historian of science in a unique situation. As a mediator positioned to both illustrate science's importance and teach students to question its objectivity, the historian of science has a responsibility that transcends traditional boundaries. This talk addresses the interplay between these institutions of power. More importantly, the thesis deals with the role of the historian of science as a member of an institution with the defined goal of recognizing, analyzing, and clarifying the relationship between science, religion and politics. The argument contends that Americans live their lives, understand their world, and make important decisions concerning issues of local, national, and international significance with a near-complete lack of intellectual engagement or broad analysis of science, religion, politics and the academy and the way they affect the world. While this may not be too novel an observation generally, the consequences for appreciating the university and its relationship with science, politics and religion is more important today than any time in recent memory. The discourse that characterizes these issues takes the form of polemics between conflicting foundations of authority, each struggling to mold minds toward interpreting the "other" according to ends that serve agendas important to that specific institution. In this equation, science is important in a larger sense, as it is understood by most as the agency whose integrity as an

objective information source is largely beyond reproach. In western society science is widely considered the purveyor of truth and reality. But today, science is often maligned as competing institutions move to manipulate society's perception of science toward specific, goal oriented objectives. It is for the historian of science to make transparent these relationships.

Kimberly Hamlin

Plumed Peacocks, Coy Females, and Pugnacious Men: Scientific and Popular Responses to Darwin's Theory of Sexual Selection, 1871-1910

This paper analyzes the flurry of responses, both popular and scientific, to Charles Darwin's theory of sexual selection and argues that this theory forever altered ideas about gender. *In The Descent of Man, and Selection in Relation to Sex* (1871), Darwin contends that sexual selection, a driving force in evolution, leads to the development of secondary sex characteristics and, among other things, perpetuates male superiority. Many female readers, however, saw in evolution a compelling alternative to religious gender paradigms and found inspiration in the variety of gender roles and in the power of female mate choice that Darwin describes in the animal kingdom. Women mounted a vehement response to Darwin's value-laden description of "biological" gender difference and, at the same time, adapted evolutionary principles and language to suit feminist purposes. Because Darwin only hinted at the specific mechanics of sexual selection, scientists, too, began studying in earnest the origins and meanings of gender. "Sex" (meaning what we would call gender) does not appear in the *Index Medicus*, for example, until 1885, but by 1890 "sex" also has many sub-topics including "sex difference." While most historians have neglected evolution's gendered ramifications, many of Darwin's contemporaries were quick to see that if one accepted Darwinian evolutionary theory, one also had to rethink gender. I have found references to the relationship between evolution and new ideas about gender in a wide variety of sources – from women's rights publications to calls for dress reform to scientific studies of sex to marriage advice books to early birth control pamphlets to circus acts. This paper traces male and female responses to sexual selection and asserts that evolutionary theory shifted the foundations of gender from religion to science and raised questions about the biology of gender with which we are still grappling.

Ernst Hamm

Science, Dissenters and the Dutch Enlightenment

The relationship between religious dissenters, usually Protestants, and the growth of science and technology must count among the more venerable problems in the history and social relations of science. Historians who have attended to this problem have, for the most part, considered how this worked itself out in Britain; I will focus on a group of Dutch dissenters known as Mennonites who were unusually active in the promotion of natural philosophy. Mennonites were involved in scientific publishing, scientific societies and, in the second half of the eighteenth century, gave a very prominent place in their seminary to the teaching of experimental natural philosophy. Prosperous Amsterdam Mennonites paid substantial sums of money to equip the seminary with an outstanding cabinet of instruments. That Mennonites devoted such attention to science raises questions of considerable historical interest about the scientific inclinations of this particular group of dissenters; it also reveals something about the more general character of the Dutch Enlightenment.

Benjamin Harris

Psychology for the Masses: John B. Watson and "Psychology Today" on the Radio (1931-1932)

In his book *How Superstition Won And Science Lost*, John Burnham identifies the 1930s as a transitional era in the popularization of science and health in the United States. Respected academics were still bringing science to the people, but were losing ground to amateur and mercenary popularizers. One example of academic popularizing that he cites is the radio program *Psychology Today*. It consisted of 30 weekly broadcasts on the NBC network, organized by Walter Bingham and the National Advisory Council on Radio in Education (NACRE). Featuring psychologists of the stature of Floyd Allport, James Angell, Edward Thorndike, and John B. Watson, the program ran from October 1931 to May 1932. Our paper will describe this effort at bringing psychology to the masses and analyze its socio-economic, institutional, and intellectual contexts. It was created, we will show, to provide academic support for commercial control of the radio

spectrum. Worried that Congress would award 15% of radio frequencies to colleges and universities, NBC and other broadcasters created NACRE, which in turn formed a psychology division headed by Walter Bingham. Among his concerns was to demonstrate that academics could be interesting; to sample all subject areas in psychology; and to offer listeners' guides, for study by individuals and listening circles, encouraged by the program. In describing the institutional context for *Psychology Today* we will analyze Bingham's experience in applied psychology and his ability to work with non-academics. To illustrate the content of *Psychology Today* we will focus on John B. Watson's talk, *How to Grow a Personality*. Watson was not just a successful popularizer, but a model for those trying to provide scientific support for modern business practices (e.g., in advertising). His lecture, we will show, was much better received than those of his university-based peers. To conclude we will discuss the paradoxical situation faced by Bingham and the NACRE. They were asked to lend academic support to the methods of corporate broadcasters. As Burnham suggests, however, most of their expert presenters were ill prepared to present science in an effective manner. A question we hope to explore is how much this contributed to the disenfranchisement of academics as popularizers in subsequent decades.

Martha Harris

Chemical Reductionism Revisited: The Physico-Chemical Nature of the Chemical Bond

The wave-mechanical treatment of the valence bond, which states that a bond between two atoms is formed through the sharing of a pair of outer electrons, by German physicists Walter Heitler and Fritz London in 1927, has traditionally been regarded by philosophers as the basis of claims of theory reduction of chemistry to physics, because it required the use of a purely physical theory to describe the mechanism of chemical combination. Historically, however, the Heitler-London treatment is an important stage in the development of chemical bond theory, because it gave chemists a new physical tool with which to study chemical structures, and was the catalyst for a new stage of interdisciplinary research in quantum chemistry in the 1930s. American chemist Linus Pauling adapted Heitler and London's method in the chemical context of the work of Gilbert Lewis, the founder of chemical bond theory, to develop the valence bond into a physico-chemical entity, blending these theoretical traditions from physics and chemistry. Because of the importance of the valence bond as an interdisciplinary entity, we must revisit the reductionist argument if claims of theory reduction are used to inform further claims about the disciplinary relationship between the two sciences. By analyzing the valence bond treatment in the historical context of Lewis and Pauling, we see that the chemical bond is best described as an emerging theoretical synthesis, rather than a catalyst for reduction.

Darin Hayton

Comets, Horoscopes and Politics at the Court of Matthias Corvinus

In 1467 the Polish astrologer Martin Bylica arrived in Pozsony (Bratislava), where he and Regiomontanus took up chairs in astronomy at the fledgling university, the Academia Istropolitana. Bylica had set his sights on a career at Matthias Corvinus' famous court in Buda. By the summer of 1468 he had succeeded in gaining Corvinus's generous patronage and would soon become the king's chief advisor. Over the next two decades Bylica tirelessly accompanied Corvinus on military campaigns and diplomatic missions, served as liaison between Corvinus and the faculty at the University of Vienna, and helped to develop an observatory at Corvinus's court in Buda. This paper explores one aspect of Bylica's activities: his use of astrology. In particular, I examine two judicia Bylica produced following the comets of 1468 and 1472. These texts reveal the dynamic interplay between Renaissance politics and astrology: Bylica's predictions are informed by Corvinus's larger political goals and, in turn, are enlisted into the king's military campaigns. Bylica was not, however, simply telling the king what he wanted to hear. He was, instead, basing his predictions on a sophisticated practice of astrology that depended on recognizable data and a canon of accepted interpretive rules. Bylica's two judicia reveal both the types of information that he relied on in his astrology and the rules that he employed to make his predictions. I want to use Bylica as an example from which to draw some larger conclusions about the practice of astrology in the Renaissance.

Gabrielle Hecht
Scenes from the Nuclear Life of Radon, Set in South Africa, Australia, and other "Peripheries"

This paper seeks to rethink the meaning of "the nuclear" from the perspective of the so-called periphery. How has uranium mining counted – or not counted – as a "nuclear" activity during the second half of the 20th century? I argue that the "nuclearity" of uranium production was and is by no means a given, a physical property residing exclusively in atoms and their decay chains. It is, instead a designation that emerges from intense ontological debates whose parameters depend on history and geography, science and technology, bodies and politics, radiation and race, states and capitalism. Historically, the nuclearity of radon (the focus of this paper) has been distributed through institutions, atoms, rocks, instruments, experts, bodies, ideologies of all kinds (national, racial, colonial, post-colonial, international), labor relations, epidemiological categories, and much more besides. That distribution is usually lost in the relentlessly national nature of most nuclear narratives. This, in turn, has meant losing the continually contested character of the ontological activity from which "the nuclear" emerges and into which it disappears. When bodies meet radon daughters, those contestations and distributions have concrete meanings and outcomes – ones which differ according to whether the bodies in question were South African, Australian, Navajo, Gabonese, French, or Malagasy. The paper develops this argument drawing upon extensive archival and oral history research on 4 continents.

Taika Helola
The Truth of the Matter: Biographies of Zoological Specimens

Of all the material objects of science, only the specimen has been seen to embody the truth about nature since curiosity cabinets. While the specimens are preserved to always stay the same, the truth is, however, subject to change. In this paper I shall look into the network of relations between truth and specimens and the consequences of this relation to individual specimens by studying the biographies of some specimens originating in curiosity cabinets that are currently located in the Zoological Museum of the University of Copenhagen. These objects have acted as vessels of truth during the three hundred years of their existence: their successes or failures in presenting truth has left evidence not only of the scientific life of the specimen but also of the truths sought by the scientific gaze.

Mary Henninger-Voss
Mathematicians and the Word

This paper echoes the title of Owen Hannaway's masterful essay into the ideological underpinnings of early modern chemical texts, *The Chemists and the Word*. Owen's work made obvious the tension between the material and technical manipulations emergent science demanded and the changing role of language through which meaning was given to the material. This paper will investigate the ways in which sixteenth-century humanists and mathematicians interpreted mathematics as a language that bridged the world of the text and the physical world of material operations. The essay will focus on the specific methods and attitudes of mathematical *readers* in the sixteenth- and early seventeenth-centuries. By following specific instances of reading mathematics--in heresy trials, in libraries, in state councils-- we can reveal the ways in which magic, humanist pedagogy and technical expansion shared intellectual space in the early modern world. Such an exploration will also show us some of the tortuous ways by which a new "language" emerged alongside the written word in the articulation of natural science.

Matthew Hersch
Geeks in Space: Selling America's Scientist-Astronauts, 1965-1982

During America's first decade in orbit, the public face of human space exploration belonged to taciturn test pilots with little patience for physicians, scientists, and other "Larry Lightbulb" types. In 1965, though, only a few years after the first humans ventured into space, the National Aeronautics and Space Administration grudgingly opened its astronaut ranks to academic scientists. While many hoped that these new "Science Pilots" would restore NASA's reputation and return science to the forefront of human spaceflight, with each passing year they seemed a tougher "sell" to pilot-astronauts, the scientific community, and the American people. The scientists faced veteran astronauts dismissive of their skills, a public indifferent to their ambitions, fellow scientists skeptical of their contributions, and NASA psychiatrists who thought they

might be insane. By the 1980s, most of the scientist-astronauts—now some of America's most qualified spacemen—had never been in space, but they navigated the astronautical no-man's land of the 1970s and survived in an institution undergoing transition and decline. In the process, they struggled to redefine exactly what an astronaut is supposed to be.

Ian Hesketh

The Sobel Effect, Froude's Disease, and the Making of Un-Popular History in Mid-Victorian England

This paper analyzes the historical origins of the "Sobel Effect" – David Philip Miller's term to describe the seemingly recent publishing phenomena of popular history of science works, of which Dava Sobel's *Longitude* (1995) is both symbol and cause. Professional historians of science are irritated by such works because it appears as if publishers are exploiting the general reading public's interest in fascinating historical drama while ignoring professional standards. This problem, I argue, is not as new as Miller suggests and can be traced to the professionalization of history in mid-Victorian England, where a group of self-conscious historians sought to make history a true science by separating their scientific endeavor from the overly literary work of their romantic predecessors, "men of letters" such as T. B. Macaulay, Thomas Carlyle, and J. A. Foude. Such romantic writers of history attracted a wide readership, a readership that was greatly expanding throughout the nineteenth century. Professionalizing historians believed that romantic historical writing – written and read for entertainment rather than for historical knowledge – had debased the reading public's ability to differentiate good historical writing from bad. In establishing professional history (i.e. scientific history) as distinct and diametrically opposed to popular or romantic history (i.e. non-scientific history), historians promoted an ideal audience for their works and that necessarily excluded the majority of readers in mid-Victorian England. Despite this, however, certain historians and their publishers sought ways to re-educate the general reading public to appreciate good scholarly work and a form of popular history written by professional historians became acceptable, which is the same remedy to the "Sobel Effect" prescribed by David Philip Miller 140 years later.

Bruce Hevly

Does Up Equal North? Travelogue, Local Knowledge and Natural Law in James David Forbes's *Norway and Its Glaciers*

Since Susan Faye Cannon associated "Humboldtian Science" with the emergence of physics as a field in the early nineteenth century, quantitative field work has found only a fitful role in the history of nineteenth-century natural philosophy, which has been dominated by accounts of laboratory and theoretical practices. This paper discusses attempts by James David Forbes, a Scottish natural philosopher, to generate natural laws for terrestrial physics based upon observations of Norwegian glaciers and a Humboldtian sensibility. Earlier criticized for theories of glacier motion based upon observations of a single alpine mountain glacier, Forbes (one of Humboldt's correspondents) traded altitude for latitude and formulated a geophysical law relating altitude, latitude, ice and foliage. His arguments extended beyond scientific literature, narrowly defined. Among the resources he deployed in this effort were an essay for the Encyclopedia Britannica on the proper philosophy of science leading from discovery to law, and a travel account, *Norway and Its Glaciers, Observed in 1851.* This work continued an important pattern in Forbes's work, relying upon, while rhetorically discounting, the expertise of local informants. But Norwegian painting from the same period provides an indicator of contemporary local knowledge and an independent source for understanding Forbes's landscape of interest.

Erwin Hiebert

The Physics and Mathematics of Just Intonation in the History of Fixed-Tone Keyboard Construction

The historical roles that physics and mathematics have played in the construction of and performance on fixed-tone microtonal keyboard instruments designed to achieve, or at least to approximate, just intonation constitutes the focus of the investigation. Keyboard tuning to achieve just intonation has a long and complex history. However it was not until the middle of the 19th century, and largely as a result of the contributions of Helmholtz, that it became theoretically desirable and technically feasible to construct keyboards to achieve just intonation with divisions of the octave into more than 12 parts.

Elfrieda Hiebert

Exploring Links Between Science and Piano Pedagogy During the Late 19th Century

The interaction between the changing piano, the evolving aesthetic tastes, and widened compositional possibilities necessarily challenged pedagogues to devise innovative methods in dealing with piano technique. Similar to the craft of piano building, the scientific world invaded the area of piano playing. A new symbiotic relationship between instrument and its music emerged as reflected in playing techniques and musical expression. This was initiated by texts on piano pedagogy that informed students on the make-up of the piano, technique required, and ideals of performance. To varying degrees pedagogues reached out to developing disciplines such as acoustics, physiology, and psychology for guidance. It is clear from their publications that many pedagogues took account of Hermann von Helmholtz's resonance ideas to help illuminate technical problems such as quality of tone and pedaling. From a burgeoning body of scientific resources during the second half of the 19th century, pedagogues drew ideas to further the technique of playing the piano.

Michael Hobart

The Zodiac of the Syllogism: Symbol and Meaning in the World of Augustus De Morgan

Seldom do we have access to a scholar's doodles as an entry into his thought; perhaps even more seldom do they provide one. Fortunately, on both counts in De Morgan's case, a number of his drawings, sketches, diagrams, and doodles, have survived, either in private notebooks or pasted into his own copy of *Formal Logic*. Collectively, these provide an alluring window not only into the mechanical, formal symbology of his logic, but also into the larger set of assumptions that motivated it. This paper will analyze the drawings (1) to illustrate the system of De Morgan's mature logical symbology, (2) to show visually how the symbology depicted what De Morgan called the "universe under consideration," and (3) to explain the 'existential import' that lay embedded in his universe under consideration. De Morgan always believed that the formal mechanisms of logic pointed to a world of meaning beyond the mechanisms themselves, a world he captured in one of his most intriguing drawings: "the zodiac of syllogism."

Michelle Hoffman

Factoring History into the Equation: History of Science in Ontario High School Physics Textbooks, 1911-present

Does the history of science belong in science textbooks? Can history of science profitably be used as a pedagogical tool in science education? It is a long-debated question. In *The Structure of Scientific Revolutions*, Thomas Kuhn famously suggested that the history of science and science teaching do not easily mix, arguing that textbooks regularly distort and revise the history of science. Stephen G. Brush has likewise argued that textbooks must distort the history of science because they can only use stories that support their learning objectives. The stories that don't, says Brush, get "rated X." Yet efforts on the part of educators and historians to restructure the science curriculum around case studies from the history of science enjoy continued support and momentum. This paper seeks to place such efforts in historical context by considering the example of Ontario high school physics textbooks. I examine the changing uses of history of science in four widely-used Ontario physics textbooks: *The Ontario High School Physics* (1911), *PSSC Physics* (1960), *Physics: A Human Endeavour* (a Canadian adaptation of *Harvard Project Physics*, published in 1970) and *McGraw-Hill Ryerson Physics 12* (2002). My survey of these textbooks highlights some of the challenges of integrating history of science into the science curriculum. I argue that the varying extent to which these textbooks have emphasized (or ignored) the history of science reflects changing views about the goals of science teaching and the nature of science itself. Finally, I suggest that history of science can indeed play a valuable – if ultimately peripheral – role in science textbooks.

Marijn Hollestelle

Paul Ehrenfest as a Mediator

The Austrian physicist Paul Ehrenfest succeeded Hendrik Antoon Lorentz as professor in theoretical physics in Leiden in 1912. This paper focuses on Ehrenfest mediating talents, as a teacher and a researcher. As a teacher, he closely monitored his students' progress. Teaching them the newest physics in a personal and unconventional way, often in informal colloquia with internationally renowned physicists attending, he moulded them into expert physicists. Most of them

obtained professorships at national and international universities. Ehrenfest was a major contributor to the revival of physics in Eastern Europe. After World War I he arranged contacts between young Dutch and Eastern European physicists. He went out of his way to support physicists in Eastern Europe, who often lacked the means to do research and had no access to Western journals. For instance, he arranged for grants to enable them to visit physics institutes in Western Europe. As a physicist, Ehrenfest didn't belong to the top of his field. Nonetheless, he was an important node in the network of scientists. He was most appreciated for his talent for discussion and debate. Together with his clarity, this made him into a catalyst. Time after time he pointed out the flaws, weaknesses and paradoxes in the theories and ideas of Einstein and Bohr, who were inspired by the interaction. Ehrenfest's articles often concerned the foundations of physics. His ability to clarify difficult concepts was famous among contemporary physicists and thus his work did have an impact on the rise of quantum theory, general relativity and modern econometrics.

Jennifer Hubbard

The Canadian Fisheries Expedition 1914-1915: Johan Hjort and the Birth of a Scientific Program in Canada

The Canadian Fisheries Expedition of 1914-15 marked a watershed in Canadian marine science. Not only did it inaugurate Canadian hydrographic investigations in the European manner of intensive area study, it introduced Canadian scientists to methods developed by the International Council for the Exploration of the Sea, and to the new methods for fish population analysis. In bringing the world's leading fisheries biologist to Canada, the Biological Board of Canada also brought to fruition the promise of Canadian marine biological stations as centres for international researchers sharing their expertise with Canadians. Hjort and his assistant Paul Bjerken were joined by renowned embryologist and anatomist James Playfair McMurrich (president of the History of Science Society in 1933), and embryologist Dr. Arthur Willey. Finally, they were assisted by a young scientist, Dr. A.G. Huntsman, the new curator of the St. Andrews' Biological Station in New Brunswick. He was appointed to help Hjort with laboratory work conducted in the winter of 1914-15, at the University of Toronto, between the Expedition's summer surveying seasons in the Gulf of St Lawrence. Huntsman was so inspired by Hjort that he abandoned ascidian taxonomy and evolutionary problems for fisheries research for the rest of his life. Due to equipment shortages, Hjort borrowed materials from Henry B. Bigelow of the U.S. Bureau of Fisheries, giving the Canadian scientists their first link to this important oceanographer - Huntsman and Bigelow later became close friends. By farming result analysis to scientists in Norway, Hjort also familiarized Canadian scientists with their Scandinavian counterparts; Huntsman was later to call on some of these for aid in later investigations, most notably H.H. Gran. The Canadian Fisheries Expedition thus not only trained Canadians in oceanographic and fisheries biology methods, but set up a network of connections of enormous importance in developing fisheries science as a new professional field in Canada. Finally, Hjort's preference that fisheries science was primarily to help fishermen was adopted by the Canadians, and especially Huntsman. This emphasis precluded studies and recommendations focussed on conservation issues in later years.

Alexandra Hui

Musical Instruments, Psychophysical Instruments: The Sound Sensation Studies of Hermann Helmholtz and Ernst Mach

Psychophysics, loosely definable as a set of ideas and methods formed in pursuit of the relationship between sensory physiology and sensory perception, was in the late-nineteenth century both an investigative technique and a belief system, interpreted broadly and to different ends by its many practitioners. Located at the intersection of the physical and the psychical, the practice of psychophysics, even as a straightforward attempt at evaluating sensory perception was troublesome. In particular, the practice of – and performance – of psychophysical experimentation on sound sensation often relied on innovative approaches that included the use of such musical instruments as pianos, organs, and violins. This paper will address the sound sensation studies of Hermann Helmholtz and Ernst Mach. I closely examine their use of musical instruments as psychophysical instruments and show that how musical experience became constitutive of psychophysics. Helmholtz and Mach consciously used these instruments to navigate both the music and natural scientific worlds and in doing so the experiments they performed were both musical and scientific. I also ask if and how these musical instruments interact with the scientists' bodies was distinctly different from their interaction with traditional

scientific instruments – how did the physical act of performing an experiment differ when musical instruments were involved? And further, I argue that the use of musical instruments in science, the specificity of the experience, contributed to new theories – both psychophysical and musical – as well as a new awareness of the historical and cultural contingency of sensory perception.

Kuang-chi Hung

When the Green Archipelago Encountered Formosa: Colonial Governance, Capitalism and the Emergence of Modern Forestry in Colonial Taiwan (1895-1930s)

In theory, there are two approaches to analyzing the interactions among capitalist expansion, colonial governance and modern forestry. The first one is to stress the power of capitalism. Following the tradition of classic or ecological Marxism, scholars analyze the methods used by capitalist enterprises to explain how peasants and indigenous people are separated from their means of production. Modern forestry is considered by these scholars as a superstructure for justifying this mode of production. Contrary to this political economy-centered approach, scholars who follow the Weberian and Foucaultian traditions shift their focus to the territorial strategies deployed by colonial state. They believe that the colonial governance transform the nature and colonized people into objects of government through mapping, surveying and investigation. They also claim that modern forestry is akin to an imperial toolbox filled with various concepts, which could help the colonial bureaucracies rationalize their regime of government and territorialize the colonies. Both approaches contribute to our understanding of the origins of contemporary environmentalism. However, it is surprising that little attention is paid to the conflicts and contradictions occurred in the processes of territorialization and transition to capitalism. Consequently, the role of modern forestry is assumed as a black box which only exists for the purpose of colonial governance or capitalism. Using the Japanese Empire's first colony – Taiwan – as an example, this paper examines the complicated interactions among the colonial governance, the transition to capitalism, and the emergence of modern forestry. This enchanting beach encrusted tropical paradise, known as Formosa or "beautiful island" for centuries, was ceded to the Japanese after the Sino-Japanese war. The Japanese, who sometimes referred the lush green of their homeland as "the green archipelago" took an active interest in regulating the relationship between forests and people of Taiwan. Considering that a great deal of research has already been compiled regarding the "Green Imperialism" of the European empires of the day, it is my intent to bolster the knowledge of the environmental history of East Asia, a subject on which relatively little research currently exists, to undertake an effective comparison of the two.

Diego Hurtado de Mendoza

Promise and Peril of Nuclear Ambitions: Argentina during the 1976-1983 Military Regime

When the military overthrew the democratic regime in March 1976, the nuclear program led by Argentina's National Atomic Energy Commission (CNEA) was already considered the most advanced in Latin America. From the outset, the authoritarian regime announced that the nuclear program would be strengthened in order to complete the nuclear fuel cycle. As part of a difficult socio-political context where the public sphere was virtually dissolved and serious violations of human rights were taking place, CNEA's nuclear scientists were almost completely isolated from their peers. However, in contrast to what occurred at universities where brutal repression severely impacted on academic research, the nuclear program was a sort of haven to CNEA's nuclear scientists. This paper discusses the decision-making process which led to CNEA's remarkable achievements during the dictatorship period (1976-1983). This story includes the agreement to transfer nuclear technology to Peru; the first important one in Argentina's history, the acquisition of a 20 MV tandem-type heavy ion accelerator; the first big science program in Latin America; the inauguration of Argentina's second nuclear power plant, and the building of indigenous reprocessing and heavy water pilot plants. Despite U.S. restrictions on "sensitive technologies," CNEA was also able to sign contracts with European firms for building its third nuclear power reactor and an industrial heavy water plant. Finally, this paper also discusses how international pressure pushed Argentina's nuclear program to the secret development which, in late 1983, reached its high point when CNEA's head made public that Argentina had built a medium-sized uranium-enrichment plant.

Kenji Ito

Transmission of Feynman Diagrams from the United States to Japan: A Case of a Resonance of Scientific Practice

This paper proposes an analytical framework to understand transmission of scientific knowledge between different cultures. In this framework, transmission of scientific knowledge is understood as a resonance of scientific practices in different places. Just as a resonance in physics, scientific practices in one place can travel to another place when there is some kind of mediation between these places and when there are conditions that produce the same or similar scientific practices. As an example, I revisit the case of transmission of Feynman diagrams from the United States to Japan in the early 1950s, discussed in Kaiser, Ito, and Hall (2004) and Kaiser (2005). I examine what kind of mediation took place when Japanese physicists began to use Feynman diagrams. Then I analyze what socio-cultural and scientific preconditions Japanese physicists had and how these preconditions generated scientific practices to use Feynman diagrams. To showcase advantages of the resonance model, I will compare it with two other analytical frameworks (what I call the conceptual scheme model and the replication of context model). I argue that replication of scientific practices can happened through a partial mediation like imperfect transmission of relevant knowledge and skills, and that similar scientific practices can emerge within different contexts and therefore replication of context is not always necessary. The resonance model, I claim, captures these aspects of transmission of scientific knowledge, whereas the other two models mentioned above do not.

Margot Iverson

William C. Boyd's Genetic Analysis of Blood-types and the Campaign to Redefine Race

In the years after World War II, immunochemist William C. Boyd was widely considered the preeminent American authority on the world-wide distribution of the human blood groups. Based on his decades of work studying human genetic data, in 1950 he developed a new definition of race which demarcated human populations using genetics and proposed a six-fold racial division of humanity based principally on blood group data collected by himself and others around the world. Body argued that race should not be abandoned as a biological concept, but should be redefined, and he believed that his proposed definition could lead to a scientifically-led movement away from racial prejudice. His book and his work were well-received primarily by those scientists who hoped to encourage a revolution in physical anthropology, and in this talk I will focus on Boyd's role as one of the leaders in this campaign to transform the study of race within physical anthropology through the study of human blood groups.

Dana Jalobeanu

Francis Bacon's Brotherhood and Its Classical Sources: Yates Thesis Revisited

In many places throughout his works, Francis Bacon emphasized, time and again, that the key to a future reformation of human knowledge is the formation of a "Brotherhood of illumination and lights". Despite quite a number of variations in style, the basic features ascribed to such an ideal model for a scientific community are identical from the early projects of 1603-5 to the New Atlantis. Francis Yates had launched the thesis of a possible connection between Bacon's brotherhood, the ideal of scientific community and the "Rosicrucian" movements of the early seventeenth century. Despite the rejection of Yates thesis by various authors, such a possible connection had been constantly investigated as a possible source of Bacon's scientific ideal. In this paper I want to explore an altogether different source for Bacon's Brotherhood: a classical tradition of the ancient school of philosophy, Epicurean or Stoic, with its subsequent practical ideals. I will show that there are numerous arguments to connect Bacon with an early revival of Stoical and Epicurean tradition at the end of sixteenth century and I will document some of his possible sources for the celebrated model of Solomon's House.

Jeremiah James

Modeling and Mimesis in Early X-Ray Crystallography

In 1975 William Lawrence Bragg wrote that if only the proper focusing device were available x-ray crystallographers could produce images of crystal structures perfectly analogous to common photographs and just as intuitively grasped. Although analogies to visible light abound in the works of Bragg and other x-ray crystallographers beginning in 1914, no crystallographer during the first fifty years of x-ray analysis claimed that all they were lacking to produce a mimetic image

of a crystal structure was the proper lens. During the first twenty-five years of x-ray analysis, existing models of crystal dynamics led many crystallographers to doubt whether directly recorded images of crystal structures might ever be feasible. Over the next twenty-five years, crystallographers focused on developing techniques that employed measurements of the invisible phase of x-rays to help them determine crystal structures. In neither era was the direct production of mimetic images of crystal structures a clearly achievable or desirable goal. Nevertheless, during these early years of x-ray analysis visual models, in two and three dimensions, were among the most common ways to characterize crystals. This strongly suggests that we need to separate early crystallographers' practices of visual modeling from any unmitigated desire for mimetic representation.

Andrew Janiak

Newton as a Critic of Descartes

Due to the extensive work of I. B. Cohen, Howard Stein, and others, it is well-known that Newton intended *Principia mathematica* to replace Descartes's *Principia philosophiae* as the dominant text in natural philosophy. Newton's dissatisfaction with Descartes was so thoroughgoing that it deserves further study. In this contribution, I intend to focus on Newton's rejection of Descartes's view that substance is a fundamental category for our ontology. The rejection was more systematic than has been appreciated in the scholarly literature; it indicates a commonality between Newton's view of material objects and his conception of space. I will also contend that the rejection underscores the continuity of Newton's thought from the unpublished manuscript, *De gravitatione*, to two significant sections of the *Principia*. Despite his fundamental rejection of Descartes, however, Newton's ontology remains difficult to subsume under the usual "empiricist" and "rationalist" labels. Especially in the case of absolute space, Newton's dismissal of Cartesian ontology should not be read as an endorsement of a recognizably empiricist view. Newton therefore defies straightforward categorization.

Boris Jardine

Darwin's Microscopes: Theory, Practice and Reputation

Although Darwin owned and used microscopes throughout his working life, Darwin scholars have largely ignored the ways in which his instrumental practice affected his professional trajectory and his broader theorising. This paper redresses the balance, concentrating first on Darwin's bio-geological work in the 1840s, and then on his reputation as a competent instrumentalist. New manuscript evidence and a focus on Darwin's microscopy enables us both to see Darwin at work with the microscope he purchased for his barnacle research, and to introduce new characters, normally overlooked, important to his instrumental practice. These factors bring a new perspective to Darwin's fame in the 1840s, whilst questioning the microscope's omission from later accounts of Darwin's life and work.

Christian Jennings

Looking Forward to History of Science in Africa: A New Framework for Research and Writing

East Africa endured more than one hundred years of research in marine and freshwater fisheries before the 1990s - "endured" is an appropriate term, as the vast majority of this research was designed to meet the priorities of foreign states and institutions. The earliest research consisted of surveys carried out by European colonial officials and academic visitors, often as a temporary diversion from sport fishing. After World War II, the colonial administration created separate freshwater and marine fisheries research organizations, established in 1948 and 1951 respectively. After independence, Kenya, Tanzania and Uganda attempted to maintain these institutions cooperatively, but when their East African Community collapsed in 1977, each cash-strapped country had to reconstruct science policy and infrastructure on its own. This reinforced an already strong reliance on outside sources of funding, which during the 1970s and 1980s often viewed developing nations simply as peripheral sites for large international projects. In response, East African scientists raised concerns that their scientific infrastructure remained stagnant and that local research priorities - such as the artisanal fisheries that provide food for many East Africans - were being ignored. In the late 1980s new bilateral programs began to focus on issues more appropriate for East African contexts and to provide better opportunities for local scientists. This has resulted, finally, in the development of viable institutions for marine science in East Africa.

Matthew Jones

From Sociability to Vis-Viva: Emilie du Châtelet on Social and Natural Order

Enlightenment thinkers, like their seventeenth-century predecessors, saw debates about the causes of sociability in human beings as intimately connected to debates about the possible insufficiency of the mechanical philosophy. Before becoming an advocate of a Leibnizian view of the non-mechanical forces necessary to explain natural phenomena, Emilie de Châtelet adapted and transformed Mandeville's "Fable of the Bees." This paper explores the continuities between du Châtelet's implicit criticisms of Mandeville's account of the causes of social order and her subsequent growing dissatisfaction with natural philosophical accounts lacking a sufficient metaphysical underpinning. It suggests that her earlier writings and discussions at Cirey about human social order can shed considerable light on the development of her natural philosophical views.

Edward Jones-Imhotep

Images and the Enemy: Ionosondes and the Nature of War

This is a paper about wave sensors and war. It examines a specific class of high-frequency radio sensors called ionosondes – deployed during World War II to aid communications and anti-submarine warfare – in order to understand how the machines and the images they produced figured in the practical, material and visual cultures of World War II intelligence operations. Since the 1920s, ionosondes had straddled the concerns of radio propagation studies and ionospheric physics. Rather than situating the instruments abstractly between upper atmospheric research and radio engineering, however, the paper explores the history that emerges from placing them firmly in the "nature" of world war – in both its senses – and in the wartime "sciences of the enemy". Exploring the strategic disposition of ionosondes across the theatres of war, locating the instruments and their images in the work of cryptographic teams, operational researchers and anti-submarine warfare specialists, and in the symbolic spaces just outside the "black rooms" of Allied secret intelligence and the German Abwehr, the paper examines how the ionosonde's engagement of the enemy through images served to translate radio disruptions, intelligence operations, convoy attacks, and submarine kills into the bases of an operationalized atmosphere, a stripped-down "nature" that transformed ion distributions and atmospheric dynamics into weapons against the enemy.

David Kaiser

When Fields Collide: Training and the Birth of Particle Cosmology

Physicists in different branches of the discipline were puzzled by the problem of mass during the 1950s and 1960s: Why do objects have mass? Around the same time, yet working independently, specialists in gravitational studies and in particle theory proposed that mass might arise due to objects' interactions with a new (and as yet undetected) field. Although the questions they posed and even the answers they provided shared several similarities -- and even though both proposals quickly became 'hot topics' in their respective subfields -- virtually no one discussed one proposal in the light of the other for nearly twenty years. Only after massive, unprecedented changes in pedagogical infrastructure rocked the discipline in the early 1970s did a new generation of physicists begin to see possible links between the Brans-Dicke field and the Higgs field. For the new researchers, trained in different ways than most of their predecessors, the two objects of theory were not only similar -- some began to proclaim that they were exactly the same. Charting the histories of these two objects of theory illuminates the complicated institutional and pedagogical factors that helped to produce a new subfield, particle cosmology, which today ranks at the very forefront of modern physics.

Allison Kavey

Desiring Subjects: The Place of Desire and Imagination in The Three Books of Occult Philosophy

Heinrich Cornelius Agrippa's *Three Books of Occult Philosophy* entered the English popular print market in the mid-seventeenth century, when it contained a plethora of treatises on everything from alchemy to necromancy. This text is remarkable, however, for the attention it devotes to the role played by practitioners' imaginations and desires in their attempts to manipulate the natural world. This talk will focus on the ways in which *The Three Books of Occult*

Philosophy made explicit the highly occult impact of practitioners' ideas about and desires for change in the natural world.

Jordan Kellman

Highly Mutable Mobiles: Guillaume Le Gentil's Passage to Brahmanic Astronomy as a Response to Disaster

This paper explores the response of Guillaume Le Gentil de la Galaisière (1725-1792), a highly trained observational astronomer at the Paris Observatory, to a series of catastrophic events during his expedition to observe the passage of Venus of 1761. Le Gentil altered his plans when the fleet that was to take him to French colonial Pondicherry to make the first observations was bombarded. When his observation of the passage of 1761 was thwarted by the decision of a ship's captain, he elected to stay in the Indian Ocean to await the second passage of 1769, altering his research agenda to focus on meteorology and ethnography. When a brief cloud cover ruined his observation of the second passage, Le Gentil devoted himself to mastering Bramanic astronomy, remaining in Pondicherry to study with its priestly practitioners. I argue that the disasters that repeatedly intruded on Le Gentil's carefully laid plans changed his epistemological approach to astronomy and his understanding of the nature of scientific knowledge, and demonstrate the fragility of the transmission of scientific knowledge across geographical and cultural space in the early modern period.

Daniel Kennefick

Pushing the Limits: Looking for Gravitational Waves in the Post-Newtonian Approximation, 1945-1965

In the period 1925-1955, General Relativity was accepted as the correct theory of gravity, but Newtonian gravity was still used for almost all practical applications in astronomy and astrophysics. The post-Newtonian approximation of GR served, at the time, as a "proof" of sorts that Newtonian gravity really was a limiting case of GR, and a possible avenue by which GR might, some day, become fertile with new physics. One of the most intriguing new phenomena which GR seemed to predict was gravitational waves emitted by binary star systems. Unfortunately efforts to use the post-Newtonian approximation to show how such systems would radiate gravity waves were dogged by controversy as theorists struggled to make the approximation scheme into a practical means of performing astrophysically relevant calculations.

Daniel Kevles

Policing Intellectual Property in New Fruits: The Case of the Golden Delicious Apple

In 1914, the Stark Brothers Nursery and Orchard Co., the largest such firm in the United States, acquired the propagation rights to a new type of apple that had originated as a bud sport on a farm in West Virginia. The firm named the fruit the Golden Delicious Apple and at a cost of several hundred thousand dollars, developed the trees that produced it into a commercially viable product that it began selling to orchardists and farmers around World War I. During the 1920s, the Golden Delicious Apple tree was one of Stark Brothers' biggest moneymakers, and the company was eager to protect its intellectual property (IP) in it. But at the time, living organisms could be neither trademarked nor patented. In the absence of such protection, Stark Brothers sought to defend its IP in this fruit tree (and in others, including the Hal-Berta Giant Peach and all of Luther Burbank's new trees or plant varieties to which it had rights) by compelling purchasers to sign a contract in which they agreed not to sell or give away for twenty-five years any of the trees they bought or any scions, buds, or cuttings from them. Most purchasers signed and honored the contract, but some defiantly violated it, holding that it was unenforceable. This paper will focus on how Stark Brothers pursued them with lawyers and a detective agency, not always successfully, and will explore what the campaign to enforce its rights in new fruits trees revealed about the state and dynamics of IP protection for the kind of asexually reproducible organisms that were the principal stock in trade of the American nursery industry.

Rebecca Kinraide

Converging Concepts of Utility: A New Look at Intention and Reception in the Useful Knowledge Movement

The British "useful knowledge movement" of the 1820s-1840s has been characterized for decades as a largely unsuccessful attempt by middle class reformers to indoctrinate and pacify the working classes. In this paper I argue that this interpretation is severely inadequate and obscures many important distinctions regarding the intentions among both the producers and consumers of knowledge. The Society for the Diffusion of Useful Knowledge was the most prominent and influential entity devoted to diffusing useful knowledge. As such, an examination of the creation and reception of the SDUK's publications provides insight into the entire movement and how it was perceived and utilized by contemporaries. In this paper I show that the SDUK did not impose a homogeneous middle-class ideology onto resistant or passive working-class readers. It produced and distributed treatises on a wide range of topics depicting a broad range of forms of utility. Readers had their own equally broad concepts of utility that determined how they interacted with the publications, from the decision to buy to how to interpret the information. Readers held various views of useful knowledge and these concepts ranged across socio-economic boundaries, exposing the similarities and differences among individuals, rather than groups. By examining useful knowledge in terms of production and consumption, a much more nuanced and negotiated transaction appears between the parties involved.

Chigusa Kita

Transistor Computer on Campus since 1960

During and after the Allied Occupied Period (1945-1952), at Japanese leading national universities, engineers and scientists struggled for designing stably operational digital computers. After the success of first Japanese transistor computer, Electrotechnical Laboratory's ETL Mark III in 1956 and ETL Mark IV in 1957, Hitachi constructed Hitachi Transistor Automatic Computer, or HITAC, 301 in 1959. The HITAC was a direct outcome of technology transfer from ETL to Hitachi. Kyoto University had decided to cooperate with Hitachi to design a digital computer for scientific computing, and a graduate student was sent to Hitachi as a liaison between academic and commercial institutions. The student, Shuzo Yajima, had already obtained substantial knowledge through available literature on computer architecture and programming. These two-step technology transfer from ETL through Hitachi to Kyoto University and its academic digestion led to the Yajima's design of Kyoto Daigaku Digital Computer, or KDC, I in 1960. KDC-I served as the first on campus computer for scientists at the university. Indeed, during the period of designing the hardware of KDC-I at a factory of Hitachi, its programming environment was also implemented at the university.

Marianne Klemun

Space, State, Territory and Habitat: Alpine Gardens in the Habsburg Countries

Botanical gardens represent institutionalised space, in which epistemes and plants are not only present as elements, but are put into practice on many different levels. Moreover, the self-referential connection to space of each botanical garden receives its dimensions by various space connotations, and variable scientific allocations of meaning also communicate with entirely different, overlapping political spaces of connotation. The aim of this paper is to look at constellations between politics and science as well as between concepts and practices, but also to try to answer the question in what context this specific form of a botanical garden, namely an alpine garden established itself and what scientific questions were solved in those gardens. The idea of an alpine garden was not realised in the center of the Habsburg Monarchy but at its periphery, namely in the botanical garden of the University of Innsbruck, in the heart of the Alps. Anton Kerner (as of 1877 von Marilaun), a professor of natural history who was the head of the botanical garden from 1860 to 1877, turned the garden into a centre of internationally renowned alpine studies. The cultivation of alpine plants, carried out in long-term experiments on various experimental surfaces and various altitudes was to document non-hereditary changes caused by the environment. The controversial hypothesis of characteristics acquired by hereditary transmission was being discussed. In the midst of the mountains, the variable habitat formed the focus of the investigation, while Kerner was laying out the garden area in Innsbruck planted with alpine plants as a fixed „schematic reflection of orographic and geognostic conditions in the Tyrol", which was to represent the Tyrol in its entirety. While at first, the alpine plants had been transferred from the periphery to the centre in Vienna to the palace of Schönbrunn and the work of the botanists was

limited to collection activities – which, at the same time, documented the idea of a stabile unchangeability of the large variety of the alpine plants – the Innsbruck concept mobilised the consciousness on the chances of organisms as modifications of habitats, while, at the same time, the origin of alpine plants was represented in a more stable schema of garden design.

Rachel Koroloff

Descriptions of Kamchatka: Stepan Krasheninnikov, Georg Wilhelm Steller and Russia's Eighteenth-Century Naturalist Tradition

Stepan Krasheninnikov and Georg Wilhelm Steller were two of the most historically significant naturalists to study and write about Kamchatka, Russia's far eastern peninsula on the Pacific. Both were scientific members of the Second Kamchatka Expedition (1733 – 1743), a unique and impressive endeavor in the early history of Imperial Russia's scientific community. Covering much of Siberia, the Far East and the Aleutian Islands, the Second Kamchatka Expedition sought to describe and study a broad range of the natural, demographic and physical phenomena of Russia's eastern territories. This paper investigates how the physical peculiarities of Russian expansion, most significantly the effects of overland and river (as opposed to oceanic) travel combined with the decidedly international makeup of its key personnel to inform the process by which the Russian state took possession of its pacific shores. In looking specifically at the work of Stepan Krasheninnikov and Georg Steller, this paper will demonstrate how Russia's colonizing eastward impulse manifested itself in the work of its designated naturalists. Russia's eighteenth century eastward expansion has often escaped the appellation of 'colonization,' and it is the purpose of this paper to demonstrate and discuss the differences and similarities of this moment in Russian history to other Western European colonial ventures.

Anne Kox

Hendrik Antoon Lorentz's Scientific Correspondence: New Insights into His Thinking and His Personality

The first of two planned volumes of H.A. Lorentz's scientific correspondence contains letters from and to the most prominent physicists of the late nineteenth and early twentieth centuries, including Planck, Einstein, Wien, and Sommerfeld. The correspondence not only sheds light on the development of physics in the period concerned and Lorentz's contributions to it, but also provides deeper and more precise insights in Lorentz's views, his way of thinking and his personality. An example is Lorentz's way of dealing with the growing friction between his "classical" views and the emerging modern, non-classical physics.

Henry Kreuzman

Where, When, Who, and What: The Empirical Nature of Alexander Gordon's Arguments that Childbed Fever is Infectious

This paper argues that Alexander Gordon (1752-1799) developed a series of empirical arguments that lead him to the conclusion that puerperal fever is an infectious disease. Moreover, the paper illustrates that his empiricism was rooted in his conception of scientific method. Gordon, thus, provides a case study of the shift during the 18th century to an empirically based approach to medicine. As the physician for the Aberdeen Public Dispensary he treated many of the women who became ill during the epidemic of childbed fever that extended from 1789-1792. This paper first examines the geographic distribution of cases of childbed fever by plotting each case on the 1789 Milne map of Aberdeen. Gordon's attention to where the cases arose led him to reject the miasma theory and to seek an alternative causal explanation. A second important observation that shaped his view of the etiology of the disease was when the illness arose. He observed that the onset of the fever never preceded and always followed childbirth; as a result, he focused upon this time as the crucial causal interval. Next, he detected a pattern linking specific midwives and physicians with women who become ill, and he thus concluded that puerperal fever was a disease carried by midwives and physicians from woman to woman. A fourth line of argumentation emerged from the detailed records that he kept as the physician for the Public Dispensary. Gordon recognized a correlation between the number of cases of puerperal fever and erysipelas (i.e., a recognized infectious fever) and noted that a surgeon can acquire an inflammation and fever as the result of a scratch during a

dissection of a patient who died of puerperal fever. As a result of this empirical line of inquiry, Gordon concluded that childbed fever is an infectious disease carried by midwives and physicians.

John Krige
Why Did the Ford Foundation Support the Creation of the European Southern Observatory (ESO) in the Early 1960s?

Throughout the 1950s European astronomers, encouraged by the success of CERN, tried to repeat for ground-based astronomy what their colleagues had achieved for high-energy physics. Their tireless efforts were constantly thwarted by governments who were reluctant to create another expensive international organization in a non-strategic scientific field. The deadlock was broken by the Ford Foundation who offered to contribute $1million for a European observatory in Chile. While this fact has been noted in the standard histories of ESO, the reasons for the Foundation's intervention have not been explained. This paper will fill that gap, situating the Ford Foundation's support for ESO in the general framework of its political and cultural agenda in Western Europe in the post-Sputnik era.

Prakash Kumar
Battle Against Bt Cotton: The Principle of 'Biological and Intellectual Commons' in the Anti-GMO Movement in India

This paper analyzes the complex politics under-girding the attempts by civil society organizations in India to oppose the expansion of Bt cotton. The Third World anti-GMO organizations claim to be "pro-poor" and "pro-farmer" in their defense of the collective innovation carried out on the indigenous germplasm and preserved in local biodiversity over millennia. They contend that local agricultural communities see these innovations as a social and collective phenomenon. Such a perspective runs counter to the intellectual property regime on plants, animals, and microorganisms that TRIPs seeks to globalize. That said, this paper resists the temptation to frame the two positions as a simple contest between the proponents of two monoliths: the "North" and the "South." The paper utilizes documents available at two prominent anti-GMO organizations based in New Delhi, Gene Campaign and Navdanya, and newspaper reports published from various Indian cities to illustrate the far more complex picture. The activists' notion of "property" in seeds has evolved in close correlation with their oppositional politics over the last decade and a half. As the Indian Government introduced facilitating amendments to its patent laws in 1999 and 2002, the state came be seen by public intellectuals as a facilitator of expansion of GM crops. Indian farmers on their part have been equivocal in assessing the effectiveness of Bt cotton for cost reduction. In fact, some farmer's organizations have openly come out in favor of Bt cotton. Under the circumstances the activists' efforts to secure Indian farmer's right to save, exchange, and improve their seed resonates with Gandhian notions of satyagraha (self-rule) that has clear pre-independence historical precedents in the country. Activists' politics has mass appeal, and serves the function of opposing the financial might of multinationals like Monsanto and the pro-GMO policies of their own national government. In that context, this paper puts spotlight on the envisioning of an alternative form of property rights in plants in contemporary India that contests the claims of universality of IP rights proposed under TRIPs.

Sofie Lachapelle
Science on Stage: Magic Shows and "Amusing Physics" in Nineteenth-Century Paris

During the second half of the nineteenth century, the renowned Théâtre Robert-Houdin featured shows of recreational physics and white magic, where the public could witness a young boy levitating, spirits of the dead seemingly communicating with the audience, physical experiments and chemical wonders all in a single night! This paper will explore the place and functions of scientific experiments in the magic shows of nineteenth-century Paris. Both recreational physics and mathematics had been popular forms of entertainment at the French court since the sixteenth century. By the end of the eighteenth century, however, the performances had become more complex, requiring experimental instruments and instruction manuals about their use. Many nineteenth-century magicians called themselves "professeurs de physique amusante." On the stage, they combined physical and chemical experiments with tricks of prestidigitation and mediumistic productions. As scientists themselves adopted the language of wonder to describe new scientific inventions and discoveries of the period—the steam engine, the telegraph, or the hot-air

balloon—magicians exploited the seemingly magical character of science. The use of chemical and physical principles made for a good show; so could levitation or communication with spirits. To dazzle their public, magicians combined the language and practices of science with the aura of magic and wonder. If they claimed to produce all of their phenomena without any appeal to the supernatural, the distinction they made between the worlds of science, spiritualism, and illusion was not clear and seldom made explicit to their audience.

Kevin Lambert

Maxwell's Method and Boole's Analogy: Or Why George Boole's Logic was Important for James Clerk Maxwell's Theoretical Practice

In the extensive literature on James Clerk Maxwell's natural philosophy, George Boole's mathematical logic has not been considered important for the understanding of Maxwell's scientific method. However, in my paper I will argue that the well-established importance of Scottish Common Sense philosopher Sir William Hamilton's Kantian metaphysics for Maxwell's use of analogy and geometric thinking in his scientific work can be better understood in the light of Maxwell's interest in Boole. In particular, I will argue that George Boole's mathematical logic was an important resource for Maxwell's project of mathematizing Michael Faraday's experimental researches into electromagnetism. Central to Maxwell's project was the problem of how reasoning with physical objects was related to reasoning with mathematical symbols. As both Boole and Maxwell were aware, it was at this intersection, between theories of mind and philosophies of discovery, that discussion of British mathematics became intertwined with the related question of how language, especially written language, represented Victorian knowledge.

Jérôme Lamy

Coordinating and Adjusting Astronomical Practices: The 'Carte du Ciel' Undertaking at the Turn of the 20th Century

Launched in 1887, the 'Carte du Ciel' was an international project aiming at photographing the entirety of the celestial vault. Tasks required for this huge undertaking were divided among 18 observatories around the globe. Instruments were standardized and a series of international conferences established operating modes and prescribed norms to be followed everywhere. In each observatory, however, the drive toward uniformity ran into a variety of minor technical and practical problems. In this paper, we examine the strategies mobilized by observers to tinker with stated rules and adapt them to their own experience as astronomers. To underscore the tension between normative prescriptions and individual practices, we consider the "Bulletin du Comité International permanent de la Carte du ciel" as an informal forum where various queries raised and arrangements adopted were shared among the scientific community.

Catherine Lange

Iconic Science Heroes as Models for the Pedagogical Use of the History of Science: Thomas Edison and Wilson Greatbatch

While there is no question that children have held heroes throughout history, the quantification of the significance that a hero has on an individual is plausible. While heroes have varied historically, youngsters today hold celebrities from sports, movies, television, musicians, and even animated characters as their inspiration and rarely, if ever, a scientist or inventor. As recent reform of Science education in America has suggested the inclusion of historically based strategies to promote an understanding of the nature of science, some have cautioned against the use of the magnanimous scientist as a pedagogical tool. The reasoning is based on the belief that students cannot relate to genius beyond their abilities. This research provides an opportunity to show how a science figure (Thomas Edison) influenced the life works of another (Wilson Greatbatch) and supports the premise that when some students have knowledge of a famous inventor or scientist, they may accept that person as their personal hero and be inspired and motivated by such a model. A comparative analysis from collected data substantiates this claim.

Tayra Lanuza-Navarro

Medical Astrology in Spain During the Seventeenth Century

It is known that astrological practice during the Early Modern period was closely related with medicine, and that it provided a tool for diagnose and treatments. An interesting aspect of this relationship of medicine and astrology is the recognition of the prevailing ideas about medical astrology in the medical treatises. This article discusses the ideas found in the Spanish printed texts of the seventeenth century, beginning with an overview of the Spanish authors who wrote about the subject, especially those linked with the universities. The paper then goes into detail about some very interesting and little known treatises on medical astrology which were a reference for the practice of medicine in the period, such as the "Book on the natural science of the sky," written in 1598 by Cristóbal Ponce de León, physician and mathematician from the University of Alcalá de Henares, and "Place, nature and properties of the City of Mexico," published by the professor of the University of Mexico Diego Cisneros in 1618.

David Leary

Between Peirce (1877) and James (1898): G. Stanley Hall and the Origins of Pragmatism

The story of the founding of American pragmatism, as commonly told, emphasizes a series of papers published by Charles S. Peirce, beginning in 1877, and a later address delivered by William James in 1898. But what happened in the intervening years? This paper will address that issue, bringing attention to G. Stanley Hall and his role in establishing a distinctive pragmatic approach to the nature of the psychological subject (i.e., the human individual) and to the related modes of psychological investigation. Long labeled the ultimate administrator (e.g., as the founding president of Clark University, founder of the American Psychological Association, founder of the first journal of psychology in the United States, etc.), Hall's scholarly work has been overlooked if not summarily dismissed as scientifically retrograde. This paper will question that orthodox opinion, showing Hall to be among the first to publicly champion Peirce's early papers on pragmatism and arguing that his distinctive scientific work reflected a thoughtful and consistent implementation of pragmatic principles, as he understood them. It will also show how his reading in literature, philosophy, and theology, prior to his encounter with Peirce and James, prepared the way for his distinctive work. The punch line will be that when James called for pragmatism in 1898, it had already been put into practice by Hall and his students at Clark University.

Seung-joon Lee

Taste in Numbers: Agricultural Science and the Rice Control Policy in Guomindang China, 1927–1937

This paper explores how modern agricultural science was introduced, understood, and practiced in the context of modern China. Nothing so menaced China as instable food supply in the early twentieth century. Filled with both a sense of urgency and self-confidence in their scientific understanding of the Chinese agriculture, many Chinese experts who had trained in western universities returned to China and helped Guomindang (KMT) policy-makers develop a series of bold rural reconstruction and rice regulation programs. With the strong support of government and their confidence on cutting-edge methods — statistical survey and quantification, they generated the most "reliable" data over China's rice production and consumption. In spite of the quantitative precision, however, their scientific knowledge completely overlooked the qualitative dimension of rice trade, including the differences of rice quality; the local variation of rice breeds; and the local particularity of consumer palate. By contrast, such a quantitative dimension of rice was understood and valued as quintessential parts of local rice trades. Consequently, Guomindang's rice regulation policy based upon the quantitative data came to confront unprecedented reactions from rice traders and merchants. Unlike past scholarship that has mostly focused on Guomindang's coercive implementation of social regulation policy, this paper argues that the social conflicts between the state and society over rice control should be understood from its intellectual foundation: the introduction of western agricultural science and its single-minded quantitative methods.

Juan León
Worldwide: the Snake Venom Specificity Debates, 1890-1912

The consolidation of the Pasteurian paradigm came partly by the hand of the development of antitoxic sera, which by the mid 1890s were being successfully produced to counter the effects of snakebites. However, and in opposition to the pervading optimism in global diseases and treatments inspired by the germ theory that allowed the development of the antidotes in the first place, there were increasing indications of the local nature of snake species, their poisons, and hence of the antidotes. Dissent came mostly from outside Europe where snakebites occurred: British India and Australia as well as Brazil, Japan and the United States. At stake in the ensuing debates over the role of locality were not just theories of immune response or variability between animal species, but the economic viability of saving lives in the marginal areas where these accidents usually occurred, and the very necessity of laboratories outside Europe in the first place. The debate itself became a reflection of these theoretical and material issues, as experimental replication of scientific claims and consensus formation involved the worldwide tortuous travel of not just scientists and "inscriptions", but especially snakes, poisons, antidotes, and technologies for their control. The knowledge and practices that emerged from the debate, while Pasteurian, replaced its universalist aims with an articulated locality that challenged the assumptions of the observation-intervention, theory-application, nature-culture and patient-doctor dichotomies.

Trevor Levere
Dr. Thomas Beddoes, James Watt, and Their Collaboration in Pneumatic Medicine

Beddoes was closely engaged with the members of the Lunar Society of Birmingham, in chemistry, politics, and medicine. He was most closely involved with James Watt, members of whose family suffered from consumption. He collaborated with James Watt in the design of an apparatus for administering gases in the treatment of consumption and other respiratory diseases, discussed pneumatic therapies and case histories with him, and exchanged drawings and ideas for a breathing apparatus. Watt had the apparatus built at the Soho foundry, and joined Beddoes in writing a small book on the treatment of consumption, and the design and use of their apparatus. The lines separating industrialist, manufacturer and engineer, from chemist and physician were bridged so thoroughly as to be meaningless; Watt administered pneumatic therapies and discussed the production of medicinal airs, while Beddoes and Darwin discussed the design and use of chemical and medical apparatus. There are differences of emphasis, but their collaboration evinces no separation of natural philosopher from physician, or of physician from engineer.

Jeffrey Lewis
Scientific Fundamentalism and the Gene as Secular Soul

While science and religion have often been depicted as polar opposites, with the former being based on reason and the latter on faith, in recent years creationists have attempted to undermine the credibility of the biological sciences by embarking on a different strategy: they argue that science and religion are similar, that both are natural philosophies based on faith. By depicting science and faith as variations on a theme, they challenge the exclusivity conferred upon scientific knowledge in public life, particularly the teaching of evolution in public schools. Unfortunately, some visible figures in the scientific community have been all too willing to provide this generation of creationists with evidence for their claims; in modern biology, especially the teaching of evolution, science has indeed become a faith tradition for some of its practitioners. Michael Ruse has examined this tendency at length in his recent book " The Evolution-Creation Struggle." In this talk I develop this theme by extending it to the work of three important figures in molecular biology and its popularization: Gerhard Schramm, a German biochemist who made significant contributions to our understanding of the role of nucleic acids; Francis Crick, co-discoverer of the structure of DNA; and Richard Dawkins, one of the best known popularizers of evolutionary theory. All three have contributed to what I call scientific fundamentalism: the elevation of science to the level of religion. In particular I examine the way that DNA has become a secular soul for these individuals. By elevating biology, and genes in particular, to sacred status they have contributed to a skewed version of biology in which the organism and biological development are trivial in comparison with the all-powerful gene. Thus scientific fundamentalism presents a two-fold challenge: it undermines the integrity of science as a discipline in the manner previously suggested, and at the same time it devalues the body in favor of the gene, which then poses challenges for improving human health and medicine. I conclude by suggesting that the harmful effects of scientific fundamentalism

can be countered by stressing the role of development in human biology and de-sanctifying the gene. More broadly, scientists need to acknowledge that there are limits to what science can tell us about the world; biology can tell us a great deal about the human body, medicine, and natural history, but it cannot and should not lay claim to transcendent questions such as immortality and the soul. This leads to my final suggestion, which is to view religion and science as complementary, rather than adversarial. Religion explores issues that are ultimately unknowable in an empirical sense. Science explores issues that are unknown—but ultimately can be known in a manner that transcends individual and cultural boundaries. The complementary dichotomy "unknown/unknowable" is a less antagonistic way of understanding the relationship between science and religion than seeing them as polar opposites (rational/irrational, logical/illogical) yet still confers authority on science for explaining questions of an empirical nature that in some way reflect the world around us.

Veronika Lipphardt

The 'Black Sheep' of Bio Sciences: Marginalizations and Rehabilitations of Race Science

The term "pseudo science" is probably most commonly used for racial science, as can be seen from academic and public discourses as well as from text books of biology. However, even today many scientists investigate racial differences in human beings, applying methods of modern molecular biology rather than skull measurement. Thus, the problem of the epistemic status of "race" and race science has not yet been resolved; indeed, the demarcation of race science as true science or pseudo-science has shifted several times back and forth throughout the 20th century. In this paper I will not use analytical tools of philosophy of science, or try to issue the final word whether race science is to be seen as a pseudo science or not. Instead, I will approach the problem by historicizing the application of the term "pseudo science" on race science and follow its career up to today. First, the paper traces shifts in the demarcation between "science" and "pseudo science" throughout the 20th century, focussing mainly though not exclusively on German speaking discourses in science, academia and the public. Surprisingly, critical labelling of race science as pseudo science began as early as 1904, and German-Jewish anthropologists played a key role in early attempts to criticize race science. Furthermore, race as a scientific category was not discredited after 1945 as commonly assumed, but instead has continued to emerge as a valid biological description of human diversity in scientific publications, textbooks and popular texts. Second, the paper therefore addresses the epistemic status of race science as a current problem in recent molecular biological investigations of differences between ethnic groups. The historical sketch outlined in the first part of the paper will shed light on the perplexity caused by these challenges in current science.

Fabien Locher

The Landed Ship and the Crusade: International Cooperation and Competition in Meteorology and Geomagnetism (1830-1850)

The 1830s and 1840s gave rise to a European movement of data accumulation concerned with the terrestrial environment, which included German and British geomagnetic programs studied by John Cawood. In this paper, we study the counterpart of these programs in the field of meteorology. We analyse the practices and discourses of a small group of French scientists in the context of the polar expedition of the corvette "La Recherche", in 1838-1840. This paper addresses the development of modern paleobotany through the microscopic observation and imaging of fossil plant specimens and their internal structural components. We show that the director of the Brussels Observatory, Adolphe Quetelet, organized European meteorological campaigns structured, in term of convergence and publication of observations, around the Brussels observatory. We show that the Brussels observatory constituted, in the 1830s and 1840s, a buffer zone between the British, the French, and the German scientists, in a context of national and scientific cooperation and competition in the field of earth sciences.

Cheryl Logan

Heredity and Race in Paul Kammerer's Endocrine Hypothesis of Somatic Induction

Austrian Zoologist Paul Kammerer turned to reproductive endocrinology late in his career to mount a physiological defense of the inheritance of acquired characteristics. He proposed that through the process of somatic induction the interstitial cells, the putative secretory cells of the gonad, mediated environmentally induced changes in heredity that

persisted in unexposed descendents. His hypothesis was presented amid great discussion of the interstitial cells, and it went well beyond consensus conclusions about the cells that were then extant among the scientific experts. I argue that Kammerer framed his hypothesis prematurely partly in an effort to challenge the hereditary notion of race that linked genetics and eugenics in racist science. His writings indicate that Kammerer rejected the permanence of racial distinctions on scientific grounds. He used endocrine physiology both as the scientific grounding for his moral distaste of racism and as the basis for a morally superior alternative that was anchored in a competing science of heredity.

Abigail Lustig

Ant Economics and Cold War Sociobiology

The study of natural and human economies have moved in and out of phase since at least the eighteenth century, and since the 1960s we have seen one of their periods of greatest interpenetration. Modern economics and modern evolutionary biology have both made grand claims to universal applicability, with approaches derived from economics being used to explain evolutionary processes and arguments derived from natural history and evolutionary biology being used to explain the nature of Homo economicus. This paper concentrates on the latter, focussing on two figures in particular. The first is an amateur biologist and professional technocrat interested in the question of the evolution of societies, Caryl P. Haskins (1908-2001), director of the Carnegie Institution and board member of the RAND Corporation among others, who gave successive, shifting interpretations of the evolution of animal and human societies against the shifting political backdrops of the Second World War and the Cold War. The second is the ant biologist E.O. Wilson (1929-), whose concept of the superorganism, central to his work, similarly transmuted from the 1950s onward to reflect evolutionary biology's responses to the Cold War's political challenges.

Anna Maerker

Making Natural Philosophy Useful: The Case of Kant's Natural History of the Heavens

In the mid-eighteenth-century, Kant was one of many philosophers in the German lands who thought about how natural philosophy could be useful for society and for the state. Early in his career, Kant published the "Natural History of the Heavens" (1755), an attempt to demonstrate the potential of natural philosophical reasoning by reconstructing the origin and development of the universe on the basis of mechanical laws. This work has generally been interpreted as an embrace of Newtonian physics. In this paper, I suggest another, complementary contextualization: the contemporary tradition of natural history. By taking seriously the odd choice of title (after all, the heavens were commonly considered to be outside of the realm of natural history), we can see how Kant adopted concepts from natural history (such as notions of the "system" and the "great chain of being") in order to make natural philosophy as useful as natural history was generally accepted to be. I use this case to illustrate that, for eighteenth-century natural philosophers, quantification was not the only road to utility.

Laetitia Maison

A Model for Reorganizing French Meteorology? Alfred Angot's Tour of U.S. Observatories in 1875

In 1875 the French physicist Alfred Angot (1848-1924) is asked by the French Government to tour American observatories. His survey is part to a large study on foreign observatories undertaken with two of his colleagues, Charles André and Georges Rayet, astronomers at the Paris Observatory. The goal of their work is to bring home helpful information in order to reorganize French astronomical research in the wake of the defeat against Germany in the 1870s. This study providing a French perspective on astronomy around the world is published in five parts between 1874 and 1881 as "L'astronomie pratique et les observatoires en Europe et en Amérique" (soon to be available on the Internet). In the part dealing with American observatories, Angot insists on the performance of the meteorological service organized by the Smithsonian Institution and on the vitality of the university and private observatories even if their survival depends on sponsorship. We will see how this American model has inspired French astronomers in a period marked by the decentralization of scientific institutions. More precisely, we will see how upon his return to France Angot used his American survey in his attempts to develop the "Bureau central météorologique".

Aryn Martin

"Nature's Experiment": A Genealogy of Chimeras Made and Found in 20th-Century Clinical Medicine

The Chimaera originated in Greek mythology as a she-monster composed of a lion, goat and serpent. The word was given material existence in biology when, in 1907, Hans Winkler chose it to name the species mixture he created in plants; he selected it precisely because such a thing did not exist in nature. Finally, the term was appropriated in the 1950's for genetically mixed organisms "found in nature", however unnatural their constitution was thought to be. The MRC Blood Group, in London, found and named Mrs. McK, the first human chimera, in 1953. Clinical practitioners constantly invoke the original monster in their discussion of human clinical cases, though they protest that this is mere metaphor. Drawing predominantly from materials in the Blood Group archive at the Wellcome library, I suggest that human genetic chimeras have been consistently located within the realm of the anatomically monstrous. Anatomical monsters have a specific history in Enlightenment embryology and anatomy, where they were classified, displayed and dissected as foils for nature's regularity. While the contours of the objectifying display have changed in our gentler era, I will argue that the basic features persist in the medical handling of these morphological rarities. Moreover, the absorption of cellular and genetic phenomena into the realm of the monstrous requires and exploits a new order of visibility in the clinical laboratory, best captured by Canguilhem's term, "micromonsters".

John Mathew

Fashioning a Regional Natural History: The Fauna of British India Series

From its inception in 1864, the Fauna of British India series became the keynote of faunistic taxonomic classification in British India until independence was obtained in 1947. I argue that the Fauna of British India was at once an imperial project of classification (sensu Said) as well as a continuance of long-standing individual efforts to secure natural history on a firm footing in the public consciousness. In this context, I shall discuss the efforts of such stalwarts as William Sykes, Brian Houghton Hodgson, Thomas Claverhill Jerdon and Edward Blyth in the Indian subcontinent, attended by concomitant interest and patronage by such institutions in the United Kingdom as the Royal Society and individuals as Charles Darwin and Joseph Hooker. My focus will be on early natural histories of particular faunistic groups and their eventual treatment as part of a larger series, involving transoceanic relay of information, and publication and dissemination of print and illustration. Such an endeavour will seek to capture and portray as systematically as possible the wild heritage of a subject colony through the efforts of a network of ethnologists, political administrators, soldiers, clergymen and natural historians.

Christina Matta

Boundary Zones and Disciplinary Divides: The Fischer-Smith Debate and its Multiple Contexts

Between 1897 and 1901, American plant pathologist Erwin Frink Smith and German botanist-turned-bacteriologist Alfred Fischer engaged in a highly criticial published debate over the possibility that bacteria could cause plant disease. This debate is nearly legendary among plant pathologists – it is usually portrayed as the moment in which an up-and-coming American plant pathology delivered a withering intellectual blow to stodgy German science – but has attracted no attention from historians of science. Yet interpreting the debate in its historical context reveals much about the process of disciplinary development in the biological sciences. In the last decade of the nineteenth century, the traditional biological disciplines of zoology and botany began to diverge into smaller, more focused research specialties, each with its own scientific curricula and methods. Because laboratory methods and research questions in these emerging disciplines often overlapped, scientists allied with a certain field sometimes found themselves at odds with their counterparts in other fields whose methods and conclusions differed from their own. The Fischer-Smith debate is a telling example of the negotiations that resulted from the development of new disciplines. Drawing upon Robert Kohler's model of disciplinary development and border zones, I argue that the debate was not an argument about pathogenicity, but rather a disagreement about the quality of scientific proof that phytobacteriology (and its research methods) offered. The Fischer-Smith Debate,therefore, illustrates the relationships among plant pathology, botany, and bacteriology as these disciplines struggled to establish credibility during a period of disciplinary expansion and instability.

Brendan Matz

Hybrid Corn and Transgenic Plants: A Comparative Analysis of Intellectual Property Regimes

In this paper I closely examine two moments in the history of intellectual property protection in sexually reproducing plants: the advent of hybrid corn and the creation of the first transgenic plants. Through a comparison of the intellectual property regimes that grew up around these technologies, I argue that developments in biological science allowed for a movement away from secrecy and towards disclosure through the patent "bargain." As scientists achieved greater intergenerational uniformity and specificity of description for their plant products, an alternative to trade secrecy and insular breeders' associations became a reality. However, I further argue that the IP regime of the biotechnology era presents new limitations on innovation that do not stem primarily from secrecy. These limitations include widespread industry conglomeration and broad and/or overlapping patents. To illustrate the differences between the two cultures of innovation, I will consider Pioneer Hi-bred, an early hybrid corn company, side-by-side with Mycogen, a present-day seed firm that develops transgenic plants.

Massimo Mazzotti

The Catholic Newton

Recent developments in Newtonian scholarship have revealed the full extent of Isaac Newton's religious concerns, and explored their significance for the understanding of his scientific work. Most studies in this perspective have focussed on the interaction of Newtonian science with eighteenth-century British culture and society. However, our understanding of the scientific Enlightenment also requires a much clearer reconstruction of the reception and appropriation of Newtonian science within different religious settings, particularly in Catholic Europe. The present paper is a step in this direction as it presents to the audience little known documents of the early diffusion of Newtonianism in Rome and in some Catholic universities. In this way I aim to replace the stereotypical view of a monolithic Catholic culture hostile to Newtonianism with a more nuanced interpretation that brings to light various processes of appropriation, meaning-shift, and use of this extremely flexible doctrine.

Patrick McCray

The 'Global Science-Sport' of Satellite Tracking during the IGY

The International Geophysical Year (IGY) presented amateur scientists with many opportunities for participation. One of these was Moonwatch, a program astronomer Fred L. Whipple and the Smithsonian Astrophysical Observatory (SAO) organized in 1956. Amateur scientists and other interested citizens around the world soon formed scores of Moonwatch teams around the world and trained themselves to observe the first artificial satellites. When the Soviets launched Sputnik in October 1957, this network of amateur groups was the only system prepared to visually spot and track it. The paper explores the history of amateur participation in the IGY via Moonwatch and pays especial attention to the establishment of satellite-spotting teams overseas and in the U.S. It explains how the Moonwatch program brought together different elements of Cold War culture: the emphasis on vigilance, the desire to participate in civic activities, and people's broad interest in science and space. Finally, I will consider the tensions between the SAO and the National Academy of Sciences regarding the participation of amateurs in IGY research and the international ambitions Whipple had for Moonwatch.

Kathryn McKay

Before the Cuckoo's Nest: Accusations of Madness and First Nations Women

Many aspects of both criminality and madness can be perceived as cultural and social constructs. Behaviours, which once "guaranteed admission" to a mental institution, now have medical explanations; "normal" is much less tangible than it was 50 or 75 years ago. Further, theories of madness vacillate between biological and cultural explanations. Where patient behaviour has stayed the same, medical records show that diagnoses varied radically over time. In British Columbia detailed records of admissions to the provincial mental hospital have been kept since 1875. An examination of the records of First Nations women illustrates the particular interaction of the biological and cultural interpretations of madness. These women, as representatives of a dying race, were considered to be savages, who had little knowledge of

proper behaviour. This both damned them and was used as an explanation for their behaviour. Unlike "civilized" women, for whom admission to a mental hospital was depicted as social failure, First Nations women were expected to emerge from the hospital experience with an appreciation for "white culture." Further, in order to be discharged as "improved," these women were expected to show the benefits of treatment through both mental and social progress. The experiences of these women, then, illustrate the dichotomy between the physical and cultural context of madness. My paper examines this dichotomy and discusses the historical issues that inform this situation.

Minakshi Menon

Colonialism and Its Forms of Knowledge: British Natural History in Late Eighteenth and Early Nineteenth-Century Colonial India

What did it mean to "do" natural history in late eighteenth and early nineteenth-century colonial India? My paper uses this question to explore the natural knowledge made by colonial administrators in India in this period. It argues that understanding nature's uses was an integral part of the processes through which the English East India Company learnt to rule its Indian possessions. Thus a history of the flora, fauna and minerals of the subcontinent emerged in the course of "Survey and Settlement" operations undertaken to maximize the revenue that the East India Company extracted from Indian agriculture. It was part of the "improving imagination" of the Company State, demonstrating a link with the burgeoning agrarian capitalism of the metropolis. The paper discusses the surveying activities of Francis Buchanan-Hamilton, a Scottish physician in the employ of the government of Bengal, in order to show that attention to colonial natural history reveals neglected aspects of metropolitan natural history, for example its close relationship with agricultural improvement. At the same time it points to a crucial difference that gave colonial natural history its specific character: its traffic with indigenous knowledge systems and the problems it encountered in effecting translations between incommensurable modes of knowing.

Carolyn Merchant

Natural Knowledge: Roundtable on the Histories of Science and the Environment

This roundtable of leading scholars at the intersection between the history of science and environmental history seek to address the perceived disconnect between these two fields. We propose to ask: 1) what is the relationship between environmental history and the history of science? 2) how have these fields developed separately and in tandem? and 3) at what points do these fields most fruitfully overlap? Central to this conversation will be an inquiry into how the history of science might better inform environmental history, and how environmental history might, concomitantly, contribute to the history of science.

Chair: Michael Egan. McMaster University

Commentator: NA

Paper 1 Author and Title: Carolyn Merchant

Paper 1 Abstract: This paper focuses on issues of gender and race as well as such STS issues as the social construction of science and nature, postmodernism, ideas of science and nature as grand narratives, and critiques of science exemplified by the science wars and related nature wars. Central to the relationship between the two fields is the question: Can Science know Nature? and if so how and with what consequences?

Paper 2 Author and Title: Gregg Mitman, University of Wisconsin, Madison

Paper 2 Abstract: History of science was in many ways a Cold War baby; not so for environmental history. While much of the Marxist turn in history of science was directed at the uses of science in the growing military-industrial complex, environmental history came into being during the heyday of the environmental movement, one that saw the ecological sciences as savior. Yet much environmental science was also a Cold War baby. Still, it led to a different politics of science. This explains in part why environmental history has continued to have a strong normative agenda, while history of science has largely retrenched from such a normative stance.

The other road that differing attitudes among the two disciplines toward science opens up is the issue of materiality and agency. There is much good work being done in historical geography, science studies, and other fields that opens up questions of materiality. When environmental historians approach the history of scientific ideas, the material environments in which scientists work seems to drop out. To create a bridge between the two fields, we need to begin

writing more materialist histories of ideas.
Paper 3 Author and Title: Edmund Russell, University of Virginia
Paper 3 Abstract: Environmental historiains see science as a tool whereas historians of science see it as an object of study. Environmental historians see science as a baseline against which to measure change and often assume or need science to be reliable. Historians on the other hand see science as mutable and changing. Environmental historians need to historicize science and science texts, while historians of science need to see the potential dangers of social construction for the material world of the environment.
Paper 4 Author and Title: Ron Doel, Oregon State University
Paper 3 Abstract: A major question deals with how the views of environmental historians and historians of science around science itself were formed. In the 1950s contributions to environmental science originally came from the physical sciences such as geology, hydrology, and oceanography, whereas until the rise of the environmental movement in the 1960s and 1970s the biological sciences were often missing. Historians of science read Thomas Kuhn and Bruno Latour, while environmental historians read Donald Worster and Aldo Leopold. How these texts and topics can be brought together depends on a fragile interdisciplinarity.

Ronald Mickens
Black Scientific Organizations

Until the last quarter of the twentieth century, African Americans were not generally welcome to freely participate in all of the activities of the meetings of the major national mathematical, scientific, and engineering professional societies. The response was the creation of a separate set of organizations. These parallel societies provided friendly social environments within which members could freely associate with each other, present the results of their current research and/or other scholarly activities, and discuss openly various issues related to career advancement and the mentoring of students. This presentation will give the genesis of a select number of such organizations, discuss their subsequent history and accomplishments, and provide rationale as to why most of these organizations are still in existence, despite the general "opening up" of the national societies.

David Miller
Seeing the Chemical Steam for the Historical Fog: James Watt as Chemist

James Watt's work in chemistry is a widely recognized but, most would argue, marginal aspect of his life and work. Watt the engineer looms so large as to place Watt the chemist in the shade. This paper unravels the layers of historical interpretation that have produced this situation and argues that Watt's chemical ideas and experiments were much more central to his work than is usually conceded. In particular, the case is made that Watt himself would have seen chemical ideas as basic to his understanding of, and improvement of, the steam engine. The historical controversy concerning Watt, Black and latent heat in the development of the separate condenser (which has run from the late eighteenth century to the present) has done as much to hide as to elucidate this point. The adoption of Watt as a 'proto-thermodynamicist' by nineteenth-century developers of that science (and by historians of science and technology) has also helped to create a climate in which Watt's chemical steam has been invisible.

Ole Molvig
The First World War and the Reorganization of Scientific Communication

This paper examines the changes to scientific communication—personal, academic and popular—brought about by the First World War. The rise of national tensions altered, rerouted, or even blocked completely many of the prewar channels of communication, be they personal correspondence, academy proceedings, telegraph services, or scientific journals. This paper uses Albert Einstein's General Theory of Relativity as a test case. Intensively developed during the War's early years, and published from 1915 to 1916 in the Proceedings of the Berlin Academy, it is well-known how little information regarding the nascent theory of gravitation traveled beyond Germany, with the exception of Arthur Eddington's correspondence with the Dutch astronomer Willem de Sitter. However, after the 1919 eclipse expedition, international attention reached a feverish pitch. This paper uses this intense interest to explore the circulation of postwar scientific information only two years after the end of formal hostilities. With belligerent scientists barred from international

congresses, foreign membership revoked from many academies, and university libraries reluctant to backorder wartime foreign journals, the difficulties faced by many non-German scientists and journalists in just finding a copy of Einstein's publications (not to mention understanding them) was particularly indicative of the state of postwar scientific communication.

Laurence Monnais

Can Traditional Medicine Be (Scientifically) Trustworthy? Colonial Views of Vietnamese Medicine in the First Half of the Twentieth Century

At first glance, colonial discourses—and particularly medical discourses—on "Sino-Vietnamese medicine" in the first half of the twentieth century seem remarkable in their uniformity. Again and again we find references to "gross empiricism;" we see Sino-Vietnamese medicine denounced as quackery; we find the same warnings concerning the risks of toxicity—or at least the ineffectiveness—of the medications proposed by Sino-Vietnamese doctors and pharmacists. And the source of such uniformity is not hard to find: France's 1887 colonization of Indochina, a mission dedicated both to the exploitation and to the civilization of the Indochinese, relied in part on the "gift" of a medicine celebrated for its discoveries and bacteriological victories, its value further enhanced by a pharmaceutical industry which was taking form and earning the confidence of practitioners—in all, a medicine unashamed to demand exclusivity. At the same time, some French doctors were to become interested in the complex nature of Sino-Vietnamese medicine and particularly in the Vietnamese medicine; others came to admit their powerlessness in the management of certain tropical diseases and native patients. This paper examines the seemingly contradictory trends toward disqualification (in particular via legislation on toxic substances which sought to limit the prescription of a long list of Vietnamese remedies) and reappropriation (especially of a certain number of vegetal substances contained in local pharmacopoeias) of this "Southern medicine", analyzing these marginal discourses so as to entertain the possibility that, for certain French practitioners, Thu'c nam came to be seen as an alternative or a complement to (scientifically?) trustworthy biomedical interventions.

Iwan Morus

Philosophical Reflections: Optical Illusions and Knowledge-Making in Early Nineteenth Century Britain

Early nineteenth-century polite society was fascinated by illusions. Crowds flocked to Baker's panoramas in London's Leicester Square or Philipstahl's phantasmagoria at the Adelphi Theatre. The phantasmagoria in particular started a vogue for spectacular and carefully choreographed magic lantern shows that lasted for most of the following century. Alongside this obsession with artificial illusions there was a similar fascination for natural illusions. Excursions to see the Brocken spectre or the Fata Morgana were a staple item on the Grand Tour for well-heeled aristocrats and impoverished poets alike. For natural philosophers there was a serious point to this fascination with illusion. From John Locke onwards, philosophers had treated seeing as a model for knowing. This made illusions philosophically important. They could be understood as experiments that tested how mind and matter interacted. This paper examines how early nineteenth-century natural philosophers used popular illusions to probe the nature of knowledge. I suggest that contemporary philosophical fascination with the phantasmagoria, as evidenced in David Brewster's *Letters on Natural Magic*, for example, or Brewster's and others' interest in developing their own illusions such as the kaleidoscope or the thaumatrope, should be understood in the context of the concern to understand how the eye served as a conduit for knowledge. Understanding how the eye could be fooled was a way of understanding how judgement could be compromised and served as a way of constructing competing accounts of the proper place of knowledge (and knowledge-makers) in society. The paper aims to show how popular showmanship and the philosophy of vision alike need to be seen in the light of early nineteenth-century efforts to re-specify just where knowledge could be supposed to reside in Regency and early Victorian society.

Staffan Mueller-Wille

Plant Breeding, Microbiology, and Biochemistry at the Carlsberg Laboratory (Copenhagen): Wilhelm Johannsen's Formative Years 1881-1892

In 1912 Wilhelm Johannsen (1857--1927) codified the distinction of genotype and phenotype to distinguish a space of heredity with an independent logic and metrics from another, physiological and developmental space represented by the cytoplasm and standing for the organism. In addition, for the elements of the genotype, he proposed the notion of the gene. Johannsen's codification, as I will argue, was based on breeders' and bacteriologist's practices of separating 'pure lines' that he came into contact with when working as assistant at the laboratory of the Carlsberg brewery in Copenhagen from 1881 to 1892. It was there, while carrying out chemical investigations of barley for the purpose of breeding high quality strains, that Johannsen came in contact with Emil Christian Hansen (1842--1909), head of the laboratory, and famous for the pure lines of yeast he produced. A similar story about a close relationship between the formation of early genetics and the conjunction of breeding, microbiology, and biochemistry in the context of the brewing industry can be told about Martinus Willem Beijerinck (1851--1931), who in 1899 brought Gregor Mendel's 1866 paper to the attention of Hugo de Vries (1848--1935), one of the re-discoverers of Mendel's laws.

Teasel Muir-Harmony

Tracking Diplomacy: The Smithsonian Astrophysical Observatory's Satellite Tracking Station in India

During the late 1950's the Smithsonian Astrophysical Observatory (SAO), in consultation with the Committee for the International Geophysical Year (IGY), constructed a global network of optical satellite tracking stations. The twelve stations, located around the world in such diverse locations as Japan, Australia, India, Hawaii, Peru, Iran, and Ethiopia, were equipped with precision photographic tracking telescopes. In each country the observatories were staffed by a combination of American and local astronomers. The SAO made a concerted effort to integrate the stations into the social, cultural, political, and scientific landscapes of these foreign countries in order to stimulate interest in science, to negate anti-American sentiment, to support international relations, and ultimately to achieve the best scientific research possible. Observers at each station held Open Houses, set up exhibits, and taught in local Universities. American observers became unofficial ambassadors of science, technology, and democracy. The paper focuses on the satellite tracking station in Nainital, India. It traces how the field station in India, in addition to the satellite tracking program in general, advanced our understanding of satellite technology, atmospheric composition, astronomy, geodesy, and space exploration. I will touch on how Cold War concerns influenced the role of the SAO in Nainital. The paper addresses the social, political, and technological impact of the Cold War on American and Indian astronomy through an analysis of the SAO satellite tracking station in India.

Shawn Mullet

Institutionalizing Brazilian Science: North American Models and the Formation of the CNPq

When examining the development of science beyond the North Atlantic historians have focused primarily on the role of North American or European individuals or institutions in the shaping of science in countries such as Brazil. Though some have acknowledged the value of 'local knowledge' and its contribution to science, with the exception of a few dedicated historians in countries such as Brazil, relatively little attention has been paid to what role scientists and intellectuals from the country in question played in the shaping of their own institutions. This paper seeks to bridge this historical gap by examining the evolution of Brazil´s National Research Council, the CNPq. Drawing from sources both in Brazil and the United States, this paper will explore how scientists, many of whom received advanced training in the United States, looked to existing institutions in the United States in advocating and instituting a federally funded program to promote scientific research in Brazil.

David Munns

The Challenge of Variations: The Observational Traditions of Ptolemy and Aristotle, and Copernicus' Heliocentric Solution.

Until Galileo's *Dialogue on the Two Chief World Systems* the Aristotelian and Ptolemaic cosmologies existed concurrently but incommensurably in ancient, Arabic, and Renaissance astronomy. Ancient, Arabic, and early modern astronomers could not reconcile either cosmological alternative with observations precisely because the status of the

observations themselves was in doubt. This paper reconstitutes an important long-standing observational tradition which proponents of both Ptolemy and Aristotle regularly deployed to critique their opponents. The Ptolemaic astronomers charged that Aristotelian homocentric spheres permitted no change in the distance between the earth and the planets, yet the phenomenon of planetary variations, especially the change in apparent magnitude of the planets throughout their motions, seemingly revealed such changes. Aristotelians, on the other hand, argued that while Ptolemaic eccentrics and epicycles might account for the phenomenon, it was at the cost of conceding real movements to circles not centered on the earth, and that even if real the predicted changes from Ptolemaic devices did not conform to observations. Thus, a fundamental tension existed between astronomical conceptual systems because the two traditions intersected at the point of observation: the 'true' position of a body necessitated witnessing the moment of maximum brightness or diameter. Surveying and contrasting a diverse range of practitioners, texts, and contexts reveals that both Ptolemaic discrete astronomical observations as well as Aristotelian common-experience observations contributed to Copernicus' cosmological formulation and were a core component of his lifelong devotion to the proposition for a moving earth. Broadly, Copernicus attempted a re-conciliation of not only Ptolemaic mathematical astronomy but also Aristotelian observational astronomy, incorporated both Ptolemaic and Aristotelian observational traditions into his argument for the heliocentric hypothesis.

Tania Munz

Famous Scientists, Popular Beasts: Teaching the Public about Animals in the Works of Karl von Frisch and Konrad Lorenz

In 1958 and 1969, respectively, Karl von Frisch and Konrad Lorenz were awarded UNESCO's Kalinga Prize for the popularization of Science. Although they are better known today for their receipt of the Nobel Prize in 1973 (together with Niko Tinbergen), the Kalinga Prize draws attention to an important aspect of their work – their efforts to teach the public about animals and nature. Both scientists wrote numerous books for lay and popular audiences; gave lectures to cultural societies, schools, and clubs; made television, film, and radio appearances; and served on the editorial board of *Das Tier*, a popular magazine about animals. By the time they received their prizes, they had emerged as two of German-speaking Europe's most important voices on animals and their place in nature. In this paper, I examine how von Frisch and Lorenz sought to teach the public to view animals, how they managed the tension between education and entertainment, and how they positioned themselves with respect to anthropomorphism and the animal-human boundary in these works. I show that this relationship did not constitute a one-way projection from the scientific to the popular domain, but was characterized by rich and mutually informed interchanges of ideas and interpretations.

Jane Murphy

Eighteenth-Century Colonies, Natural History, and Old World Exploration

This paper examines a series of eighteenth-century natural historical investigations in Egypt culminating with the French occupation, 1798-1801, to trace the transformation from exploration into colonization. In particular, I ask how Old World explorations and colonial projects were envisioned in light of the much-heralded achievements of contemporary exploration into unknown territories. How did naturalists argue for the importance of Old World exploration and what impact did centuries of heavy trade, travel, and exchange of commodities and people have on the practices and postures of pre-colonial and colonial natural history in North Africa?

Michael Nauenberg

Huygens "anomalous suspension" Revisited

In the 1660's, Huygens announced that he had failed to replicate Boyle's observation of the fall of a Torricellian column of water inside a receiver which he had evacuated of air by means of a pump similar to the one constructed by Boyle and Hooke. Huygens's result was dubbed "anomalous suspension", and became the subject of considerable controversy at the birth of modern experimental science. From the perspective of the sociology of science, this controversy was discussed by Shapin and Schaffer in their book "Leviathan and the Pump" which received the 2005 Erasmus prize. Based on original accounts, I will present a new historical perspective on this controversy, and provide an explanation, supported by a

modern replication of the experiments of Boyle, Hooke and Huygens, for the long standing unsolved paradox of anomalous suspension.

Jaume Navarro
From Father to Son. The Electron and the Thomsons

In 1928, George Paget Thomson measured the wavelength associated with an electron in his experiments on refraction. This was the first proof of a principle that the French physicist Louis de Broglie had proposed five years earlier in his doctoral dissertation, according to which all particles had a wavelength associated with them. Thus, electrons were the first corpuscles to prove the wave-particle duality. Ironically, it had been his father, Joseph John Thomson, who, in 1897, had first attributed a corpuscular nature to the undulatory phenomenon of cathode rays, in a suggestion that is commonly seen as the discovery of the electron. In this paper I want to discuss the possible influence of J.J. Thomson on his son's early career. After graduating in Cambridge, G.P. Thomson moved to Aberdeen where he had to start a new laboratory of Physics from scratch. J.J. had been in a similar situation when, being a young graduate from Cambridge, he was appointed director of the recently created Cavendish Laboratory, and it is justified to imagine some advice from father to son. Furthermore, the specific direction G.P. gave to his research is not alien to his father's theoretical interests. While he was the first to bring forward evidence for the existence of what he called corpuscles, J.J. always believed that electrons were a corpuscular manifestation of some dynamical process taking place in the ether. The measurement of the wavelength associated with the electron and the dual nature of the particle probably appealed to J.J. as much as to G.P., but for different reasons. To the father, as a proof of the ethereal nature of the electron. To the son, as a contribution to the incipient quantum mechanics.

Nancy Nersessian
Does Cognition Matter to History?

In the 1960's Hanson, Kuhn, and Feyerabend brought insights from history, philosophy, and psychology to bear on the problem of conceptual change in science. At that time the cognitive sciences were in their infancy and the resources they drew from were limited. In the 1980's historians and philosophers again picked up the program of what they deemed "cognitive-historical analysis". The new book by Hanne Andersen, Peter Barker and Xiang Chen provides significant evidence that the "cognitive-historical" method can be fruitful for the history of science. In my presentation I will consider how the problem of understanding conceptual/representational change remains important to the history and philosophy of science and the extent to which cognitive-historical accounts preserve positive features of social approaches to knowledge while avoiding their limitations.

Kristian Nielsen
Postcolonial Partnership: Science, State and Media in the Galathea Deep Sea Expedition 1950-52

The Galathea Deep Sea Expedition 1950-52 combined postcolonial, postwar national interests of the Danish state with scientific ambition and extensive real-time media coverage. In organizing the expedition, scientists and journalists joined forces with the Government to advance field science (oceanography, in particular), to communicate science to the public, and to promote national self-esteem in the immediate post-war period. In the wake of extensive and widespread collaboration with the German occupation forces during the World War II, the organizers promoted scientific expeditions as a way of rehabilitating Denmark's image, nationally as well as internationally. They managed to attract funding from the Government and successfully appealed to Danish expatriates for additional financial support. In order to serve science and national power, the Galathea Expedition included an on-board information department to communicate science to the broader public in national as well as international media and to take care of public relations on the way round-the-world. In particular, the expedition cultivated national relations with Danish communities in previous Danish (trade) colonies such as the Ivory Coast, Tranquebar, the Nicobar Islands, and the West Indies. Moreover, the expedition waved the flag in many other harbors/countries. Indeed, postcolonial flag-waving went hand-in-hand with scientific exploration and science communication. This paper explores the Galathea Expedition and the specific historical circumstances of the postcolonial partnership between science, the state and the media.

Maureen O'Malley

'Everything is everywhere': Beijerinck, Baas-Becking and Microbial Ecology

Microbial ecology, traditionally conceived of as separate from general ecology, has been dominated for over a century by the assumption that 'everything is everywhere' – meaning that microbes have no biogeography or localized patterns of species distribution and that similar environments harbour a consistent range of species. The early sources of this mode of thinking can be found in M. W. Beijerinck's (1851-1931) work in the late 1800s on microbial ecology, which he initially developed during his employment at the Netherlands Yeast and Alcohol Works (Nederlandsche Gist-en Spiritus Fabriek) from 1885-1895. The microbial ubiquity thesis was elaborated on by L. G. M. Baas-Becking (1895-1963) as he attempted to formulate laws for microbial ecology. Between them and Russian soil microbiologist, Sergei Winogradsky (1856-1953), they were responsible for the basic tenets of an ecological approach to microbiology. It involved different methods to the ruling pure culture approach and led to the development of new fields and concepts, such as geobiology and the earth as an interactive ecosystem (Gaia). The presentation will explore the context in which this ecological approach developed and discuss its impact, both on the general microbiology and biology of the late nineteenth century as well as on agricultural and biomedical applications.

Richard Oosterhoff

Did Literalization in Theology Affect Natural Philosophy? Testing Harrison's Hypothesis

In 1998 the Merton Thesis was revamped by Peter Harrison in his "The Bible, Protestantism and the Rise of Natural Science." Harrison's argument is that the 'book of nature' metaphor at the heart of late medieval and early modern natural philosophy suggests how literalism could be transformed from a strategy of interpreting the Bible into one of interpreting nature. This development cut short the chain of indeterminate meanings with which the medievals exegeted the book of nature. Freed from the need to see the world entrapped in secondary and tertiary meanings, natural philosophers could then read nature for its own meaning: modern science was born. The purpose of this paper is to test Harrison's hypothesis against the history of biblical interpretation. We compare interpretive strategies of medieval and early modern Bible interpreters between and within different Christian traditions, and find that the different literal and allegorical strategies of interpreting Scripture do not correspond closely with a Protestant / Catholic divide. There were literal interpreters among Roman Catholic Bible scholars while some Protestant exegetes continued to use typological and allegorical interpretation in addition to literal interpretation. Furthermore, we do not find a close correspondence between literal Bible interpretation and the rise of modern science. These observations are at variance with Harrison's hypothesis. More comparisons of interpretive strategies of medieval and early modern Bible interpreters are needed before Harrison's hypothesis can be rejected.

Takushi Otani

Replication and Redesign of Transistor Manufacturing Through Visual Images in Japan During the 1950s

We know that it is difficult to transfer an advanced technology from one site to another 'without the visual experience of the apparatus' and the instruments' working. In the transfer of transistor technology from the U.S. to Japan, visual experiences were utilized to replicate transistors' manufacturing process. Many Japanese engineers visited U.S. manufacturers' factories and talked with U.S. scientists and engineers to get information about the apparatus and the process for manufacturing transistors. They got information about the instruments' manufacture and apparatus from the visits and conversations, but they observed the work on site to get information about their specifications to replicate them in Japan. They reported their experiences to their companies' headquarters in Japan with many visual images, and engineers and technicians in Japan built their apparatus and instruments into their manufacturing process. In the case of Tokyo Tsushin Kogyo (later renamed Sony), more happened than just replication; transistors' manufacture was redesigned, and a new way was invented. It was necessary to redesign the manufacturing process of the Ge grown-junction transistor in order to make a high-frequency transistor for radio receivers, so a new way was invented.

Sumiko Otsubo

Emperor, Family, and Modernity: The Passage of the National Eugenics Law in 1940

My paper explores the debate behind the passage of the 1940 National Eugenics Law. This act was modeled after the 1933 Nazis sterilization law. I ask why it was passed, even though sterilization threatened the patriarchical family system ideology. Considering that it stressed the continuity of family lineage, claimed that every Japanese' descent from the imperial ancestors, and thus fostered loyalty from subject to emperor, the head of the state Shinto religion as well as its heightened influences in 1940, the passage is extremely puzzling. I am examining the tensions between peculiarly Japanese nativist, religious, and traditionalist ideology and modern science in the parliamentary debate leading up to the passage of this law. How did parliamentarians and bureaucrats debate the science of eugenics and reconcile the traditionalist emperor-centered family state ideology and modern science in the passage of this law? I argue that the Japanese eugenics movement was a distinct blending of the family- emperor ideology and nativist -traditionalist folk myth.

Trevor Owens

A Child's Eye View of Life as a Scientist: Science, Society, and Gender in the History of Children's Biographies of Marie Curie and Albert Einstein

Marie Curie and Albert Einstein are the two most written about scientists in American children's books, having been the subject of several hundred biographies for children over the past sixty years. This paper taps this unutilized resource to cultivate a unique perspective on the history of public understanding of science. This paper explores a historical comparison of the portrayal of gender, the relationship between theory and experiment, and the images of education and authority in children's biographies of Curie and Einstein. Comparing these factors in the children's books against their more authoritative scholarly counterparts this study offers new insight into important themes in the public understanding of science and scientists, concluding that these children's books have and still do hold strong gendered messages about Science and School.

Larry Owens

Science Fiction and the Mobilization of Youth in the Cold War

This paper explores the ways in which young adult literature, from science fiction to textbooks, loosely constituted a genre one can call catechetical and which helped enroll adolescents as citizens of the Cold War "rocket state."

Paolo Palmieri

Replicating Galileo's Pendulum Experiments

Some scholars believe that Galileo was a consummate experimentalist, but some scholars do not believe that he actually did the experiments with pendulums he "vaguely" reports doing, because they argue that the results cannot come out as he said. I have replicated Galileo's experiments with pendulums with a new approach. My apparatus is as faithful as possible to that used by Galileo, although he says very little about it. In addition, it is equipped with modern electronics and data acquisition systems which I use to build a computer model of the apparatus. The computer model allows me to run tens of virtual experiments to explore all the uncertainties surrounding Galileo's original experiments (length of the strings, weight of the bobs, air resistance, etc.). By replicating the experiments with the computer model I have come to the conclusion that Galileo confronted an infinite continuum of possible outcomes. This suggests that the secret behind his "vague" reports lies precisely in the continuum of all possible pendulum experiences.

Cesare Pastorino

The Alchemical Background to Bacon's Proteus

Recently, Francis Bacon's use of the mythic figure Proteus as a metaphor for nature has become something of a cause celebre, thanks to an influential article by Peter Pesic. Unbeknownst to Pesic, however, Proteus had a long history as a trope in alchemical texts, and it is highly likely that Bacon was drawing upon them. One can see this already in Bacon's *De Sapientia Veterum* (*On the Wisdom of the Ancients*, 1609). In Bacon's account, Proteus symbolizes alchemical

matter; only through "vexation", Bacon states, does matter turn and transform itself "into strange shapes, passing from one change to another till it has gone through the whole circle and finished [its] period". The alchemical connotations of Bacon's Proteus are very clear if a passage from his posthumous work *Sylva Sylvarum* is considered in parallel to the previous one. In the *Sylva*, Bacon describes a peculiar process of thermal decomposition taking place into a sealed vessel. According to Bacon, in bodies subjected to this procedure "it is like that this Proteus of matter, being held by sleeves, will turn and change into many metamorphoses". In this paper, I will then try to clarify the alchemical background of the Baconian account of Proteus.

Debasmita Patra

History of Institutionalization of Solid State Chemistry in India: Deriving From a Particular Case

For a sociological study of the formation of a scientific specialty and to understand its dynamics, historical sensitivity is very important. Similarly for a historical study of science, sociological insights are needed in relating science to its context. The present paper is based on a study of an interdisciplinary specialty and its institutionalization of cognitive and organizational dimensions in India. The paper attempts to identify the factors that contribute towards the formation and development of a scientific specialty and its practice in different contexts. To understand the dynamics of solid state chemistry, a research specialty, the paper focuses on a department, that is, the Solid State and Structural Chemistry Unit (SSCU), I.I.Sc. Bangalore. The present study examines how for the first time in India, the SSCU was as a department, exclusively devoted to teaching and research of solid state chemistry was established in 1976 in one of the premier science institutions of India, that is, I.I.Sc (Indian Institute of Science). This study takes into consideration twenty-five years of the establishment of the SSCU, that is, from 1976 to 2001, to understand the dynamics of the research agenda of the scientists and their national and international linkages in terms of collaboration. Analysis of the published works of the scientists of the SSCU over these twenty-five years yielded some quantitative measures to discern the direction of research and the pattern of collaboration. Further, the scientists in the SSCU as well as some of their peers located in other organizations were interviewed to understand the micro level processes relating to interaction and decision making with regard to setting the research agenda and leadership both at the cognitive and organizational levels. The major findings of the study indicate that the scientists, who were recruited with specializations in different sub-areas of sold state chemistry and of physics, brought in different theoretical and methodological skills that led to setting the research agenda of the Unit and in establishing collaborative partnerships with scientists in India and abroad. The charismatic style of leadership of the founder of the Unit and his managerial abilities helped in mobilizing cultural and physical resources to facilitate the research activities of the scientists. The pattern of collaboration suggests that the SSCU scientists, during the period under study, had more collaborative partnerships with scientists located in the advanced countries than they had with scientists in India except within the I.I.Sc.

Andrea Patterson

The Medicalization of Racism: Public Health Policies in the Early-20th-Century American South

This paper investigates the impact of scientific racism on public health care policies for African Americans in the early twentieth century U.S. when the newly emerging sciences of evolutionary biology, microbiology, and genetics promoted ideas of racially based pathologies. Proclaiming a physiological difference among the races, researchers provided scientific justification for already preexisting cultural and social prejudices. Scientists viewed the disproportionately high morbidity and mortality rates among blacks as a consequence of inherent racial deficiencies, rendering any attempt to ameliorate their situation as futile. Instead, in response to scientific research on the laws of heredity, public health officials promoted drastic measures such as involuntary sterilization or abortion among blacks. While the belief in a different pathology in blacks initially deterred most health officials from taking any action to address health crises among African Americans, advances in medicine and microbiology, in particular the germ theory, stirred a variety of responses out of sheer self preservation: fears among whites initiated sporadic and limited actions to improve the health of African Americans at the first sign of an epidemic. Race proved not merely a disadvantage in securing access to prompt and appropriate medical

care, but often became a life and death issue for blacks in the American South during the early decades of the twentieth century.

Sharrona Pearl
Women and People of Colour in the Profession: A Graduate Student/junior Scholar Perspective

As part of this session, I will discuss the challenges facing women in the History of Science during graduate school and the beginning of their careers. I will address such issues as decisions about family planning, relationships with undergraduates and faculty members, and the challenges of finding female mentors and role models.

Nicola Pezolet
Anti-Functionalism and "Nomadic Science": Asger Jorn, Giuseppe Gallizio and the "Mouvement International pour un Bauhaus Imaginiste"

Founded in 1954 in-between Switzerland and Italy by Asger Jorn, the *Mouvement International pour un Bauhaus Imaginiste* (M.I.B.I.) was an informal collective of artists that examined, exposed and attempted to solve the elementary problems - practical and theoretical - inherent to the relationship of art, science and industry. The story of the M.I.B.I. is therefore an attempt to answer one of the fundamental questions which re-emerged frequently over the course of modern art's history: what type of social relationship should experimental artists have with science and technological production? While that specific question had already been tackled directly by the members of the original Bauhaus in 1919, it underwent a very critical reappraisal after World War II. On the one hand, the West German *Hochschüle fur Gestaltung* (HfG), founded by the Geschwister-Scholl foundation in collaboration with the Swiss architect Max Bill, tried to revive the Bauhaus' utilitarian ideal by promoting a productivist approach to pedagogy, science and design, abandoning the idea of the school of design as a place of "self-expression" and "autonomous" artistic experimentation. On the other, the M.I.B.I. explored what historian Joseph Rykwert dubbed the "irrational, strong dark side" of the Bauhaus. Drawing on Gaston Bachelard's philosophical contributions to epistemology and on the practical experiences of modern physicists and chemists as well as on Surrealism, Jorn and his colleagues endorsed the use of technological innovations as tools to struggle against art's increasing alienation from daily life. It adopted a nomadic structure and, with the help of Giuseppe Gallizio and of local Italian industrialists, promoted a playful, radically anti-functionalist relationship to industrial production and architectural design. This paper will take as its starting point the polemic between Asger Jorn and Max Bill over the Bauhaus' historical heritage. It will then analyze the specific tactics used by the members of the M.I.B.I. in order to promote an anti-utilitarian understanding of science and industry, tactics that were ultimately presented in Jorn's now famous collection of essays *Pour la Forme: Ébauche d'une Méthodologie des Arts*.

Jahnavi Phalkey
Urgent and Highly Important: The Organisation of Nuclear Research in Postwar India (1946 -1948)

This paper looks at the history of the Indian Atomic Energy Commission (IAEC) policy on the organisation of nuclear physics research from its inception in 1946 until 1948, when the Atomic Energy Act was introduced in India. India was independent of British colonial rule in 1947 and IAEC policy on organising nuclear research was already being implemented before independence. The shape that modernisation would take in the new India was fervently contested in an atmosphere of serious debates around the organisation of nuclear research following the use of the atom bomb on Hiroshima and Nagasaki. The scientific community debated their stake alongside discussions in the political domain amidst speculations about the potential of atomic energy for civilian use and the dangers of weapons proliferation.
It is my intention to draw together the pressing concerns of the newly independent country as expressed through debates on the organisation of nuclear research by physicists, science administrators and political representatives; Particular attention will be given to the international references within which the IAEC policy was shaped - in terms of designs by example for organising research, that is the discussion on which model was suitable for Indian interests as well as the context of post-war international politics.

Kathryn Plaisance

Fisher v. Fisher: The Origins of Analysis of Variance in the Biological and Behavioral Sciences

Analysis of variance (ANOVA) is well-known to be a central tool for the study of population, quantitative, and behavioral genetics. However, the use of ANOVA in human behavioral genetics has received much criticism, both from philosophical and scientific approaches. In the philosophical literature, ANOVA is often criticized in the spirit of Richard Lewontin's seminal 1974 paper, "The analysis of variance and the analysis of causes"; in addition, other scientists (e.g., agronomists) have criticized the non-experimental use of ANOVA in twin and adoption studies. In this paper, I argue that attending to the specific history of Ronald A. Fisher's development of ANOVA can shed light on understanding its use in human behavioral genetics and can demonstrate an important connection between that use and its use in experimental biology. In particular, I emphasize the difference between two of Fisher's papers, one written in 1918 that introduced the theoretical basis of ANOVA specifically for use with humans, and the other in 1923 which demonstrated an experimental ANOVA on plants. (Interestingly, textbooks relevant to human and quantitative behavioral genetics cite the 1918 paper as the origin of ANOVA, while books on agronomy, population genetics, and even statistics cite the 1923 paper as the starting point.) By acknowledging the difference between these two papers, and thus two different historical trajectories with respect to ANOVA, we gain some insight as to how Fisher intended ANOVA to be used in human behavioral genetics. Furthermore, reconsidering the development of these two papers illustrates a connection between the uses of ANOVA in experimental and non-experimental disciplines, which Fuller and Thompson (1960) discuss in the first textbook written for behavioral genetics.

Rachel Ponce

Murder, Passion, and Insanity: Rationalization and Pathologization in Late-Nineteenth and Early-Twentieth Century France and the United States

The *crime passionel* is, in many ways, a peculiarly French concept. Originating in the nineteenth century, it was a highly ritualized category of crime that was both romanticized and criticized by contemporary observers. The crimes themselves, however, were not entirely culturally contingent. The features that typified the crime of passion--its tendency to occur among couples or within families, to involve the potential ruin of one or both parties, and to frequently position itself as a means of justice where no legal recourse would be available to the injured parties--were more or less universal. In fact, it was exactly this sense of the universality of both the situations and emotions they produced that underpinned the legal leniency of the French in such cases. Using the French model as a point of departure, this paper explores how crimes of similar circumstance were conceptualized in an entirely different framework in the United States. Sympathy still existed for the perpetrator of a crime committed whilst influenced by powerful emotions, but the rhetoric of normalcy was very short-lived in the United States. By the middle of the nineteenth century, emotional impulse was becoming highly pathologized by the American medical community and the press. Acquittals for such crimes were obtained through the rubric of insanity, not normalcy. My paper explores the legal appropriation of medical rhetoric and subsequent shifts in medical conceptions of emotion, disease, and criminality. My conclusion also suggests how pathologizing emotion may have played an important role in increasing public skepticism toward medical notions of insanity in the late nineteenth and early twentieth century United States.

John Powers

Alchemy at the University: Herman Boerhaave's Lectures at Leiden

For three decades (1709-38), Herman Boerhaave was the heart of the University of Leiden medical faculty. He set the intellectual agenda for medicine, teaching every major subject and producing hundreds of students. Yet most of the time that he devoted to research was spent reading and experimenting in alchemy. He first practiced in a small laboratory that he set up at his residence, but when he became Professor of Chemistry in 1718, he moved his experiments to the university's chemical laboratory in full view of his students. Despite modern views of alchemy as a pseudo-science practiced by secretive quacks, Boerhaave clearly saw alchemy as a legitimate part of chemistry, natural philosophy, and medicine. This paper will examine how Boerhaave deployed alchemical knowledge in his university lectures on chemistry and medicine to promote larger philosophical and pedagogical agendas. I will focus on two specific items: the

essentially alchemical theory of metals that Boerhaave presented in his chemistry courses and Boerhaave's analysis of urine, which he discussed in his lectures on the "Institutes of Medicine," but which derived from earlier alchemical experiments on dissolving gold. The first provided Boerhaave with a useful way to organize the metals for pedagogical presentation, and the second allowed him to attack a predecessor's competing physiological theory. Ultimately, I will argue in support of recent work in early modern chymistry that most 17th and early 18th century chemical practitioners did not make modern distinctions between chemistry and alchemy, except in specific rhetorically-charged contexts. In fact, sources that we now see as "alchemical" often contained the knowledge and approaches most useful to early modern chymists and physicians.

Joel Press

What Leibniz Failed to See in Locke's Conception of Space

Leibniz and Newton famously clashed over the nature of space. Newton held that space is a really existing thing over and above the physical objects it contains, and against which such objects can be said to be absolutely in motion or at rest. Leibniz, on the other hand, argued that space is not real, but merely an instrumentally useful way of organizing certain sorts of relational facts that hold between normal physical objects. Each seems to have regarded these two positions as, if not mutually exclusive, at least the only serious alternatives. However, in *An Essay Concerning Human Understanding*, Locke implicitly allows for such an alternative. While Locke would have agreed with Leibniz that space is relational, not absolute, he nevertheless explicitly accepts the possibility that space is real, not instrumental. In other words, unlike Newton or Leibniz, Locke appears to have recognized that the absolute vs. relational controversy is distinct from the real vs. instrumental controversy. Though Locke was dead before the Newton-Leibniz controversy began, and though his remarks on the subject are only a few pages in a book devoted primarily to philosophy of mind rather than natural philosophy, the fact that Locke recognized the possibility of a space that was both real and relational is interesting for a couple of reasons. First, since contemporary physics rejects Newton's postulation of an inertial frame at absolute rest, and since philosophers of physics have pointed out that even Newton's own theory is really most naturally viewed in a space-time structure that lacks such an absolute frame, one can no longer reasonably be a realist about space (or space-time) without believing that one can be a realist about a merely relational space (or space-time). At the same time, other aspects of contemporary physics do appear to offer strong reasons to be a realist about space-time. Though Locke's remarks are much too sketchy and ambivalent to constitute a priority claim for this important possible conception of space, it is interesting to note that he allowed for it long before its importance was recognized. Second, because of Leibniz's *New Essays on Human Understanding*, which is a section-by-section critique of Locke's *Essay*, we know that Leibniz himself carefully and critically read and commented on Locke's passages on space, apparently without recognizing the coherence of simultaneously being both a realist and a relationalist about space. Furthermore, since the *New Essays* were published before the relevant portions of the Newton-Leibniz controversy got underway, we know that Leibniz had been exposed to Locke's writings on the subject prior to his contribution to the controversy. However, as was mentioned above, neither Leibniz nor Newton appears to have given any consideration at all to the possibility Locke recognized. This suggests that, for whatever reason, Leibniz was completely unaffected by his reading of Locke on this matter. It is puzzling that such a remarkable intellect as Leibniz could stare directly at what many contemporary physicists and philosophers of physics would consider the truth without even seeing it as a possibility distinct from his own or Newton's.

Robert Proctor

Why Have So Many Medical Historians Been Working For the Tobacco Industry As Expert Witnesses? And How Does Defense Expert Testimony Differ from that of Plaintiff's Witnesses?

Since the 1980s at least 34 academic historians have served as expert witnesses for the tobacco industry in litigation. Only 3 historians have testified against the industry. The industry has organized elaborate networks to recruit historical talent, through organs such as Philip Morris' secret "Project Cosmic" but also through bodies such as the "Special Trial Issues Committee" (STIC) organized by the National Counsel of the industry to coordinate litigation defense strategies. Among those historians who have testified for the tobacco industry are prominent historians of science and/or medicine,

including Kenneth Ludmerer, Jon Harkness, Robert P. Hudson (now deceased), and Peter English. Others work as consulting experts, keeping a lower profile. Several of these medical historians have earned many hundreds of thousands of dollars testifying for the industry. The industry recruits such talent primarily to make the argument that while the hazards of cigarettes have long been known, establishing such hazards has been difficult. Here I compare and contrast the historiography used by defense and plaintiffs experts in tobacco litigation, looking also at the ethics and publication impact of such testimony. I'll also draw from my own experience as a plaintiffs' expert witness in tobacco trials over the past decade and talk about how industry agendas have permeated scholarship in previously unrecognized forms.

Katie Proctor
Selling American Optics: Clark Telescopes and the Uses of Science

In the years between 1844 and 1896, the optical instrument-making firm Alvan Clark and Sons built hundreds of telescopes, including the world's largest five times over. In this same period, Alvan Clark and his two sons, Alvan Graham and George Bassett, are credited with discovering upwards of fifty double and triple stars. Observers around the globe used telescopes of Clark manufacture to discover many more. This paper examines how the discoveries made by the Clarks and their clients were used to promote the rapid growth and remarkable success of the Clark enterprise. Through this analysis, I will show that the 'pure science' for which Henry Rowland pled was transgressed not only by scientists seeking to profit from applications of their abstract work, but also by craftsmen who moved in and out of scientific realms for their own ends.

Helena Pycior
The Pioneering African-American Research Scientists: Superimposed Callings to Research, Teaching, and Service

This paper is part of a larger project on the lives and career patterns of the pioneering African-American research scientists and mathematicians ("PAARSAM"). These scientists received advanced degrees from roughly 1900 through the early 1930s. The paper studies the PAARSAM through the interpretive framework of superimposed callings to research, teaching, and service. The framework comes from an essay, "On Being Scientist, Humanist, and Negro," that Percy L. Julian (one of the PAARSAM) published in 1969. Julian's thesis was that, unlike their European-American counterparts, early-20th-century African-American scientists were largely denied the opportunity to immerse themselves in research. The PAARSAM found their professional calling to research blunted not only by the heavy teaching demands of the historically African-American colleges and universities but also by social pressure to perform humanitarian service for their race. Using case studies to probe how the PAARSAM viewed and negotiated the calling to service, the paper analyzes their engagement with social activism as well as their pursuit of applied science, scientific outreach, and scientific popularization.

Sean Quinlan
Monstrous Births, Medical Networks, and Obstetrical Authority in France, ca. 1780-1820

In France, between roughly 1780 and 1815, provincial doctors opened a broad correspondence with medical faculties and public officials about severe foetal anomalies, or what contemporaries called monsters. Using extensive archival records found at the Académie Royale de Médecine, the Société de l'Ecole de Médecine, and Assistance Publique, this paper shows how this medical correspondence gives an intimate insight into changing medical practices and values, by showing how doctors encountered monstrous births in their daily practice. Indeed, medical reports reveal a slip between theory and practice, underscoring that monstrous births raised scientific, ethical, and emotional issues that doctors were unable to resolve. In their correspondence, doctors wrote about monsters in four ways: to discuss case studies and specimens; to explain embryological development (what was called generation); to conduct forensic inquests; and to deal with obstetrical complications. These four genres were interconnected and tell a broader story. Here, institutional and legal reforms in prerevolutionary and revolutionary France caused doctors to encounter monstrous births with greater frequency. In response to these demands, doctors developed new ideas about heredity and embryology to explain congenital malformations and to satisfy the public officials who wanted answers. Though doctors achieved some consensus on etiology and pathology, they struggled to apply these ideas in real-life situations, especially when they dealt

with cases of doubtful sex. In these instances, state interests and medical interests did not always correspond, as doctors mistrusted personal motivations and testimonies, particularly on the part of their rural colleagues. At the same time, medical networks allowed doctors to raise new obstetric questions, as new licensing regulations forced ordinary practitioners into direct (and deeply disturbing) encounters with anomalous births, encounters that they had not known before. In the wake of these changes, the paper concludes, doctors developed a new ethics for treating monstrous children, viewing them separately as pathological specimens, forensic objects, and obstetrical tragedies.

Mary Quinlan-McGrath
The Visual Arts and Astrological Practice

This paper will suggest ways that astrological practice worked within the visual arts in Renaissance Italy. Learned astrologers were called on both to help create visual programs for fresco cycles, as well as to astrologically fortify visual objects ranging in scale from the macro to the micro.

Sheila Rabin
Giovanni Pico della Mirandola and the Kabbalah

Pico wrote his first major work, the *900 Conclusions* in 1486. In the work he made extensive use of Kabbalah and initiated what Wirszubski and Copenhaver have called the beginning of a true Christian Kabbalah. Pico called attention to the Kabbalah in his *Oration*, which was intended to introduce the *Conclusions*. Three years later he published *Heptaplus*, a Christian kabbalist interpretation of the creation story in Genesis. While most Jewish kabbalists supported astrology, so did many of the Christians, like Albertus Magnus and Thomas Aquinas, whom Pico claimed supported his anti-astrology stance in the *Disputations against Judicial Astrology*. This paper will examine the changes in Pico's attitude toward Kabbalah from the *Conclusions* to the *Disputations*.

Gregory Radick
The Reactionary Origins of the Chomskyan Revolution:
The Unmaking of a Modern Synthesis

As part of a wider "Cognitive Revolution," Noam Chomsky's program for the scientific study of language had a major, transforming impact on linguistics and neighboring human sciences. In this paper I offer a new interpretation of the origins of that program. I shall argue that, in important respects, it can best be understood as a comprehensive repudiation of another, already existing, ambitiously synthetic program, due to the then-rising star in American linguistics, Charles Hockett. Where Hockett, a self-conscious follower of the unity of science movement, argued for an information-theoretic account of grammar, a stimulus-response account of language acquisition, and a comparative, evolutionary approach to human language and animal communication, Chomsky gradually came to take vigorously contrary stances on all three issues. With this new view of the origins of Chomsky's program in place, the old question of why that program comprises the elements it does finds a biographical and disciplinary answer. Moreover, the program as a whole is revealed – contra Chomsky's own historical writings – as belonging intimately to the linguistics of its time and place. Finally, Chomsky on this analysis emerges not, as he is often presented, as one of the great scientific unifiers, but as one of the great disunifiers.

Ronald Rainger
Radioactivity and Experimentation in Southern California

In the 1950s work with radioactivity transformed the Scripps Institution of Oceanography. The laboratory's new director, Roger Revelle, drew on his close ties to military and other federal agencies to promote radiological research on several fronts. In addition to hiring new personnel and creating new laboratories, Revelle organized expeditions linked to nuclear weapons tests. Scripps quickly became a center for research on tracers, isotopes, and the effects of radioactivity in the oceans and the atmosphere. Revelle and others defined their activities as experiments, particularly in the case of weapons tests and increasing carbon dioxide in the atmosphere. Drawing on that work Revelle also sought new institutional experiments. In the mid 1950s he established close institutional ties between Scripps and General Atomic, and set out to

create a new, experimental university in which radiological research would play a prominent role.

Chitra Ramalingam

Sparks, Striations, and Radiant Matter – Inside the Early Vacuum Tube

The luminous effects of electrical discharge in a vacuum are exotic and stunning. In Victorian London a small, eclectic group of physical researchers outside the university system attempted to achieve mastery of these colorful electrical phenomena. These men – among them William Grove, John Gassiot, William Spottiswoode, and William Crookes – learned to manipulate and map the glowing landscape inside the vacuum tube in an attempt to resolve deeper concerns about the nature of electricity, light, and matter. They also generated ever more complex and bizarre luminous patterns, treating the tube as a medium for virtuostic aesthetic production irrespective of any theoretical insight. This paper examines the questions asked and techniques used by these investigators, in order to pose some larger questions about shifting visual regimes in late-nineteenth-century physics and the transition to the "electronic."

Brigit Ramsingh

Making History: A. Linton Davidson and the Story of the Canadian Food and Drug Directorate

Capturing the history of large public institutions can be a daunting task for historians due partly to the size and mandate of their chosen organization. The history of food and drug control in Canada had an early voice in the mid-twentieth century as told by A. Linton Davidson (1888 – 1950), a senior public servant in the Food and Drug Division of the Department of National Health and Welfare. Davidson, a pharmaceutical chemist by training, took it upon himself to chronicle the early history of food and drug administration in Canada, beginning with the original Adulteration Act of 1875 (which was superseded by the Food and Drugs Act of 1920) up to the end of the Second World War, when developments in the sciences of food hygiene, pharmacology and biological chemistry prompted reorganization of the Division's national and regional laboratories. His publications included historical accounts such as: *Canada Pioneers in Food and Drug Control: The Story of the Food and Drug Directorate* (1949), *The Genesis and Growth of Food and Drug Administration in Canada* (1949), as well as the edited series, *Food and Drug News*. Davidson's initial set of narratives serves not only as a starting point for framing the early history of Food and Drug Control in Canada, but also as a case study for larger historiographic questions such as: *who* decides to tell the story, and *how* does one construct institutional narratives?

Renee Raphael

Accepted by Mathematicians and Confirmed by Experiments: An Investigation of 17th-Century Attempts to Verify Galileo's Science of Motion through Experiment

In his 1687 *Principia*, Isaac Newton (1642-1727) pointed to the accomplishments of his predecessors to affirm the three laws of motion presented at the start of the work. According to Newton, the principles he set forth were "accepted by mathematicians and confirmed by experiments of many kinds." First in the list of mathematicians named by Newton was Galileo Galilei (1564-1642), to whom Newton gave special attention for the claims he had made in his 1638 *Two New Sciences*, particularly the time-squared rule of acceleration and the statement of the parabolic path of projectiles. This paper will explore the experimental activity carried out to investigate Galileo's claims about local motion from the publication of the *Two New Sciences* in 1638 to Newton's writing of the *Principia*. Through investigation of a myriad of instances, from the texts of individuals, including Marin Mersenne and Pierre Gassendi, to the work of the scientific societies, such as the Accademia del Cimento and the Royal Society, the nature of 17th-century experimentation and the fate of Galileo's science of motion will be examined. By focusing on the conditions of experimentation, the language in which results were communicated, and the relationship sought by natural philosophers between theory and experiment, this study will speak not only to the more specific literature focused on 17th-century mechanics, but also to recent work on the "experience-experiment" thesis, including that of Peter Dear and Lorraine Daston.

Nicolas Rasmussen

Amphetamine and the Reinvention of Depression, 1935-1955

Contemporary critics of the pharmaceutical industry often suppose that practices like 'disease mongering', the reinvention and marketing of illnesses (particularly mental conditions) to sell new drugs, are a recent problem. Examining the

invention and initial marketing of amphetamine as the first 'antidepressant' in the 1930s, I will show that the same basic set of tactics was in place two generations ago, including the manipulation of the research literature to shape medical opinion. Furthermore, the profile established in marketing amphetamine then helped define all subsequent antidepressants, and had long term consequences for knowledge in the current understanding of depression as characterised by 'anhedonia' and failure of reward mechanisms.

Amanda Rees

Working with Beasts: Animal Societies in 20th-century Popular Culture

In the immediate aftermath of WWII, the study of animal societies began in earnest, motivated by the intertwined desires both to record the behaviour of wild-living animals before they were eradicated by the global spread of industrial and urban development, and to seek in the structures of such natural societies the solutions to the devastating social problems caused for human communities by those same 'unnatural' processes. From the outset, then, behavioural biologists working in the field had to face the fact that their work had direct political consequences, both in terms of animal survival and in terms of the ways in which wider public and intellectual cultures made use of their work. Perhaps in an attempt to retain direct control over the circulation and interpretation of their own work, wildlife biologists have also consistently produced popular accounts of their research for public consumption, an unusual strategy in the wider context of professional scientific culture in the latter half of the 20th century. This paper will examine a number of these narratives, based on studies involving a range of mammalian species. It will demonstrate how these accounts have been constructed so as not only to convey information about animal behaviour, but also to encourage the development of a sense of moral community between humans and animals. It will outline the way in which the array of contextualising detail about the problems and pleasures of studying animals in the field is used to establish and retain the location of scientific authority even as the audiences are encouraged to believe that this sense of acceptance by another, animal, society, is something that they too could achieve. In conclusion, this paper will show how politics, personality and privation intertwine in these attempts to bring wild animals into the imagination of urban households.

Michael Reidy

Joseph Dalton Hooker and Verticality in the Mid-Nineteenth Century

This paper examines the Himalayan adventures of Joseph Dalton Hooker, who explored several passes between Nepal and Tibet, and attempted to scale Kinchinjunga, then thought to be the highest peak in the world. Not only was Hooker the first naturalist in history, including Darwin himself, to collect in a new world armed with the theory of evolution through natural selection, but Hooker also traveled as an agent of the Crown. He reported, for instance, on the possibilities of cultivating cotton, tobacco, and sugar, a duty he performed as an economic botanist, and he produced an exceptionally detailed map of Sikkim, published by the Indian Trigonemtrical Survey and subsequently used for numerous political campaigns. As historians have noted, in Hooker one finds the perfect blend of naturalist and imperialist. Yet, Hooker's Himalayan Journals is a mountaineering narrative more than it is a botanical hunting narrative. Hooker mixed a scientific eye for different plants at different altitudes with harrowing adventure, including near death experiences, his captivity by Sikkim authorities, and the exhilaration of being the highest European on the globe. Attaining elevation is the one string that pulls his narrative together. From the beginning – and Hooker does not keep this at all secret – he wanted to climb, and climb HIGH. I will argue that a vertical orientation guided Hooker's scientific research program in the Himalaya, one that matched his and his country's synoptic – and concomitant imperial – ambitions in the mid-nineteenth century.

Carsten Reinhardt

Knowledge as Expertise. The Interactive Development of Analytical Chemistry and the Juridical System in Germany, ca. 1850

In the middle of the nineteenth century, analytical chemistry reached a level of development that permitted its application not only in chemistry itself, but also in neighboring fields such as forensic science, agriculture and toxicology. At the same time, the German juridical system changed from a closed, inquisition-like procedure to a public jury system. In this

process, chemists displaced physicians as expert witnesses at court, arguing that the analytical methods of their science enabled them to reach impartial and objective knowledge—in contrast to the narrative case descriptions of medical doctors. The aim of this talk is to show the interactive emergence of analytical chemistry as a sub-discipline of chemistry and the newly reached status of chemists as experts at court. Drawing on the German situation in the middle of the nineteenth century, I argue that the juridical system and analytical chemistry interacted in ways that were crucial for the development of both sides, and led to the emergence of a new type of scientist, the public chemist.

Susan Rensing
Teaching Women, Gender, and Science at Mississippi State

As a new assistant professor of American women's history and the history of science and technology at Mississippi State University (a southern, land-grant, research university), my comments for this workshop would be directed at the process of tailoring a women, gender, and science course to fit the institution where I teach. In particular, I will be incorporating much more history of women and science in the south, which has been understudied, so I will be exploring new source material and assignments for this. Also, I am attempting to design several suitable teaching sources on African-American women in science and technology, in addition to the sources on race, gender, and science more generally. Broader pedagogical questions that I will want to address concern the extent to which gender can be incorporated into women, gender, and science without a loss of content on women in science, in particular at a school with a rather conservative student body.

Andrew Reynolds
The Power of Metaphor: The Cell as Metaphorical and Literal Factory

From its inception the concept of the cell has been based upon metaphor, and the history of the development of the cell theory is one of alternative metaphors and analogies. While some, like the original metaphor of a small space enclosed by a rigid wall, are chiefly static and morphological, others are dynamic and emphasize cellular activity and function. Emphasis of cell activity and function has been most successfully enabled through metaphors drawing analogies with human economic activities and systems. This paper looks at the characterization of the cell as a chemical factory or laboratory within the context of early and modern biochemistry, and how it has resulted in the literal conversion of cells into chemical factories for the synthesis of commercially valuable bio-products. That metaphor can result in tangible modifications to materials in the living world, beyond alterations in how we conceive or classify them, adds a dimension seldom noted in discussions of metaphor in science.

Joan Richards
From Matter to Spirit: Language and Meaning in the World of Sophia De Morgan

Sophia De Morgan's 1863 book *From Matter to Spirit*, moves quickly from an attempt to justify experiences like table turning and spirit rapping to developing a cosmology that would make sense of them. This effort forced Sophia to face a cacophony of voices from sources that ranged from dying children to Plato, illiterate housemaids to the Bible. Crucial to her attempts to make sense of the bewildering variety of their utterances was a theory of language and meaning with which she could create coherence. By the end of her book Sophia had developed a complex cosmology that made a seamless whole of the physical universe, the spirit world and the words with which they were described. Sophia's use of language as a path into a full understanding of the universe was a highly original contribution to a tradition in which she had been raised since childhood. Her father, the radical Unitarian William Frend, had also seen language as the key that opened both the physical and the spiritual universes. Her husband, Augustus De Morgan, understood much of his mathematical and logical work as a next step in the development of the linguistic approach that had grounded his father-in-law's world. Throughout her life Sophia remained deeply committed to both of these men, but her view of language, meaning and the universe constituted a radical, feminine challenge to the tradition that had essentially shaped their lives.

Edward Richards, Jr.

Securing the Conceptual Foundations of Newton's Mechanics: The Case for a Post-Principia De Gravitatione

The Newtonian manuscript known as *De Gravitatione* has been of significant interest to philosophers and historians of science since it was first published in 1962. Though unpublished by Newton, *De Gravitatione* is the only extant work in which Newton argues explicitly against the ontology of Descartes, and thus provides insight into Newton's rejection of the relational concepts of time, space, place, and motion. Like the majority of Newton's manuscripts, *De Gravitatione* is undated. The determination of a date of composition has been contentious: some have argued that *De Gravitatione* was composed by Newton in his early student days, while others have argued that it was composed as a precursor to the composition of the *Principia* Contrary to these pre-*Principia* datings, this paper will argue that Newton composed *De Gravitatione* in response to a critical review of the *Principia* published in the *Journal des Sçavans* (August 2, 1688). This later dating of *De Gravitatione* fits well with the report of Coste concerning the divine creation of body, and the observations of modern scholars concerning the concepts of pressure and of composite body in *De Gravitatione* In addition, this later dating illustrates that Newton was worried about the conceptual foundations of his worldview, belying one of the rallying cries of the later Newtonians.

Jessica Riskin

Mechanical Christs, Hydraulic Brutes and the Invention of Consciousness

This paper begins with two sorts of machines that drew travelers and provoked discussion across Europe from about the early fifteenth century: religious automata in churches and cathedrals (such as the automaton Christ, the Rood of Grace, at Boxley Abbey in Kent) and palace waterworks such as those described by Montaigne, Evelyn and others, which enacted elaborate scenes and drenched the unwary. These cathedral automata and palace fountains were designed as sights to be visited in the public spaces of the city and the court, and therefore featured on the itineraries of philosophical travelers. The paper will move from these machines and the conversations they generated to the philosophical conceit of the animal-machine as it emerged during the mid- to late 17th century. I will argue that the animal-machine was already a familiar image in both religious and secular settings as well as in philosophical and theological writing, and therefore not a radical idea in itself. But this very familiarity made it ideally suited to serve as a vehicle for some closely associated ideas that were much more radical: Descartes's mechanist epistemology and the notion of consciousness as the basis of selfhood.

Peder Roberts

The Norwegian-British-Swedish Antarctic Expedition and the Making of Modern Scientific Internationalism

The Norwegian-British-Swedish Antarctic Expedition (1949-52) is frequently considered a prototype for the international scientific cooperation that defined the International Geophysical Year (1957-58). Funded largely by Norway with contributions from the British and Swedish governments, and personnel drawn from all three nations, the expedition reinforced Norwegian territorial claims while advancing particular research agendas. The aim of this paper is to examine the public discourses that the expedition generated and consider how the expedition's stakeholders created a new image of polar exploration suited to the unstable geopolitical context of early Cold War international relations. Unlike earlier expeditions that featured multinational crews under a single flag, the NBSAE was presented as a formalized joint venture between nations, reflecting a broader trend toward recognition of constituent states within international organizations. These discourses drew also on established rhetorical strategies privileging science over other motives for exploration, notably territorial acquisition or attaining geographical goals (such as the South Pole). I conclude that discourses generated by the expedition attempted to break connections to pre-war modes of Antarctic exploration by emphasizing its novelty and modernity – embedded in organizational structure, field practices, and relevance to overarching scientific questions (notably glaciology and climate change). As a result, the NBSAE became the idealized exemplar of a new form of international scientific exploration.

Libby Robin

Science for a Country in Crisis: Conservation Biology in Australia 1950-2006

In 1985, Michael Soulé, defined the 'synthetic new discipline' of conservation biology as a 'crisis discipline', that demanded a new sort of science. He commented that: 'In crisis disciplines, one must act before knowing all the facts; crisis disciplines are thus a mixture of science and art, and their pursuit requires intuition as well as information'. In this paper I will examine the nature of crisis in a first-world society and how it has shaped the local forms of conservation biology in Australia in the period from the boom development years of the 1950s until the present. Key figures will include Francis Ratcliffe, Officer in Charge of the CSIRO's Wildlife Survey Section (from 1949) and foundation member of the Australian Conservation Foundation (in 1965), A.J. (Jock Marshall), Foundation Professor of Biology at Monash University (1961) and author of *The Great Extermination: A Guide to Anglo-Australian Cupidity Wickedness and Waste* (1966), and current conservation biologists, including David Lindenmayer and Mark Burgman, authors of *Practical Conservation Biology* (2005), who are concerned with protecting biodiversity in one of only two 'megadiverse' nations with a first world economy.

Sage Ross

Natural Philosophy Images: Pedagogy and Popular Science in America

High school natural philosophy, physics and chemistry textbooks in 19th- and early 20th-century America occupied a critical niche at the border of pedagogy and popularization. Science education matured and gradually broke from the British mold as public education became a significant force in American society, laying the groundwork for the self-image of a nation of pioneering scientists and inventors that replaced the frontier mentality. In particular, the visual conventions governing the introduction of scientific concepts to a lay public in textbooks and science magazines—often precisely the same images, produced by the educators and amateur scientists—signified and helped shape the place of science and technology in the American culture. As the growth of the printing industry enabled more numerous and complex images, two distinct styles of illustration emerged: one, consonant with educators' emphasis on the moral and practical value of science in daily life, emphasized context with richly detailed conceptual illustrations; the other, favored by the university scientists who were increasingly important as textbook authors, emphasized the mathematical and geometrical connections between image and text. This bifurcating trend accelerated as the cutting-edge in science and technology became increasingly opaque to the untrained observer, yet increasingly crucial to "modern times" in the early 20th century.

John Rudolph

Epistemologies in Conflict: Scientific Supply Companies and the Biology-Education Reforms of the 1960s

The launch of Sputnik and the national-security anxieties it triggered with respect to Soviet advances in scientific training brought science education front and center in the public consciousness of the late 1950s. One of the key federal responses to the perceived crisis was the passage of the National Defense Education Act (1958), which provided $280 million to equip the nation's classroom and led to a scientific-apparatus boom of unprecedented scale. The resulting era of apparatus manufacture and distribution in the 1960s provides the context for examining how the material components of science classrooms embody ideas and assumptions about scientific epistemology. This paper examines two important sources of school apparatus at the time, those developed by the university researchers working on the Biological Sciences Curriculum Study (who were pushing for dramatic reforms centered on experimental biology) and the biology-related materials produced commercially by more traditional scientific supply companies. A comparison of the products of these two groups reveals widely divergent views of the basis of knowledge construction in science and contributes to our understanding of the factors that influence the public portrayals of science in schools.

Micah Rueber

In One End and Out the Udder: Vitamins, Oleo Margarine, and American Dairy Science

In the early 20th century researchers discovered the important, even vital, role that vitamins and minerals play in nutrition. By the 1920's dairy scientists debated how to incorporate these new findings into their work. Agricultural

experiment station bulletins and circulars publicized the ensuing debate between scientists who clung to 19th century notions of cattle feeding and those who insisted that these new developments required a re-conceptualization of both cow and milk - that vitamins and minerals effected not only the well-being of the cow but also the qualities of the milk that the cow produced. Dairy farmers, eager for any advantage in their war against oleomargarine, entered the fray; they believed that advertising the nutritional benefits, i.e. the vitamin content, of butter would lead to greater sales. Thus, this examination of the introduction of vitamins to dairy science not only illustrates the internal tension between competing scientific theories but also shows how external factors can influence scientific debate.

Andrea Rusnock

Counting in the Clinic: Medical Statistics and Hospital Medicine

The emergence of hospital medicine in the decades around 1800 proved critical to the development of medical statistics. Hospitals provided an institutional framework for the collection of numerical data about mortality and therapeutic efficacy. This paper will focus on the collection and use of smallpox vaccination statistics in London and Paris hospitals in the first decades of the nineteenth century. Traditionally, Pierre Louis is credited with developing medical statistics in the 1820s with his work on the efficacy of bloodletting in the treatment of typhoid fever. This paper will demonstrate that physicians and mathematicians made significant contributions to medical statistics in their evaluation of smallpox vaccination in the two decades prior to Louis' work. It will draw on pamphlet literature and reports (especially from the Comite Central de Vaccine) that related the conditions and results of clinical trials, and it will examine the analyses of these data, such as those presented in the work of the French mathematician E.E. Duvillard.

Alexandra Rutherford

Inside the Human Skinner Box

Human behavior is the subject of greatest interest and if I had had the facilities I should have used species closer to it than rat or pigeon.
-B. F. Skinner to Bob Bailey, June 17, 1977
Skinner Papers, Harvard University Archives
In the history of experimental psychology, perhaps no piece of apparatus is as well-known as the eponymously-named "Skinner box" designed by Harvard psychologist B. F. Skinner. Findings from controlled experimental analyses of rat and pigeon behavior conducted within the operant chamber formed the core of his science and technology of behavior. However, Skinner occupies a unique role in the history of psychology - not because he invented laboratory apparatus - but because his strict scientism ultimately gave way to a wide-ranging social philosophy despite the fact that he never conducted experiments with humans, nor did he apply his methods directly to the study of human behavior. Others, however, did. In this paper I draw on archival material, interviews, and published sources to describe and analyze the work of three Skinnerian psychologists - Charles Ferster, Ogden Lindsley, and Sidney Bijou - who constructed human-sized Skinner boxes to expand the range of the operant project. In the case of Ferster and Lindsley, I highlight the influence of Skinner's Harvard Pigeon Lab on their research with humans. In the case of Bijou I emphasize his delayed conversion to the Skinnerian approach and his influence in moving basic research "beyond the box" into natural settings. In each case, however, I argue that the physical design of the operant chamber "writ large" impacted each man's thinking about human behavior and how to study it from the ground up.

H. Darrel Rutkin

Why Newton Rejected Astrology: A Reconstruction

It is a striking fact that there are no horoscopic figures or calculations among the millions of words and numbers Isaac Newton (1642-1727) left behind in both manuscript and print. Indeed, there is virtually no discussion about astrology whatsoever. Although this silence may seem normal to a modern sensibility, it is still unusual and in need of explanation for even a late seventeenth century mathematician and natural philosopher, especially when practicing or reforming astrology was still a normal activity for such great scientific lights at Tycho Brahe, Johannes Kepler, Galileo Galilei and Francis Bacon. In this talk I will present evidence and argue that Newton's rejection of astrology can be understood within the context of his socio-political, natural philosophical and theological views.

Abdelhamid Sabra

The Simple Ontology of Islamic Kalam Atomism

The paper will present Islamic kalam atomism as an alternative philosophy to Hellenizing falsafa. Kalam is a theologico-philosophical discourse which first (in the third/ninth century) rivalled the falsafa represented by the likes of al-Kindi, and which later (in the 6th/12th century on) mingled with it in a series of syntheses yet to be precisely understood and evaluated. Focusing on the simple ontology of the basic kalam atomism and noting the hybrid character of kalam itself, the hope is to make clear the problematic of those major adventures of Islamic intellectualism.

Arnaud Saint-Martin

The New Astronomical Eldorado: The French Look at American Astrophysics, 1900-1920

At the beginning of the 20th century, as international competition in astronomy increased, French astronomers had serious doubts about their international supremacy. Now challenged by the development of interdisciplinary specialties such as astrophysics or geophysics, celestial mechanics had traditionally conferred most of its prestigious status to French astronomy. Considering they were unable to make important contributions on the international scene, a marginal community of French astrophysicists publicly lamented their lack of instrumental resources or the inadequacy of existing ones, as well poor institutional support. In this communication, I examine the way in which leading French astrophysicits (e.g. Henri Deslandres, Maurice Hamy, Jean Bosler) looked at American astronomy. Leading expeditions to the U.S. in the first two decades of century, they wrote reports about the organization of U.S. observatories and shared a fascination for Californian observatories. In particular, all believed that George Hale's Mount Wilson Observatory was the only place in the world where astrophysics could really develop: a new "astronomical Eldorado" (as Pulkovo and Greenwich had been before). Back home, they sought to import the U.S. research system to transform the French astronomical community as a whole. The invocation of American astrophysics was a pretext for local issues: a prism that colored professional claims.

Neeraja Sankaran

Autobiography: Insights from F.M. Burnet's Ego-Documents in Reconstructing His Investigative Pathway in Bacteriophage Research, 1924-1937

Biography and autobiography serve a dual function in history serving both as historical sources and as narrative forms of history. Drawing on my doctoral thesis, in which I use biography to examine the early scientific career of Sir Frank Macfarlane Burnet (1899-1985), I explore the personal context of his research on bacteriophages. In the course of my research I used a variety of autobiographical sources including, personal diaries maintained by Burnet while a medical resident (1923-1925); letters that he wrote to his fiancée, Linda Druce, while on a research fellowship in England (1926-1928); notes from the margins of a text on bacteriophages, which he purchased in 1926; and a scientific memoir or autobiography that he published later in his life (1968). Juxtaposed with his scientific publications on phage, the autobiographical materials provide a new understanding of the forging of Burnet's investigative pathway. Here I examine the nature of each of these autobiographical sources, emphasizing how the purpose and content of each determined its place and its value in the reconstruction of Burnet's bacteriophage research.

Tilman Sauer

David Hilbert's Lectures on the Foundations of Physics

Volume 5 of *Hilbert's Lectures on the Foundations of Mathematics and Physics, 1891-1933* is devoted to his "Lectures on the Foundations of Physics, 1912-1927". It will present, among other documents, Hilbert's lecture courses on the foundations of physics (1916/17), on radiation theory and early quantum theory (1912), as well as on the mathematical foundations of mature quantum mechanics (1926). It will also present three unpublished manuscripts that deal with specific topics related to Hilbert's foundational concerns in physics, on epistemological issues, and the intricate relation between nature and mathematical knowledge. In the presentation I will focus especially on the peculiar character of lecture notes for a study of Hilbert's program of an axiomatization of physics.

Michael Sauter

Germans in Space: Astronomy and Anthropologie in the Eighteenth Century

I propose to present a paper that puts the origins of German *Anthropologie* in eighteenth-century astronomy's encounter with new spaces and places. This paper will show, first, how German astronomers such as Eberhard Christian Kindermann and Johann Elert Bode reorganized the German understanding of the globe by providing Germans with a sense for their location on the earth and with respect to other planets. Bode's *Guide to the Knowledge of the Starry Heavens* (1768), for example, offered an extensive tutorial on the stars, along with discussions of other planets and places along the way. Second, it will argue that astronomical discussion had anthropological effects, in that the mental exploration of space cast humanity's destiny in a new light. As Johann Gottfried Herder put it in his *Ideas on the Philosophy of the History of Humanity* (1791), "Wherever and whoever I may be, . . . [I am] a being in the unforeseeable Harmony of one of God's worlds." Hence, by the end of the eighteenth century, the German contemplation of space created a new orientation: human beings were small *and* unique. To borrow an idea from Ernst Cassirer, although awash in a massive universe, human beings were self-fashioners, creating their mental world, while leaving other worlds to other minds. In this sense, knowledge of the physical universe opened the door on a wholly human one. Or to put the point another way: space made people human.

Margaret Schabas

More Like Apes Than Angels: Natural Historical Modes of Thinking in the Political Economy of David Hume and Adam Smith

The contributions to political economy by Hume and Smith are legendary, but less well known are their respective and sustained interests in natural history. David Hume clearly absorbed arguments regarding the adaptation of species for his celebrated *Dialogues Concerning Natural Religion* but he also injected modes of thinking drawn from natural history into his essays on economic topics. This is manifest in the broad temporal brush strokes by which he paints the web and flow of wealth, and in the emphasis on cyclical processes. Hume draws numerous analogies between economic phenomena and plants and animals, suggesting too that his mind was prone to seeing these as part of one seamless web. Smith likewise read natural history for much of his career, and was particularly interested, starting in the 1750s, in the work of Linnaeus. His 1756 Letter to the Edinburgh Review ferried the ideas of Réamur and Buffon over to Scotland. Again, there are numerous elements of natural historical modes of thinking in his political economy, including the processes of equilibration and adaptation that he may well have gleaned from his studies of natural history. Two historians, Roger Emerson and Paul Wood, have argued that for the Scottish Enlightenment, the most central and unifying trope was that of natural history, but apart from one article by Andrew Skinner (1967), the links between Smith's political economy and natural history have remained under explored. This paper will establish that the links are numerous and go further and suggest that Hume and Smith be seen as part of the common terrain of natural history and political economy.

Simon Schaffer

Laboratory Work and the Spaces of the World

Owen Hannaway taught us much about the significance of the sites of laboratory work and of the conditions of access to such sites. One challenge of this project is then to develop a history of laboratory work which would chart in more detail the mutations to which the places of scientific labour and their links with their surroundings have been subject, thus to explore the importance of connexions between laboratories and other spaces. This paper selects some examples both from early modern experimental workshops and from later nineteenth century academic sites of physical and chemical performances: these were cases which Owen Hannaway masterfully analysed and which have much to teach us about how local knowledge acquires its wider powers. In particular, the paper offers some remarks about how varying audiences for laboratory work, including apprentices, private patrons and officers of state, much affected the forms of scientific practice pursued within the laboratory setting.

Sara Scharf
Training the mind's eye with identification keys

In the late 18th century and early 19th century, the identification key was a new technology. Keys enabled those who did not have extensive botanical background knowledge to identify plants more quickly than ever before. The relatively instant gratification of plant identification using keys was, in the words of one French botanist, "a sort of lure to compel students to bite at botany." In fact, the great 19th century botanist George Bentham got hooked after his first experience with keys. Despite the success of keys at interesting students in plant identification, botanical instructors were wary of keys as educational tools. They wanted students to learn more about plants than just names – something that keys based on obvious features of plants did not stress. Didactic instructors took pains to build their own keys such that students had to examine minute details of individual plants and translate what they saw into technical terms in order to identify specimens. The aim was to familiarize students with major features of plant groups while engaging them in rigorous analytical thought – training their minds' eyes so that they could recognize which details of plant anatomy were important. But emphasis on technical skill and natural plant groupings made keys tedious and difficult to use, detracting from their original purpose. This presentation will examine how these sometimes contradictory ideas of what identification keys were meant to do resulted in different kinds of identification tools being made and used, not just by students, but eventually by everyone identifying plants.

Brian Schefke
The Hudson's Bay Company as a Context for Science in the Columbia Department

This paper aims to elucidate and analyze the links between science, specifically natural history, and the imperialist project in what is now the Pacific Northwest and western Canada. Imperialism in this region found its expression through institutions such as the Hudson's Bay Company (HBC). The heart of this study will be an examination of the activities of naturalists such as David Douglas and John Scouler in the context of the fur trade in the Columbia Department. The main question I wish to answer through such an investigation is: how did natural history aid Britain in achieving its economic and political goals in the region? A related question I also wish to address is: in what ways did imperialism delineate the research priorities and activities of the naturalists working in the Columbia Department? Ultimately, I hope to contribute to our historical understanding of the role science plays in a wider political context in both the United States and Canada.

Londa Schiebinger
Agnotology and Colonial Science

"Agnotology"—the study of culturally-induced ignorances—serves as a counterweight to more traditional concerns for epistemology. As a methodological tool, it refocuses questions about "how we know" to include questions about what we do not know, and why not. Ignorance is often not merely the absence of knowledge but an outcome of cultural and political struggle. Nature, after all, is infinitely rich and variable. What we know or do not know at any one time or place is shaped by particular histories, local and global priorities, funding patterns, institutional and disciplinary hierarchies, personal and professional myopia, and much else as well. Examples for this discussion will be taken from my historical work in colonial science.

Eric Schliesser
Hume's Attack on Newton's Philosophy

In this paper I argue that major elements of Hume's metaphysics and epistemology are designed to prevent an appeal to the authority of Newton's natural philosophy. Claims of natural philosophy are constrained by philosophic considerations. In doing so, I depart from two largely independent interpretive traditions. One tradition notes that Hume was very interested in and attempted to emulate Newton in his 'science of man.' My claim is not that Newton did not figure importantly in Hume's philosophy, but, instead, that Hume's project is in many respects more hostile to Newton's achievements -- as available to informed 18th century readers -- than many of his present interpreters realize. There is a different tradition that argues Hume simply did not understand Newton and, thus, cannot do justice to Newtonian science. However, this tradition begs the question; it takes the authority of 'science' for granted in Hume. Moreover, against this

tradition I argue that Hume did understand salient features of Newton's methodology. If this is so, Hume's departures from Newton are best interpreted as philosophically motivated. Here follows a summary of my argument. In the *Opticks*, Newton claims that natural philosophy should be the foundation for other sciences, while in the Treatise and first Enquiry Hume asserts the supremacy of the "science of man." For Hume it can attain the high epistemic status of "proof," while much of the physical sciences must do with lower forms of "probability." Moreover, Hume's account of causation is designed to undercut the causal apparatus of Newton's natural philosophy. Furthermore, while it should be granted that Hume's "rules by which to judge of causes and effects" are largely modeled on Newton's Rules of Reasoning, Hume does not replicate Newton's rule 4. This omission allows Hume to claim that the parts of natural sciences that go beyond "common life" should be treated in Instrumentalist fashion. I then discuss an objection: the subtitle of the Treatise, "Attempt to Introduce the Experimental Method of Reasoning into Moral Subjects," may be thought to show Hume's debt to Newton. While drawing on Hume's remarks in The History of England, I argue that it illustrates Hume's methodological commitment to Boyle's experimental philosophy. This fits much of the available historical evidence on the importance of Boyle in Hume's education and intellectual orientation.

Judy Schloegel

Nuclear Fear, the Atomic Energy Commission, and Environmental Research at Argonne National Laboratory, 1955-1975
From the late-1940s through the early-1960s, multidisciplinary fallout studies were commissioned by the US Atomic Energy Commission (AEC) partially in response to growing public anxiety concerning radiation exposure from nuclear fallout. Researchers in Argonne National Laboratory's Radiological Physics Division carried out considerable atmospheric and physical studies of nuclear fallout at the request of the AEC. By the mid-1960s, however, fears over direct human exposure to nuclear testing were largely displaced by even more intense public and political anxieties about environmental pollution and the role of nuclear reactors in the environmental crisis. This paper examines the transformation of Argonne's Radiological Physics Division as it launched into environmental research in the late 1960s and early 1970s in response to the rapidly changing public opinion regarding environmental pollution. It focuses in particular on the central role played by Argonne researchers who engaged in fallout studies in the 1950s and early 1960s in the later development of the laboratory's multidisciplinary Great Lakes Research Program. Long interested in the study of radiation effects on the environment, these researchers now received the political and financial support of the AEC and other institutions to apply methods and techniques developed in their research on fallout to questions of reactor-related environmental pollution and Great Lakes ecology. Although environmental research at Argonne was overwhelmingly carried out by researchers whose training and expertise were in the physical sciences, the political liabilities of both nuclear weapons and nuclear energy contributed to the broad conception of this research as "biological" in nature.

Sigrid Schmalzer

Youth and the "Great Revolutionary Movement" of Scientific Experiment in Socialist China

This paper examines how state officials and young people in socialist China (1949 to early 1980s) created an understanding of science as the domain of youth. Unlike in the United States and other capitalist countries (including post-socialist China), socialist Chinese campaigns to mobilize youth for science seldom emphasized the long-term benefits of such efforts. Rather than investing in children as future adult scientists, they considered youth to have unique characteristics that suited them to science, and they expected youth to make substantial scientific contributions as *youth*. Also unlike Cold War American propaganda, girls were included or even especially encouraged to imagine themselves as scientists. Mao had famously lauded the energy, willingness to learn, and freedom from conservative thinking that youth possessed. These comments formed the basis for propaganda encouraging youth to take leading roles in scientific research. Young people appear to have been eager to oblige. Memoirs, sociological studies, and personal communications offer strong, if anecdotal, evidence that youth from the educated classes held science in high esteem and in many cases dreamed of being scientists themselves. Their image of scientists was not of older, establishment professionals who were frequently the targets of political campaigns against "rightists" and "specialists." Instead, they appear to have embraced the more youthful, rugged image of scientists as brave, hardworking revolutionaries. This image allowed them to imagine the opportunity to engage in high-status, interesting work without the stigma of being an intellectual. The paper will

address the idea of "youthful science" with a particular focus on youth participation in the "scientific farming movement," which peaked in the 1970s when many urban youth were sent to the countryside to promote revolution and learn from the peasants.

Gail Schmitt

Modeling Cytoplasmic Inheritance: The Debate between Ruth Sager and Nicholas Gillham

Cytoplasmic inheritance was a contested topic throughout the first half of the twentieth century and a focus of research for only a few researchers, most of whom worked with several different organisms, generally higher plants. After World War II, more researchers turned their attention to this phenomenon and to microorganisms for studying it. Having worked in maize genetics, Ruth Sager switched to cytoplasmic inheritance and began a search for a suitable organism in which to study it, eventually settling on a single-celled alga, *Chlamydomonas reinhardtii*. Her work would establish *C. reinhardtii* as the model organism for work on chloroplast genetics. Taking her cues from the microbial geneticists of the 1940s and 1950s, she began to elucidate the transmission genetics—and later, molecular biology—of the chloroplast genome. Sager's various models for her experimental system and research involved a simplification that would eventually constrain her examination of alternative explanations. Other researchers also using *C. reinhardtii* (Nicholas Gillham and his laboratory), invoked different models for their interpretations, leading them to contrary conclusions, even for observations Sager. This paper will explore the debate between Sager and Gillham on chloroplast genetics.

Daniel Schneider

Public vs. Private Science: Biological Sewage Treatment and the Struggle Over Patents, 1896-1937

In this paper I examine two episodes of intense struggle in the sanitary science and engineering community over the legality and ethics of patenting biological treatment processes: the septic tank (1896-1913) and the activated sludge process (1914-1937). What unites these two cases, aside from sewage, was the open and vocal controversy over public vs. private science–whether patents should be taken out for research performed by public bodies, and the role of these patents in preventing innovation in sewage treatment. As dozens of municipalities across the U.S. were sued by patent syndicates, scientists and engineers on both sides of the Atlantic were forced to question the ethics of patents. Controversy centered around 1) the distinction between processes and apparatus, as the cases revealed lingering scepticism on the part of engineers concerning the rights to patent what many considered to be basic scientific principles, 2) the ethics of patenting advances that had already been revealed in the public literature, and 3) the ethics of patenting research paid for by the public, in these cases by city governments. Municipalities across the U.S., supported by the engineering profession, formed organizations to fight the patents in court. The legal battle over activated sludge focused on infringement suits against the cities of Milwaukee and Chicago, which ultimately lost, owing millions of dollars in damages. These controversies have implications for current patent disputes involving the biomedical and software industries.

Vera Schwach

Seek a Field of Science and Find Fishes. Johan Hjort and the Emergence of Oceanography 1890-1920

The Norwegian marine- and fisheries biologist Johan Hjort (1869–1948) was a renowned oceanographer in the western hemisphere. In 1914 he published the monograph *Fluctuations in the Great Fisheries of Northern Europe Viewed in the Light of Biological Research*; the theory of natural fluctuations he presented in the book constitutes a foundation for today's fisheries biology. Hjort and his colleagues at the Directorate of Fisheries in Bergen established the concept of year classes in the populations of herring (Clupea harengus) and cod (Gadus morhua). The size of the different year classes varies enormously, and this causes large fluctuations in the catches of fish. Hjort also sought an answer as to why the sizes of the year classes fluctuate; he suggested that the numerical value of a year class is determined at a very early stage. "The critical stage", Hjort found, was when the fish larvae had consumed their yolk and had to seek food in the sea. The questions in relation to the exact conditions that determine the size of a year class remain unanswered, however. The focal point of my paper is Hjort's intellectual background and the investigation that ended with the publication mentioned above. I emphasize Hjort's inspiration from a stay at the Stazione Zoologica in Naples, the importance of his compatriot

Fridtjof Nansen's (1861–1930) voyages and field studies in the Arctic, and the establishment of a Council for the Exploration of the Sea (ICES) in Copenhagen, Denmark 1902. A second focus will be on the significance of Hjort's theory in the emerging field of oceanography, and linked to this, the eagerness with which the Norwegian oceanographer sought to spread his theory and methods of investigations to Canada and the USA.

J.B. Shank

Courtly Mathematics? Evangelista Torricelli's Finite Volume Infinite Solid in Cultural Context

In the 1630s, Evangelista Torricelli, a young and aspiring savant with ties to the Tuscan circles of the recently exiled Galileo, produced and circulated a stunningly innovative mathematical demonstration. In it, he showed that the volume of an infinite solid produced by rotating a hyperbola around the axis of its asymptote could be shown geometrically to have a finite and determinable volume. This posed for many a seeming paradox: how could a solid with infinite dimension enclose a finite space? Torricelli circulated his demonstration throughout the Republic of Letters, where it attracted intense interest, especially in Paris, where it moved through the networks of the "Mersenne Circle," but also in London, where Thomas Hobbes among others commented upon it. It ultimately established Torricelli's scientific reputation in Italy and throughout Europe, preparing the way for his more famous work on the barometer and atmospheric air pressure several years later. It also associated him with the Italian school of "infinitesimalist" mathematicians, which also included Galileo and Cavalieri, who were then beginning to attract attention throughout Europe. Accordingly, historians commenting on Torricelli's finite volume infinite solid have tended to focus on its theoretical dimensions, absorbing it into the broader history of Torricelli's scientific work or into accounts of his contributions to the seventeenth-century "infinitesimalist" revolution in mathematics. Building on this work, my paper seeks to explore a different dimension of Torricelli's achievement: namely its role in establishing his reputation in both the Medici court circles of Tuscany and in the wider Republic of Letters. Torricelli's mathematical work, I will argue, bears the traces of the seventeenth-century cultural environment from which it was born, and by restoring the cultural context that produced it, I hope to shed light on the interplay between princely courts, the international Republic of Letters, and the development of advanced, infinitesimalist mathematics in seventeenth-century Europe.

Adam Shapiro

The American Textbook Industry and the Roots of the Anti-Evolution Movement

When California required its State Printing Office in 1884 to produce textbooks for the state's public schools, it did not intend to regulate the content or quality of school books, but rather to put an end to corrupt competition and price-fixing by rival sales agents from textbook companies. Over the next fifty years, many states, particularly those of the Western and Southern U.S., attempted to create printing offices or to regulate textbooks through statewide adoption. Textbook publishers, based in the regions of the U.S. nearest their largest markets, the Northeast and Midwest, were slow to adapt production to the new marketing environment, and turned their efforts towards opposing regulation of their industry by states. In 1925, the American Book Company was still marketing separate biology textbooks for urban and rural audiences. As public education expanded in the rural South, and state regulators continued to be dominated by urban educators, the content of biology textbooks being used became increasingly unsuitable. This was due not only to the evolutionary content of these books, but the treatment of other civic issues such as public sanitation and food safety, and the use of biology for safe city living. The time-scale involved in statewide textbook adoption also played a crucial role in putting an eleven-year-old textbook into John Scopes' hands. In 1924, Tennessee postponed the adoption of textbooks for a year, forestalling a substantial price increase, but leaving Scopes teaching from the American Book Company's 1914 *Civic Biology*.

Hanna Shell

Productive Mimesis and the Art of Disappearance: Abbott H. Thayer, Protective Coloration in Nature, and the Modeling of Strategic Invisibility (1890-1920).

The original camoufleur – plaster-white as a ghost – hides, cast in a box at Houghton Library. Part of a small collection of ribbon-wrapped death masks, the plaster cast bust of Abbott H. Thayer (1849-1921) -- naturalist, artist and often-touted

as the "father of modern camouflage" – sits on shelf lodged between the ineffable Napoleon Bonaparte and Thayer's friend and kindred spirit in life, philosopher-psychologist and founder of pragmatism William James. In "Productive Mimesis and the Art of Disappearance," I examine the textual, visual and material productions of Abbott H. Thayer in light of his evolution-based theorization of protective coloration. Drawing on the Jamesian psychology and Peircian semiotics (in which Thayer himself was immersed). I consider the relationship between "Thayer's Law" of obliterative coloration and disruptive patterning in nature (first articulated in 1896 and debated among natural historians, painters and the general public well into the 1910s) and Thayer's efforts to "prove" his law through the production, dissemination, and demonstration of both three-dimensional models and hollow stencils by means of the painterly manipulation of photographs and animal skins. This relationship – epitomized in the figure of the stencil – corresponded to an emergent (and materially-grounded) psychology of evanescent (scientific) selfhood, which Thayer would stage in exhibitions of natural history and his later portrait paintings. In the years to come, it would also be staged in the theaters of war, and integrated into the clothed surface of the human body of the soldier.

Matthew Shindell

"To Hell with the Moon": Harold Urey, Expertise, and Scientific Exploration

The marriage of NASA's early lunar exploration program with Harold Urey's model for the origins of the Moon was beneficial for both NASA and Urey. By entertaining the notion that the Moon was a sample of the oldest solar material in the universe, NASA's manned program could be seen not only as accomplishing political goals, but answering fundamental questions about the origins of the solar system. By making the composition of the Moon primary and its surface features of only secondary interest, the scientific justification Urey's model leant to lunar exploration had the potential to make Urey's brand of geochemical expertise primary in the lunar program. Unfortunately for Urey, this marriage did not last long. As Urey's model for the formation of the Moon failed to stand up to evidence provided by early exploration, and as Urey failed to unseat the "second-rate" geologists from the USGS Astrogeology Branch who were finding themselves ever more useful, Urey became more and more outspoken about the decreasing scientific value of lunar exploration and of NASA's ability to do good science. This paper argues that sour grapes alone did not fuel Urey's criticisms of NASA. While some of the conflict was personal, much of it had to do with notions of expertise (it's proper form, use, and measurement), scientific responsibility, a pessimism toward nationalistic/political projects, and a preference for science that answered fundamental questions, all of which had evolved over the course of Urey's life and career. Tracing these notions as they are presented in Urey's correspondence, publications and interviews gives a sense of Urey's culture shock when forced to work with USGS geologists and NASA bureaucrats. A tension is revealed between Urey's idealized (though by no means naïve) notion of scientific exploration and the realities of exploratory science.

Robert Silliman

Pilgrim's Progress: Leo Lesquereux (1806-1889) and the Rise of Palaeobotany in America

When in 1879 and the years immediately following Lesquereux saw through the press the four volumes of his illustrated synopsis of the coal flora of the U. S., he was bringing to fruition a project he had initiated three decades before. It had begun with a suggestion from Edouard Desor, his Swiss compatriot and former secretary of Louis Agassiz, when the two men were employed on the first Pennsylvania Geological Survey. With zest and determination Lesquereux took up the idea of compiling a comprehensive catalogue of American fossil plants, particularly those of the Coal Age, while at the same time launching in America a science of "vegetable paleontology" similar to that pioneered by Adolphe Brongniart and others in Europe. Attaining these objectives posed a difficult challence both because of the scope and intrinsic difficulty of the undertaking and because of Lesquereux's limitations. He was totally deaf, socially isolated and had scant financial resources. Over the years he slowly advanced his project, although not infrequently he met with setbacks that made him feel he was wallowing in "the slough of despond." During such episodes he found consolation in Providentialism, believing everything represented the working out of a divine plan. Making extensive use of Lesquereux's correspondence in the archives of the American Philosophical Society and Harvard University, this paper explores Lesquereux's struggle to complete his coal flora and construct a science of plant paleontology. It has reference to the general problems of disciplinary history and the roles of religion, personality, and disability in the practice of science.

Grace Sirju-Charran
Content and Pedagogy of a Course on Gender and Science

Science courses as currently taught generally do not give students the opportunity to analyse, synthesise, think critically and solve problems. The course on Gender and Science affords them this opportunity. Students keep a research journal, undertake a research project,lead the discussion of selected papers, attend seminar presentations and do an oral presentation, in addition to writing a final exam which includes an essay. The presence of an equal number of males following the course gives an added dimension and allows for greater discussion of the issues. The experiences in teaching this course will be shared and critically reviewed.

Patrick Slaney
James B. Conant on Science Education: Science, Security and the Institutions of Social Order in the Early Cold War

In this paper I examine Conant's concerns about science education as a part of general education. In contrast to Steve Fuller's (2001) claims that Conant introduced the dynamics of cold war nuclear conflict into the history of science I argue that Conant's plans for science education are better placed in an earlier Cold War context: i.e., not where two superpowers (or paradigms) competed in a contest of mutually assured destruction, but in a context of obsession with security and communist witch hunts. In such an ideologically fraught era, Conant argued that new institutions of science education were needed in order to provide the unity needed for the sustained ideological struggle that characterized post WWII life, a kind of struggle that Conant did not think was unprecedented. Unity was important, but because Conant thought that a techno-scientific elite was needed, his program of science education depicted scientists as engaged in a distinctive kind of work and, at the same time, tried to depict scientific activity in a way that made autonomous scientists credible. Conant's general education in science was important because it articulated an early vision of the community of scientists as self-regulating and detached from industry, government and other social institutions.

A. Mark Smith
How Should We Interpret "Experiment" in Alhacen's Optical Analysis?

Because of its deep and obvious significance in the development of Western science, Alhacen's *De aspectibus*, the Latin version of Ibn al-Haytham's *Kitab al-Manazir*, has been characterized as "revolutionary" on a variety of fronts. One such front involves Alhacen's use of empirical demonstration, or experiment, throughout the *De aspectibus* and a prevailing view that such reliance on experiment was truly innovative. Perhaps the clearest articulation of this view is to be found in Saleh Omar's *Ibn al-Haytham's Optics: A Study of the Origins of Experimental Science*. There, Omar examines several of Alhacen's experiments, but the one designed to confirm the equal-angles law of reflection stands out because it is rigidly controlled in terms not only of the mirrors tested, but also of the complex apparatus within which the experiment is conducted. According to Omar, two crucial features mark this particular experiment as modern. First, it is meant to be universal in that it is designed to prove that all types of luminous radiation reflect at equal angles from all reflective surfaces, no matter their shape. Second, it is based on precise instrumentation. The very exactitude of the experimental apparatus used by Alhacen guarantees the universality of both the experimental tests and their results. Omar's evaluation of this experiment and its modernity according to instrumental precision and universality makes some sense at a theoretical level. However, a close examination of the experiment, as presented in full by Alhacen, reveals serious problems with that evaluation at the practical level. In fact, as I intend to show through such an examination, it is doubtful that Alhacen ever conducted, or could have conducted, the experiment as he describes it. From there I will go on to argue that the experiment was in no way revolutionary, much less modern, at either the practical or conceptual level.

Pamela Smith
Butter and Mercury, Lizards and Vermilion: Artisanal Views of Nature in Early Modern Europe

This paper examines two artisanal practices of sixteenth-century European metalworkers involving butter and mercury, in order to attempt to draw out the underlying principles by which these craftsmen organized their work and viewed their

world. This paper seeks to show that these workshop practices were underpinned by a broad but coherent body of principles and beliefs about nature and the behavior of natural materials; a body of knowledge that artisans often sought in an empirical and systematic way. We might call such a body of knowledge a "vernacular science."

George Smith
Messages from the Inside of the Earth

The initial seismometers were developed late in the nineteenth century with the goal of monitoring and thereby gaining an understanding of earthquakes. Within the first decade of the twentieth century, however, it became clear that seismic waves propagating from earthquakes carry information about the interior of the Earth that had promise of answering questions, originally posed in Newton's Principia, about the density distributions within it. This realization put a premium on designing seismometers and locating them around the Earth in ways that would allow information about the interior of the Earth to be extracted from the waves -- a quest that received important later support from the U. S. government's effort to monitor underground nuclear explosions. This paper will start from the early design of seismometers and the realization that seismic waves could be used to answer questions about the inner structure of the Earth, and it will then trace the history of the interaction between identifying measurements that yield useful information, the evolving design of seismometers and seismographic stations, and the development of an international grid of these stations. This history is still continuing, and some mention will be made of recent developments, but the paper will concentrate on the period up to 1981 and the publication of PREM, the Preliminary Reference Earth Model.

Laura Snyder
Connexion and Unity in William Whewell's Science of Architecture

In an 1862 speech before the Institute of British Architects, William Whewell compared the role of the architectural historian to that of the comparative anatomist. "In architecture we have a principle," Whewell explained, "that the details of the building are involved in the general plan; and if we had only the lowest courses of a clustered pier before us, we could, in idea, restore the building; just as the anatomist can, from the bones of the foot, restore the whole of the animal. There is an organic connexion and unity in the forms in the one case as in the other." This "connexion and unity" in the case of anatomy had been demonstrated twenty years before when researchers found the whole skeleton of a bird that had been "restored" earlier from the fragment of a thigh bone by Whewell's good friend, Richard Owen. Just as Owen had used the unity of nature to uncover the structure of the Moa, so Whewell thought that historians of architecture could use the unity of Gothic architecture to discover the design of individual buildings. Whewell's equation of architecture with comparative anatomy in this speech was not uncharacteristic; indeed, it was consistent with his attempts to create a science of architectural history. Whewell's major architectural work, *Architectural Notes on German Churches*, was first published in 1830, just as Whewell was beginning to formulate publicly his view of inductive science. In this paper I will show how Whewell's view of inductive science informed, and in turn was informed by, his architectural studies.

Alistair Sponsel
"The Greatest Laboratory in the World:" The 1947 Scientific Resurvey of Bikini Atoll

The plan for Operation Crossroads, in which two nuclear devices were detonated at Bikini atoll in July 1946, called for comprehensive hydrographic, geological, and biological baseline surveys of Bikini and neighboring atolls. In the summer of 1947 scientists in ten divisions conducted a massive resurvey that included a "mobile lab" on wheels and a crew of Oklahoma oil drillers obtaining rock samples for the geologists from as deep as half a mile beneath the reef's surface. In what was often referred to as "this experiment," Bikini was treated as a discrete system to be compared to neighboring "control" atolls with lesser exposure to the bomb test. Many of the 1946-47 studies were geared toward comparing existing surveying techniques to those based on tracing radioactivity. Knowledge was simultaneously generated about the atoll ecosystem, radiation, and the physical and radiological effects of the bombs themselves. I will argue that the decision to conduct the test on (not just *at*) an atoll expanded the scope of what was knowable about nuclear weapons. I will also follow the work of a handful of survey geologists and zoologists to show how the bomb tests presented the opportunity for research into existing questions within their respective disciplines. This progress being made in "pure science" was

advertised enthusiastically by the U.S. Army and Navy in press releases from Bikini, which I will argue was a strategy undertaken to portray the bombs, which harnessed nature's power, as just one aspect of the broader study of nature that justified the Crossroads tests.

Frank Stahnisch

German-Speaking Neuroscientists in North-America after 1933: The Issue of Emigration-Induced Scientific Change

With special regard to theoretical concepts and scientific applications of "interdisciplinarity" in neuroscientific research, the proposed paper shall centre on a time period, which has long been on the margins of historians of medicine and the life sciences. However, with the provision of ample biographies of neuroscientists as well as case-histories of individual institutions and clinics, emigration specialists have pointed out that the loss of nearly 30% of all senior scientists in Germany between 1933 and 1945 did ruin the country's foundation for scientific investigations. It was further argued that the reintegration of differing communities of neuroscientists into the research culture on the other side of the Atlantic initiated a strong enhancement of knowledge production and led to a gradual transformation in the scientific field. But like in many other contemporary disciplines and research areas, a firmly corroborated evaluation of the effects of the massive exodus of scientists on the growth, the content, and the international standing of the neurosciences in North-America and Germany is still lacking. In a first attempt and with special view to the scientific changes at the cultural, social, and institutional levels, several methodological perspectives for "emigration-induced scientific change" (C. Fleck, 1996) shall be evaluated: I will therefore concentrate on the neuroscientific cultures that existed in Canada, the United States, and Germany, before and after so many neuroscientists were driven into exile. I will then assess certain types of "gains" and "losses" in differing neuroscientific research styles and focus on the changes that the "disciplinary matrices" (T.S. Kuhn, 1977) of the field had experienced on varying organisational and contextual points. In the last part, I shall focus on the status of collective biographies, scientific networks, and interdisciplinary endeavours for the historiographical analysis of this subtype of scientific change. It is the objective of this survey to develop a more adequate model for evaluating emigration-induced scientific change in the field of the neurosciences, which shall also encompass a cultural and social description of the research activities.

Richard Staley

Relative Measures, Absolute Standards and the Perfect Laboratory

When Henry Rowland described his ideal laboratory in his famous 1883 plea for pure science, it was modeled on the astronomical observatory. This paper will explore the relations between patronage, research programs, and materials and methods that saw both Rowland and Michelson relate much of their most important work in building the young physics discipline in the U.S., to the existing strengths of astronomy. The astronomical community provided institutional ideals, but also research goals in the velocity of light and spectroscopical standards, and in the case of Michelson, a rigorous training in methods. Through William Rogers' work on standards of length, we will also see that astronomy provided both Rowland and Michelson, quite literally, with the yardstick by which to measure the progress of physics. Rowland needed to understand friction mechanically, and Michelson sought to overcome it optically as both moved between relative measures and absolute standards to demonstrate the distinctive contribution physicists could make to science in the U.S. In turn, their engagement in projects between physics and astronomy has implications for our understanding of the relations between astronomy and astrophysics in the late nineteenth century.

Henderikus Stam

Instruments of Intelligence: Animals in Early Twentieth-Century Psychology

In the constitution of objects of investigation and the boundary conditions of the human, animals have always had their special place in the discipline of psychology. They (along with children) were foundational to the early twentieth-century preoccupation with the technological and organismic conceptions of what it is to constitute something as psychological. Psychologists represented psychological processes in the creation of a relationship between an instrument and an individual animal. In order for these processes to make sense, the individual animal had to be removed as far as possible from an ecologically meaningful habitat or umwelt. The animal itself gradually took on the nature of an abstract

organism, subject to increased isolation, continuous surveillance, control of responses and, finally, the mechanization and automation of the experimental animal itself. These processes aimed to increase the overall integrity of the representations, a crucial step if they were to move from local knowledge produced by way of initially eccentric instruments to a form of universal knowledge, removed from its local and historical origins. This paper will examine the key moments in this process during the years 1898 to 1930, particularly with respect to the critical stance taken by psychologists toward anthropomorphism. I will focus on the relationship between John Watson and Robert Yerkes.

Ida Stamhuis

Why No Dutch Statistical Society after the Establishment of Central Official Statistics?

In 1857 in the Netherlands a Statistical Society was founded which, over the course of time, attracted a wide and diverse membership, though the number of physicians on its rolls was low. The Society itself was dynamic, discussing statistical and economic topics at its annual meetings, working to compile a "General Statistics of the Netherlands," and publishing a yearbook. Although the absence of well-organized, official state-generated statistics played a role in the foundation and continued existence of the Statistical Society, this does not seem an adequate reason in explaining why the Society changed its name and stopped being engaged in statistical matters when a central official statistics organization was finally created in the Netherlands in 1891. Explaining this transformation is important as the abolition of that aspect of the Society is crucial in the development of statistics in the Netherlands. In this paper, I will give a sketch of the foundation, history, and the end of the Dutch Statistical Society, and compare some of its characteristics with the English Royal Statistical Society. Through this examination, I will try to answer the question posed in the title of this paper

Matthew Stanley

Work of National Importance: British Science, A.S. Eddington, and Conscription in the Great War

During the Great War the British government was notably reluctant to take advantage of the nation's scientific resources. British scientists were rarely exempted from conscription, regardless of their potential for technical contributions to the war effort. This paper examines the wartime conscription apparatus as a way of exploring how Britain assessed the value and role of scientists in wartime. Many scientists argued that they should be valued for their special skills, but the conscription system treated technical experts the same as farmers and factory workers. Conscription required the government to formally declare the proper role and relative value of all citizens, including scientists, which provides a valuable historical opportunity to uncover the state's thinking on science. Further, scientists' protests against the system demonstrated competing visions of the role of the wartime scientist. As a case study, this paper will particularly focus on the conscientious objection trial of the Cambridge astronomer A.S. Eddington, in which the tensions among competing visions of the wartime scientist are especially visible.

Laura Stark

Observing and Deceiving: The Science and Ethics of Research Methods, 1966-1973

Between 1966 and 1973, leaders of both the American Anthropological Association and the American Psychological Association wrote professional codes for the treatment of human subjects in an effort to stave off federal regulation of their members. In this paper, I compare how leaders of the two groups defended or rejected research methods that had been central to the disciplines but that also raised ethical questions about the treatment of their human subjects: observation in the case of anthropology and deception in the case of psychology. I examine how and to what extent anthropologists and psychologists used findings from their own research into the nature of human beings to make sense of their subjects' rights; what anthropologists and psychologists considered to be the consequences of aggressive truth-telling for knowledge production; and how their moral predicament shaped—and was shaped by—understandings of their disciplines as 'science.'

Martin Staum

Nature and Nurture in French Psychology and Sociology, 1873-1914

Anthropological assumptions about a hierarchy of physically determined racial groups with inherent psychological characteristics and about the nearly insurmountable retardation of primitive cultures permeated the work of the founder of French empirical psychology, Théodule Ribot. Assumptions about the correlation of brain mass and shape with intelligence also affected Alfred Binet. The rise of sociology and challenges to existing theories of inheritance led Ribot to surrender fitfully some hereditarian assumptions. Binet's experimental caution and contemporary critiques of anthropometry tempered his enthusiasm for psychophysical correlations. Meanwhile, the hitherto neglected non-Durkheimian sociologists organized by René Worms displayed both the persistence in sociology of anthropological notions of race and gender while also allowing strong critics of these views to be heard. The "discovery of the social" encouraged opponents of neo-Lamarckian notions of heredity while radical feminists such as Madeleine Pelletier challenged ideas of an indelible feminine nature.

Jacob Stegenga

The Chemical Characterization of the Gene: A Sociological Analysis of Scientific Reception

The first chemical characterization of the molecule responsible for genetic change was presented in the now famous 1944 paper by Avery, MacLeod, and McCarty (AMM1944). Using the transformation of pneumococci, their results suggested that the transforming factor was deoxyribonucleic acid (DNA). Peter Medawar (1915-1987), a Nobel Laureate (Medicine and Physiology 1960), retrospectively called the transformation work by Avery's group "the most interesting and portentous biological experiment of the 20th century." Reception of this work at the time was mixed: some immediately saw the potential of nucleic acid research; others maintained an open, albeit sceptical, attitude towards DNA; still others rejected outright the possibility that DNA could play a functional role in gene transmission. This manifold reception was due to the work's "interpretive flexibility." There were contemporaneous, vocal criticisms of interpreting Avery's results as conclusive evidence that genes are composed of DNA; textbooks of genetics in the years following publication of AMM1944 were skeptical of its results; citations to AMM1944, though frequent, were intellectually vague; most notably, Avery was not awarded a Nobel Prize, for neither his important prior achievements in immunology nor for his studies on transformation. In Nature's 50th anniversary of Watson and Crick's famous letter describing the structure of DNA, the editor wrote "the fact that McCarty, Avery, and MacLeod were not awarded the Nobel Prize is an oversight that, to this day, still puzzles." In this paper I investigate the reception of AMM1944, and then apply Trevor Pinch's notion of evidential context and sociological theories of Bourdieu in an attempt to understand the complex reception of this infamous scientific work.

John Stenhouse

'True knowledge' the 'handmaid of true religion': Christian Missions and the Spread of Science, 1790-1930.

Many nineteenth century missionaries esteemed science as a useful if not indispensable handmaid of "true religion." In schools, colleges, universities, seminaries, hospitals, and books, and with indispensable help from indigenous translators, missionaries pumped European scientific ideas and practices around the globe. Yet few spread science for its own sake. This paper explores the religious visions that motivated missionaries to spread science, and that shaped the kinds of science that they spread. The missionary campaign cannot adequately be understood by focusing on the missionaries however. In many contexts, and especially in Asia and the Islamic world, modernizing elites showed more interest in Western science than in Christianity. Missionaries learned to supply what their hosts wanted, converted by those they set out to convert. Moreover, Asian religious leaders beat the missionaries at their own game by deploying Western science in the service of their own religious traditions and against the missionaries, the West, and Christianity.

Larry Stewart

Industrialists and Instruments in the Late Eighteenth Century

Manufacturers and tradesmen in the first industrial revolution had an abiding interest in experimental practise. Often these passions would overlap with their own manufacturing concerns. Well-known industrialists like Josiah Wedgwood,

Thomas Cooper, James Watt and James Keir seized a place in debates central to pneumatic and industrial chemistry. While Wedgwood was himself a manufacturer of apparatus, he and his sons purchased experimental devices much as did those in trades in Birmingham, Manchester and London while Watt designed and built apparatus for the breathing of airs. Beyond the industrial elite, much less well-known tradesmen had access to experimental apparatus. Craftsmen in Spitalfields and chemical manufacturers in London bought devices at the leading edge of pneumatic and electrical experimentation. This paper seeks to compare the uses of apparatus in private and public settings at the end of the eighteenth century. It will explore the extensive market for experimental devices and their role in the laboratories of industrialists and craftsmen.

Heiko Stoff

Active Substances as Precarious Substances: Institutionalizing Research on Enzymes, Vitamins and Hormones in Germany, 1920-1970

In the year 1920 it was common sense that enzymes accelerate metabolism processes, that glands secrete hormones, which control bodily functions and finally that vitamins are accessory food factors, without which the organism would fall ill and grow weak. These active substances seemed to be responsible for a whole compendium of effects: general health and specific diseases, bodily transformations, sex and age, fermentation etc. As Georges Canguilhem has shown, the concept of regulation was tied to the experimental practice of modern science. Active substances thereby received the status of autonomous and potent epistemic things, which were able to secure the homeostatic condition of organisms. But their autonomy and potency also made them highly suspicious of as well producing unwanted and deadly effects like cancer. Active substances at the same time generate und endanger the bodily balance. While scientists performed this productivity in spectacular biological and physiological experiments, the public expected the most utopian results: rejuvenation, absolute health, fitness. Biologists and Biochemists seemed to be in the position to solve the highly debated crisis of degeneration, the volatility of sex and the danger of an aging society - a state of national emergency - through the empowering of hormones, vitamins and also enzymes. The urge to isolate these potent substances in order to activate them for various purposes – as biological drugs, as biopolitical tools, as technical things - lead to a productive cooperation of the pharmaceutical industry, scientists and the state. This talk will focus on the role of the Deutsche Forschungsgemeinschaft – German Research Foundation - to promote research in the field of active substances at the longue durée of the years 1920 to 1970. The aim is thereby to emphasize the lasting importance of the controlling function and the condition of precarity of these elements of life.

Bruno Strasser

Banking DNA Sequences : Physicists, Biologists and the Electronic Management of Biomedical Data

GenBank, today's largest DNA sequence database, was founded in 1982 at Los Alamos National Laboratory (LANL) under an NIH contract. Why did the NIH choose a physics laboratory, known for its participation in the Manhattan project and the development of thermonuclear weapons, as the home of a crucial facility for the biomedical community? Why was the project under the direction of a theoretical physicist? And how did this unusual setting shape the development of GenBank? The different archives pertaining to the creation of GenBank point into different directions. However, the new technologies for the electronic collection, management and distribution of data offered by Los Alamos seem to have been the crucial arguments for the NIH and its biomedical consultants. These technologies were part of a broader strategy to insure the close collaboration of the numerous individuals producing the data in the biomedical community. Thus, the creation of GenBank illustrates, before the Human Genome Project, the role of electronic information technologies in expanding the scale of cooperative biomedical research at the end of the 20th century.

Steve Sturdy

Scientific method for medical practitioners: The case method of teaching pathology in early twentieth-century Edinburgh

Historical studies of pedagogy in the medical sciences during the nineteenth and twentieth centuries have largely concentrated on how students were trained to become fully-fledged scientists in their own right. Next to nothing has been

done to explore the ways in which scientific training might have influenced the way that students approached the work of medical practice. The present paper examines a pedagogical innovation that aimed to do just that. The case method of teaching pathology, developed in Edinburgh from 1913 by the professor of pathology, James Lorrain Smith, was organised around the study of medical cases, and exemplified the integration of clinical and laboratory-based approaches to disease. This paper shows how the case method of teaching was intended to inform clinical epistemology, and relates this to the particular ideal of "method" that was seen as one of the key virtues of the scientific approach to medical education on which the Edinburgh school prided itself.

Edna Suárez

Information as "History": Metaphor and Politics in the Early Days of Molecular Evolution

The paper explores the uses of the metaphor of information in the early days of the field of Molecular Evolution, as shown by papers written by Emilé Zuckerkandl, Linus Pauling and Walter Fitch. The metaphor acquired a powerful use as a substitute for "history", while preserving some of the meanings already acquired in the 1950´s discourse of molecular biology. The talk aims to highlight the ways in which claims on the validity and superiority of molecular evidence were connected with issues of epistemic authority within the broader field of evolutionary biology. In particular, the idea that molecular characters constitute a "cleaner", and "more direct" evidence of evolution was contested by the architects of the Evolutionary Synthesis. The debate is situated within the framework of the battle for resources between traditional evolutionists and molecular biologists at the beginning of the 1960s in the United States.

Woodruff Sullivan

Radio Astronomy after World War II: A New Way of Doing Business

Investigations of the sky at radio wavelengths grew out of the intense wartime development of radar in the US, England, and Australia. For many years the practitioners in this field, largely physicists and electrical engineers, knew little astronomy and had little relation the astronomy establishment. Even as wholly new phenomena we to re being discovered in the sky, this led to fundamental errors in the astronomy that was done and a lack of acceptance by many in the old guard. Eventually, however (by the mid to late 1950s), the situation changed and the new field of "radio astronomy" in fact created the field of "optical astronomy" (which had until then been simply "astronomy"). In this paper I will use contemporary correspondence, reports, and publications to trace the changing terminology as a proxy for the attitudes towards the status of the problematic "semi-astronomers."

James Sumner

Liquid Assets: Beer as a Chemically-Managed Commodity, 1760-1830

Beer-brewing in mid-eighteenth century England was a capital-intensive trade. London Porter, the staple urban product, appreciated tremendously in value during maturation, attracting many investors unconcerned with the underlying artisanal skills; brewing, like banking, increasingly offered an acceptable route for entry into landed society. Yet beer, unlike cash, was a bulky and volatile commodity needing scrupulous physical management. Catastrophic losses could result when a large brewhouse's production or stock went "out of order"; conversely, enormous profits were assumed to await anyone who could successfully revive sour beer by "marrying" it with new. From the 1760s onwards, breweries were increasingly receptive to natural-philosophical investigations, with both heat processes and "foxing" (infection) understood primarily as chemical effects manageable by new techniques and instrumentation; meanwhile, a profession of "brewers' druggists" emerged to "doctor" unreliable beer. To drinkers, however, these changes could suggest fraud, toxic adulteration, and a general shift towards artifice and away from the "purity" of the traditional artisan-brewer's practice. Here I consider how the major brewers worked to overcome this view: mechanisation, temperature management and chemical intervention were presented not as remedies for ills but as means to ensure a uniform, reliable drink. Ironically, this process led to the routinized management of a much shorter-lived and less robust product, and hence to the gradual disappearance of the maturation premium itself in the nineteenth century.

Justin Suran

Colin M. MacLeod & Cold War Microbiology

From his early days as a researcher at the Rockefeller Institute to his stewardship of the Army Epidemiological Board in the late 1940s and early 1950s, Colin MacLeod's career epitomized not only the emergence of molecular biology, but also the emerging significance of microbiology to the U.S. military establishment. This paper focuses on MacLeod's mid-century career to situate the early history of molecular biology in the context of World War Two. In the 1940s, Colin MacLeod, Oswald Avery, and Maclyn McCarty first pointed to DNA as the hereditary material: their 1944 paper on "the substance inducing transformation of pneumococcal types" is now a scientific classic. When their paper appeared in 1944, all three men were preoccupied by medical questions of particular interest to the military. Avery was a member of the newly created Army Epidemiological Board (AEB); McCarty was working with the Naval Medical Research Unit at the Rockefeller Institute and on active duty in the Navy Medical Corps; MacLeod headed the AEB's Pneumonia Commission. When their DNA paper appeared, MacLeod was supervising a major clinical trial of a pneumococcal pneumonia vaccine at the Army Air Force Technical School in Sioux Falls, South Dakota. In the 1950s, MacLeod would become a member of the seven-man Epidemiological Survey Commission with oversight responsibility for the biological weapons program at Camp Detrick, Maryland. This paper focuses on the career of Colin MacLeod to connect the familiar story of "the discovery of DNA" to a less familiar one: how biological scientists became deeply embedded within the postwar national security apparatus.

Peter Susalla

Conflict or Consensus? The Neglected Middle Ground Between "Old" and "New" Astronomy, 1890-1910

Some of the most important developments in astronomy during the late 19th century were those in the area commonly known as "astrophysics." Historians tend to view astrophysics as distinct from the positional astronomy that it largely supplanted, arguing that the astronomical community was characterized by antagonistic proponents of the two research fields. Although astronomers recognized differences between the "new" and "old" astronomy, I will argue that many understood the importance of cooperation and a diversity of research practices. In particular, the formation and naming of the Astronomical and Astrophysical Society of America (AASA) in 1899 demonstrated not a division among astronomers, as historians argue, but an effort to preserve unity within astronomy and to maintain interdisciplinary relationships with physicists. I present case studies from the career of astronomer George Cary Comstock, a founder of the AASA and director of the University of Wisconsin Washburn Observatory. Comstock has been seen as an "old" astronomer, but his research in the 1890s and 1900s shows that he welcomed astrophysical methods, such as in his study of the effective wavelength of starlight and his contributions to the so-called "sidereal problem," alongside the methods of positional astronomy. I will argue that this research demonstrates a significant, but overlooked middle ground between positional astronomy and astrophysics at the turn of the 20th century.

Akihito Suzuki

Medicine, Climate, and Global Immigration in the Japanese Empire 1930-1945

This paper explores the historical intersection of medicine, climate and global immigration in the Japanese Empire in 1930-1945. Particular emphasis is laid on how Japanese colonial medicine conceptualized the malleability of human body in different climates in order to approve Japanese immigration to the ever-widening sphere of the Empire. History of colonial medicine has focused upon tropical or indigenous diseases, how the climates, inhabitants, and societies of colonies were conceptualized as a dangerous and pathological "Other". Colonial medicine had, however, another important element of studying the adaptability of the immigrants to the local climates: whether the Western bodies could acculturate themselves to tropical climates. Colonial medicine thus had to deal with the two distinct or almost contradictory aims of arguing the Otherness of the tropics and of claiming the possibility of human bodies to overcome the climactic barriers. The latter problem was particularly acute for the colonial medicine of the Japanese Empire, since it extended over the vast realm from extremely cold Manchukuo to the typically tropical Pacific islands and countries in South Eastern Asia. This paper will examine how Japanese doctors tackled the question of the acclimatization of the Japanese body in the diverse climates of its Empire. Their attempts to draw evidences from various disciplines such as

geography, climatology, population studies, and archeology of early humans will be discussed. Through combining those diverse disciplines, I would like to argue, a segment Japanese colonial medicine was transformed into the total and interdisciplinary study of the environment, climate, and civilization.

Kara Swanson

Scientific Men, Working Ladies, and the Inventive Community in the Antebellum United States Patent Office

From the 18th century, when Benjamin Franklin eschewed any patent for his famous stove, to the 21st century, when university professors negotiate technology transfer agreements, there has been a perceived tension between the roles of scientist and inventor in the United States, frequently made visible by the process of patenting. In the antebellum period, this tension manifested itself in a debate about what manner of person was best-suited to act as a patent examiner. Through the pages of the Scientific American, published by one of the largest patent agencies, the inventive community was encouraged to see itself in opposition to the so-called "scientific men" who were staffing the patent office. At the same time, these "scientific men," college-educated participants in the tiny but growing American scientific community, were confronted by a working lady in their midst, Clara Barton, hired as a patent clerk at a salary equal to her male colleagues. Her presence was a continuing source of controversy. The dual sets of conflicts about the appropriate gender and skills of patent examiners illuminate the early history of separation of science and technology, and the gendered nature of that separation, demarcations that became more important and solidified in the second half of the 19th century with the establishment of graduate programs in science and engineering, and with increasing employment opportunities for both "scientific men" and inventors, although not necessarily for working ladies.

Edith Sylla

The Place of Jacob Bernoulli's The Art of Conjecturing in the History of Mathematics

Although Jacob Bernoulli's name is known to historians of early modern mathematics and science, his contributions, together with those of his brother Johann Bernoulli and, indeed, those of their mentor Gottfried Wilhelm Leibniz, have not been sufficiently integrated into historical narratives of the rise of modern science. In preparing my recently published English translation of Jacob Bernoulli's *Ars Conjectandi*, I have tried to put Bernoulli's work into its historical context. With a bow to Marshall Clagett's Archimedes in the Middle Ages, I propose to lay out the array of earlier mathematical publications that provide the background to Bernoulli's effort to create a new mathematical art of conjecturing. In the words of Clara Silvia Roero, Jacob Bernoulli was an attentive student of the works of Archimedes. What other mathematical works did he read and who read his work?

Samuel Talcott

Kant's concept of race and the science of living things

Recent literature has made much of Kant as the first proponent of a scientific concept of race. This paper argues that his writings on this concept, born out of contemporary debates about the classification of human beings and also the genesis of living things, agrees with the Kantian science of living things as laid out in his *Critique of Teleological Judgment*. Reading this text and the works on race together, then, can provide insight into the difficulties involved in knowing the living, especially the human world, that lead Kant to abandon mechanical causality as the method for the nascent biological sciences. Yet his appeal to purposiveness in the science of living nature is not without major difficulties of its own, as the writings on race attest; thus the paper highlights the dangers of employing such reflective judgments about purpose in the attempt to produce scientific knowledge of human difference. The paper closes with a consideration of the problems inherent in Kantian anthroplogy and the possibility, or impossibility of such a science of man.

Colin Talley & Howard Kushner

Public Health Science and Smoking in Atlanta, 1964-2006

Since the 1980s tobacco control scientists have pursued a policy of demonizing cigarettes in order to reduce the prevalence of smoking in the United States. For example, health educators moved from warning the smoker about the danger and hazards of smoking to focusing on the danger the smoker posed to nonsmokers, especially children. Elements of this have

included directly attacking the tobacco industry as a vector of disease and the social stigmatization of smokers. It is not known precisely how this population-based strategy has affected individual smokers' behavior or the behavior of various sub-populations of smokers. This is in part because the tobacco industry has attempted through advertising and other means to counter its demonization and smokers' stigmatization. This paper, based on an extensive examination of newspapers reports, advertising, local publications, minutes of local government meetings, and interviews with current smokers explores how these countervailing influences have affected smokers in the cultural environment of Atlanta, Georgia from 1964 to the present. Of particular interest is the effect of the perception of doing harm to others on local health policy and smokers' behavior. In other words, to what extent have health educators and policymakers cultivated the image of the smoker as an antisocial perpetrator, to what extent have smokers resisted or incorporated this into their self-image, and what effect has this had on smoking prevalence in the local population?

Lucia Tanassi

Anatomy Biopolitics: Plastination between Dismemberment and Performance

Since 1996 Gunther von Hagens and the Body Worlds exhibit of real human bodies have toured the globe. Von Hagens' own premise was to redefine classic anatomy, and demystify and democratize modern anatomy. The recent proliferation of Plastination exhibitions in the United States seem to have set in motion the creation of what Giorgio Agamben calls "zones of exception" where Plastination appears to support the "habituation" process where individual bodies are refashioned into universal, anatomical bodies and vice versa by dismembering, obscuring or reconfiguring body individuality and identity. This paper examines the underlying ethical and biopolitical tension embedded in the social life of the cadaver in relation to the popularity of Plastination and the recent scandals surrounding the misappropriation of cadaveric tissues.

Joseph Taylor III

Peeking into the Black Box: The Science and Politics of Mapping Pacific Salmon Migratory Patterns

The Pacific Ocean Shelf Tracking Project (http://www.postcoml.org/index.html) was recently funded by a number of natural resource research and management organizations to construct a series of listening arrays in the Northeast Pacific Ocean for the purpose of tracking ocean migratory patterns of Pacific salmon runs (Oncorhynchus spp.). The POST Project is the latest and, by any measure, most technologically advanced effort to limn the movement of fish, but its spatial focus reveals that social and natural structures have constrained it as much as the earliest ocean tagging experiments. This paper will review the history and geography of ocean tagging experiments of Pacific salmon since the 1910s and place them in a broad context of international diplomatic efforts to resolve fishery disputes between the United States, Canada, Japan, and the Soviet Union/Russia and modern endangered species listings. Political and ecological contexts are crucial for understanding the intellectual and geographic limitations of research on the ocean phase of Pacific salmon during the last century.

Tracy Teslow

Reveries of Race Mixing: Travelogues, Potboilers, and Popular Anthropology

From its inception in the nineteenth century well into the twentieth century, physical anthropology was preoccupied with the "problem" of race mixing. In America, miscegenation was initially associated with slavery, with hysterical policing of racial boundaries, and, ultimately, with pervasive anxieties surrounding the preservation of whiteness and the assimilation or segregation of various racialized "others." In the 1920s and 1930s, anthropologists, eugenicists and other writers strode into this racial maelstrom with scientific and literary texts meant to explore and elucidate the consequences of race mixing for eager popular audiences. My paper will offer a preliminary analysis of two texts drawn from this broad discourse. One is an anthropological study of race mixing in Polynesia, *Heritage of the Bounty*, by Harry Shapiro, and the other is a serialized story set in Africa, by George Schuyler. In both cases, the authors employed literary, travel narratives set in distant, exotic locales to explore the complexities of race and intermarriage. In 1939, Shapiro, a physical anthropologist at the American Museum of Natural History, published a narrative of his sojourn on Pitcairn Island with the descendants of the mutineers from the Bounty and their Tahitian wives. Convinced that the bodies and lives of the

Pitcairn islanders would refute arguments against race mixing, Shapiro constructed for the public a vision of Polynesian intermarriage that combined elements of racial science with sensitivity to cultural and historical contexts. Participating in the longstanding fantasy of Polynesia as an interracial paradise while simultaneously critiquing that vision, Shapiro used Pitcairn Island to shape how race and racial mixing were viewed in America. Like Shapiro, Schuyler, a leading African American writer and newspaperman, also sought to shape American perceptions of race and intermarriage. Published in the mid-1930s in the *Pittsburgh Courier*, Schuyler's serialized fictions of the African jungle used this already well-worn literary trope to explore blackness, whiteness, and racial mixing through a popular medium meant to reach a wide black audience. My paper sketches how Shapiro's and Schuyler's imaginative, literary texts were part of a broader discourse of anthropological racial constructs in interwar America.

Bert Theunissen

The 'Holsteinisation'of the Dutch dairy cattle breeds in the 1970s and 1980s

Until the 1960s, Dutch farmers prided themselves on their dairy cattle as being the best in the world. Since the 1880s Dutch Friesians (known as Holsteins in the U.S.) had provided the breeding stock for the dairy herds in Europe and beyond. Around 1970, however, the Dutch faced serious competition from American breeders. The latter had concentrated their selection efforts on the production of milk, whereas the Dutch had bred their Friesians as a double purpose breed, producing meat as well as milk. The competition began in the 1960s, when breeders everywhere began to ask themselves which breed was the most economic. Comparative research on this problem was undertaken by the Dutch Agricultural University at Wageningen, and at the same time Dutch breeders began to experiment on their own with Holstein sires. A prolonged debate ensued between breeders, farmers, the herdbooks and scientists on which breed qualities should be selected for. Yet long before the final results of the comparative experiments were available, the 'Holsteinisation' of the Dutch dairy herds began, and it continued until the Dutch double-purpose breed had been replaced by the Holstein milk breed. This result is surprising since the herdbooks, the scientists involved and even most breeders had advised strongly against a complete Holsteinisation. In my paper I will try to explain this outcome by unravelling the dynamics between scientific, practical and economic considerations involved in the process.

Michele Thompson

The Natural Laws of Reproduction and Inheritance in Nguyen Dynasty Vietnam, 1802-1945

The nature versus nurture debate regarding human traits, physical and mental, is not new. Societies worldwide have discussed physical inheritance and social influence for millennia. The Nguyen Dynasty (1802-1945) provides an interesting case study regarding this debate. The Nguyen was the most sinified of all Vietnamese dynasties in political structure and social norms, it was also the only Vietnamese ruling house to be colonized by a Western power, namely France. It is generally accepted that Vietnamese Traditional Medicine acquired most if not all of its medical theories from Chinese Traditional Medicine. My earlier research has indicated that the Vietnamese, under the Nguyen, were rather open to Western medical techniques even when the theoretical constructs those techniques were based on ran directly counter to Chinese medical theories. This paper will give an overview of traditional Vietnamese concepts regarding reproduction and physical inheritance and what were considered to be natural laws governing conception, pregnancy, and childbirth. The paper will then move to an examination of the Vietnamese response to the Chinese theory of tai du or fetal poison which was thought to predispose a child to certain medical problems. This 'class' of afflictions was thought to be congenitally transmitted. Ideas of what is congenital or what is hereditary are tied to concepts regarding the physical relationship between mother and fetus, father and fetus, mother-father and fetus and between the fetus and all those who are seen as its kin. The paper will conclude with a discussion of the impact of Western ideas regarding reproduction and physical inheritance as they were presented to the Vietnamese by the French.

Rajive Tiwari

Astronomy Education and Religion in Colonial India

The introduction of Western astronomy in Indian education was used as a way to legitimize the colonial rule by emphasizing its superiority over the traditional indigenous views of the universe. Traditionally in India, there had been

two distinct ways of understanding the universe - a religious view replete with lores about different natural phenomena and a rationalist view based on mathematical astronomy. Some British officials ignored the rationalist tradition and singled out the religious views of Hindus to prove their intellectual inferiority. Christian missionaries working in India projected their own religion as being compatible with the truth of the Western science and hence superior to Hinduism. Two notable British science educators, L. Wilkinson and J. R. Ballantyne, working in India made clever use of the traditional indigenous scholarship as a pedagogical tool for pushing European science. Their ultimate goal, however, remained the strengthening of the colonial rule and the spread of Christianity.

Beth Tobin

The Duchess's South Pacific Shells: Gift Exchanges, Commercial Networks, and Regimes of Value in Natural History Collecting

This paper examines the intersection of natural history with the culture of collecting. In my attempt to understand the cultural implications of the practice of natural history collecting, I focus on Margaret Cavendish Harley Bentinck, the second Duchess of Portland (1715-1785), who possessed one of the finest shell collections in all of Europe. The Duchess of Portland was a collector of natural history specimens, including shells, insects, fossils, birds, and plants, as well as a collector of fine and decorative arts, ranging from seventeenth-century European paintings to snuff boxes to antiquities, namely the Portland Vase, now housed in the British Museum. The breadth of the duchess's activities as a collector and the depth of her collections are beyond the scope of this paper, but should be acknowledged as we attend to one aspect of her multiple interests. According to Thomas Martyn in The Universal Conchologist (1784), the duchess had the largest and finest shell collection in Britain, if not all of Europe: "In this branch of science her Grace's superior knowledge is as well known as it is eminently demonstrated, in the critical arrangement of this immense cabinet, which altogether justifies the very great expence of time and money employed in the formation of it." Not only did the duchess collect shells, she understood Linnean taxonomy and worked hard at mastering the intricacies of classification. For a collector, the duchess was impressively engaged in the science of her shells, though she had recourse to the assistance of naturalists, such as Rev. John Lightfoot and the taxonomist Daniel Solander, on loan from British Museum. When she died, her collections of shells, coins, art, and classical statuary and other antiquities, including the Portland Vase, were sold at auction. The sale lasted for 38 days, her shells constituting the majority of the items for sale. At this auction were collectors and their agents from Britain and Europe, who bought her shells, some of which were very rare and from Cook's voyages to the Pacific. I approach the topic of the duchess's accumulation and exchange of shells, not only as an episode in the history of science but as a topic that can benefit from viewing shells as material culture. This mini-ethnography of shell exchange in late eighteenth-century Britain is one that focuses on the language in which the actors in the exchange of shells describe these material objects, the processes by which shells were accumulated and displayed, and the values and meanings these objects possessed. In addition to borrowing my methods from anthropology, I have made use of ideas from economic anthropologists, such as Christopher Gregory, Annette Weiner, Arjun Appadurai, and Nicholas Thomas, who have grappled with the question of value and exchange and the differences and similarities between the gift and the commodity within Pacific Islander cultures. While my theoretical borrowings are not deployed in an explicit way, they inform my close attention to the gift and commodity potential within the shell exchange. Shell exchanges within European societies were very complex, participating in gift as well as commodity economies, archaic as well as modern forms of exchange. Early modern European society was undergoing the transition from a quasi-feudal, hierarchical social and economic structure to the modern's capitalized, commercialized economy structured around the contract. Shell collecting in the late eighteenth-century was a site of contradiction as these two economies, one based on hierarchy, patronage, and the gift exchange, and the other organized around commercialized exchanges of the marketplace, overlapped and penetrated each other, producing confusion for its participants as they bought, sold, gave away, traded, and loaned shells to their fellow collectors. To capture the complexity of the social interactions and economic practices involved in shell collecting, I examine the duchess's correspondence with Richard Pulteney, a provincial doctor, amateur botanist, and author of The Progress of Botany, and Henry Seymer, a country gentleman and an avid collector of natural history specimens, to explore the cultural implications of the shell exchange.

Achim Trunk

A Triple 'Pseudo' Project? Non-Existent Enzymes as Tools in Racial Research Conducted on Auschwitz Inmates

The contribution deals with one of the most widely discussed research projects in German life sciences during National Socialism. It presents a short overview on the controversy about the project and then asks about the viability of the analytical category 'pseudoscience' in this special case. The project was taken up in 1943 by hereditary pathologist Otmar von Verschuer in Berlin. Verschuer received blood samples taken from inmates of the Auschwitz extermination camp. These were sent to him by his former doctoral student, the SS physician and Auschwitz 'Angel of Death' Josef Mengele. The samples were prepared in Berlin, with staff and laboratories lent by Verschuer's eminent collegue Adolf Butenandt, 1939 Nobel Laureate in Chemistry. Methodologically, the project was based on the so-called 'defence enzyme reaction', also known as 'Abderhalden reaction', named after its inventor, Swiss biochemist Emil Abderhalden. Obviously, Verschuer was looking for serological traits he thought to be characteristic for human 'races' – but the reconstruction of his research aims is still controversial. The author's reconstruction is that the blood samples were collected for the purpose of developing a racial diagnosis based on serological principles. Categorisation of the project as 'pseudoscience' is possible in three respects. First, defence enzymes actually do not exist – they have indeed been characterised as the 'Abderhalden Fraud'. Second, the notion of Human Races is – to say the least – obsolete. And third, research on victims of Nazi extermination policy is already ethically objectionable as such. The paper will assess the scientific status of this project using each of these three criteria.

James Turner

Thinking Big: Conservation Biology and U.S. Public Lands Advocacy, 1975-2000

Conservation biology transformed the scientific-advocacy goals of the environmental movement during the last quarter of the twentieth century. Much of the existing scholarship on conservation biology, however, has focused on the interface between scientists and advocacy in the international arena. In this paper, I examine the relationship between conservation biologists and environmental advocacy organizations with a focus on U.S. public lands politics. Drawing on the archives of environmental organizations and papers of and interviews with scientists, I argue that considering U.S. public lands debates reveals how conservation biologists pursued their scientific research amid a contested dialogue that engaged mainstream environmental groups, such as the Wilderness Society, and more radical environment groups, such as the Wildlands Project. By situating scientists and their work in this political geography we can begin to understand the historical interconnections between science and advocacy that have shaped U.S. environmental science and politics. I argue that this alliance of science and advocacy helped drive the political polarization that has characterized U.S. environmentalism since the 1980s.

Christina Turner

The Early History of Gravitational Lensing

The classic starting point for the officially recorded history of gravitational lensing is Einstein's December 1936 short paper in the journal *Science*, though the effects of gravitation upon light has been discussed since the eighteenth-century. Gravitational lensing was first observed in 1979 and has since been detected in a variety of astrophysical bodies. The talk recounts the history of the concept of lensing by massive bodies, from the early discussions of Michell and Laplace, Cavendish's initial derivation and the experiments of Marat, through the calculations of Soldner and Einstein (pre-General Relativity), and finally, to Zwicky's visionary ideas. Comparisons between Chwolson's 1924 "halo effect" paper and Einstein's 1936 paper will be made. The role of Link, who made detailed calculations of the effect, will be noted and compared to the ones played by Mandl and Freundlich. The development of cosmological applications will also be detailed.

Sabetai Unguru

Interpretation and Overinterpretation of Apollonius's Conica

I shall argue that there are really only two ways of reading the *Conica*, or any other historical mathematical text. Although there may be different interpretations, they all amount to just two fundamental approaches. The first of these

treats mathematical texts at face value; it assumes that authors' intentions, as revealed in their texts, are what they (authors and/or texts) say they are, and that the authors have done their best to make their ideas clear, however strange or obscure their language or exposition may seem to us. The other way treats texts as fundamentally obscure; it assumes that authors reveal only dimly, or even dissemble, their intentions; texts, in this way, must be unmasked to be understood. The first way of reading historical mathematical texts is the historian's way; it is the way Michael Fried and I have tried to read Apollonius in our own work on the *Conica*, *Apollonius of Perga's Conica: Text, Context, Subtext* (2001). The second way of reading texts actually covers a range of possibilities, from the legitimate, but wrongheaded, way of the mathematician to readings that take even the mathematical subject matter as if it were mere surface matter, insidiously concealing the author's true message. The best and deepest illustration of the mathematician's way, which tries to uncover the 'true' mathematical content hidden behind the author's unrevealing, mathematical mode of presentation, is, in the case of the Conica, H. G. Zeuthen's *Die Lehre von den Kegelschnitten im Altertum* (1886). The illegitimate variant of this kind of reading is one in which the author of the text becomes so obscured that only the reader is left, or the reader and author become hopelessly confounded. Richard Rorty has built a philosophy around this way of reading texts. Fortunately, Rorty never took up the *Conica*, but we, I and Fried, have unearthed an author, Jacques-Michel Davidoff, who has.

K (Kenneth) Valente

'Who Will Explain the Explanation?': Higher Dimensional Spaces and Spiritualism in Britain, 1875-90

The possibility that space is not restricted to three dimensions, together with its inherent implications, captured Victorian imaginations at about the same time that modern Spiritualism emerged in Britain. Combining this temporal conjunction with certain explanatory scenarios hinted at in higher dimensional discourses, Johann Zoellner's association of 'spirits' with four-dimensional space being the most explicit, might be enough to persuade us that Spiritualists were eager to discuss and disseminate these ideas. Indeed, since the 1960s, several popularizers of mathematics and its history have strongly suggested such. However, a careful examination of the most influential British periodicals dedicated to furthering the cause of Spiritualism during the years 1875–90 provides little evidence to support a claim that their contributors or readers seriously embraced higher dimensional possibilities. This paper explores lay engagements with scientific and mathematical innovations in redressing an apparent historical misunderstanding and considering why Spiritualists of the period were seemingly reluctant to endorse or exploit the concept of four-dimensional space.

Stephane Van Damme

Philosophical Mobility within European Capital Cities Between Scientific Practices and Sociability : A Comparative Study.

It is very common today in the postmodernist literature to identify nomadism to philosophical thinkers, from Descartes to Derrida. Beyond the singular practices of great traveling scholars, historians have paid less attention to the culture of mobility shared by philosophers and scientists within metropolis. In the case of scientist, philosophers, professors, many studies had revealed a vast range of long-distant practices of circulation which included along side perigrinatio academica, the grand tour, scientific expeditions, but the short-range distant movements such as botanization, walks, findings, mineralogical, geographical and astronomical mobile practices, which invented a new relationship with the city. Through the analysis of three centres of knowledge (Paris, London and Edinburgh) from the middle of the seventeenth-century to the end of the eighteenth-century, this paper will ask what is at stake in the circulation of scientist or natural philosophers within the metropolitan space. By focusing on displacement within the city, I would like to assess the possible effects of these circulations on the transformation of local and customary culture into a metropolitan one. This transformation involved new forms of mobility and sociability adopted by capital elites. At the turning point of the seventeenth and eighteenth centuries, I will suggest that the profound changes in the culture of mobility of scientists contributed to the modification of the metropolitan culture, by producing a shift from a very localized and monumental conception of the classical city to a flowing and energized metaphor of modern capital.

Jeroen van Dongen

German Reactionaries and Einstein's Fame: The Anti-Relativity Campaign of 1920

In the summer of 1920, two events greatly disrupted Einstein's life: the anti-relativity rally in Berlin's Philhamonic Hall and the 'Einstein-debate' in Bad Nauheim at the meeting of the German Society of Scientists and Physicians. These not only impacted on his personal life, but also his public persona; fears abounded that Einstein and his family might give cause to further fuel the charge of unduly advertising his work. We will review this episode in light of new documentary sources as they have become available through the publication of Volume X of the Collected Papers of Albert Einstein.

Frans van Lunteren

Individualism and Bureaucracy in Science: Opposing the Metric Convention

Both in the 1790's and the 1870's Paris hosted international meetings concerned with the standardization of weights and measures. In both cases Dutch scientists played a prominent role in the negotiations. But there is a striking contrast in the political maneuvers of the Dutch state following each of these conferences. Whereas in the 1810s the Netherlands had been one of the few European states to adopt the new metric system, in 1875 the Dutch were exceptional in their refusal to sign the Metric Convention which involved the establishment of the International Bureau of Weights and Measures. In both cases these political decisions were predominantly based on the advice of the Dutch representatives at the international conferences. In the latter case we are dealing with Johannes Bosscha, professor of physics at the Delft Polytechnic. In Dutch scientific circles Bosscha's opposition to the establishment of the Bureau and his negative advice to the government had been highly controversial. It is perhaps telling that immediately after Bosscha's decease in 1911 the Dutch Academy advised the government to support the Bureau. Pieter Zeeman's entry into the Comité International des Poids et Mesures 1929 finally ended the Dutch isolation. In this talk I will discuss Bosscha's steps and motives as well as the resulting disputes in the Academy with the reputed physiologist Franciscus Donders. At the bottom of this controversy were different loyalties as well as different perceptions of the relationship between science and the state.

Jitse Vandermeer

Georges Cuvier and the Use of Scripture in Geology

Historians disagree on whether religion has affected Cuvier's science. Those who deny such influence do so for two reasons. They have failed to see that Cuvier uses the Christian scriptures as a source for general perspectives on nature. But they have also missed his use of the Bible as source of factual information because it did not start until the second and later editions of the *Discours preliminaire*. These editions show that Cuvier treated the Bible both as a book with divine authority and as a source of information about nature and history. He distanced himself from a speculative geology based solely on Bible texts, but he accepted what he considered a responsible use of Bible texts as givens in accounting for the features of the earth, of organisms and of ancient civilizations. This use was limited by an awareness of the accommodated language of the texts and called for the development of a stronger empirical alternative based on the standard belief that God's work in nature agrees with that in scripture. At most, the general idea of geological catastrophes may have been inspired by the story of the Flood, and the definition of biological species by the story of creation of pairs of animals and the first human couple. In using the principle of accommodation, Cuvier positioned himself between the literalism of Scriptural geologists and the theological liberalism of higher criticism. His distance from higher criticism is shown not only by his acceptance of Moses as the single author of the Pentateuch, but also by his use of the Pentateuch as a source of factual information as well as by his use of the Augustinian principle of accommodation. The latter also marks his distance from the literalism of Scriptural geology.

Theodore Varno

Sewall Wright at the Bureau of Animal Industry: Inbreeding and the Agricultural Roots of the Modern Synthesis

Between 1884 and 1953, the Bureau of Animal Industry of the U.S. Department of Agriculture sponsored scientific investigations of livestock diseases and animal husbandry techniques. Among these was an enormous long-term guinea pig breeding project to study the effects of close inbreeding, begun in 1906. Nearly a decade into the project, after seeking the advice of geneticist William Castle of Harvard's Bussey Institution, the Bureau hired a young Sewall Wright, later

famous for his work in theoretical population genetics, to take over the project and help resolve its complex analytical difficulties. The paper describes Wright's work at the Bureau of Animal Industry from 1915 to 1925, examining how it both broke from and continued lines of investigation of inbreeding that had been on-going since the middle of the nineteenth century. The paper explores how the needs of an agricultural bureaucracy promoted the type of statistical population modeling that would become central to the modern synthesis.

Koen Vermeir

Divination and the Circulation of Contested Knowledge cCaims (1690-1720)

In 1688, a peasant from the south of France discovered that he could trace criminals with his divining rod. After solving some difficult criminal cases and after some experiments were performed in the province, his fame spread rapidly. He was brought to Paris by the Prince de Condé and by the Académie Royale des Sciences for a rigorous test of his divinatory capacities. Simultaneously, many tracts were published by natural philosophers who attempted to find out the causes of this wondrous new phenomenon, while others set out to discredit the capacities of the diviner. The case sparked off an international controversy that reverberated in England, the Netherlands and Germany. A close study of the tests performed with the diviner will allow me to highlight the difference in attitude and experimental procedures between capital and province. Furthermore, the ensuing controversy is an excellent locus for tracing the circulation of contested knowledge claims from the provinces to Paris as well as to other European cities. Central to the debates was the question of what happened when knowledge was circulated. Some natural philosophers constructed a subtle epistemology of the human body in order to defend the primacy of situated knowledge against demands for universality. Things change when they are circulated and put in different contexts, they claimed. Others protested that natural phenomena always worked 'in a constant and uniform way'. By means of an analysis of this vehement and wide-ranging controversy on the naturalness of divinatory phenomena, I will be able to unearth some of the core issues at stake in contemporary debates on the circulation of knowledge.

Janet Vertesi

Images of Instruments: the Visual Rhetoric of Virtual Witnessing in Hevelius' Organographia

Instruments were not only put to use in the laboratory: they were also pictured for external circulation along early modern scientific networks. Shapin and Schaffer (1985) have argued for the importance of such images to experimental virtual witnessing, and historians of science today still use these artifacts as evidence for how, where or by whom an instrument was used. But while images of instruments may bring distant outsiders into the laboratory space, in doing so they can be used to promote a particular vision of practice or to attempt to secure their owner's status among an external community of practitioners. This paper takes the case of *Hevelius' Organographia* (1674) to argue that pictures of instruments do not, in fact, offer the analyst a transparent frame through which to witness historical experimental apparati: even images of Hevelius's sixty foot telescopes offer more than meets the eye. Placing Hevelius' detailed plates – often assumed to show us 'what his observatory was like' – into the context of his debate with Hooke over telescopic sights and his position in a private observatory far from the centers of natural philosophy, reveals a crafted vision of his astronomical practice and skills, a careful self-presentation to a professional network, and a claim as to which instruments and instrumental techniques guarantee trustworthy observation. Through close analysis of Hevelius' instrumental images, their production and reception, this paper explores how picturing instruments can promote a particular kind of virtual witnessing experience and naturalize an observational agenda, suggesting renewed analytical attention to the role of images in instrumental cultures in the history of science.

Ayo Wahlberg

Caught in Transition – Traditional Medicine and the Emerging Problem of 'unhealthy lifestyles' in Vietnam

In many countries, traditional or alternative medicines are often viewed as incompatible or incommensurable with western medicine. Indeed they are often portrayed as the quite literal remedies to the numerous dehumanising and toxic side effects that have been attributed to the 20th century professionalisation, modernisation and bureaucratisation of

modern medicine. Somewhat in contrast, Vietnamese health officials, doctors and traditional practitioners alike have since 1955 been engaged in a concerted effort to combine the effects of traditional and modern medicine, resulting in a number of unique collaborations as well as one of the world's few 'integrated public health systems'. In this paper, I argue that the recent mobilisation of traditional medicine in national public health efforts must be placed within the context of what the Ministry of Health has identified as an ongoing epidemiologic transition from infectious disease towards lifestyle-related illnesses. This has required on the one hand a scientific modernisation of traditional medicine and on the other a differentiated health promotion strategy in which the use of traditional medicine is targeted differently in rural and urban areas of Vietnam. Moreover, a division of competences has emerged whereby acute or life-threatening conditions are referred to modern medicine specialists while traditional practitioners are often preferred in cases of chronic illness.

Scott Walter

Henri Poincaré's Correspondence with Physicists, Chemists, and Engineers

Henri Poincaré's engagement with physics was an enduring one, spanning almost the entire length of his scientific career. It was also singular, in that he pursued investigations of questions of pure and applied physics in parallel with research in analysis, topology, geometry, celestial mechanics, and philosophy of science. Historians have illustrated Poincaré's innovative approaches to questions of mathematical physics, and his critical, but largely solitary evaluation of leading theories: Maxwellian electrodynamics, kinetic theory, Newtonian gravitation, the electron theories of Larmor and Lorentz, and quantum theory. This image of Poincaré's practice of physics contrasts with one formed on the basis of an analysis of his correspondence with physicists, chemists, and engineers (Correspondence of H. Poincaré, Vol. 2, Birkhäuser, Dec. 2006), underlining the importance of manuscript sources to our understanding of modern scientific practice.

Adam Warren

"Monsters" and Their Meanings in Colonial Peru: An Examination of the Birth of Conjoined Twins in 1694

This paper examines how the birth of conjoined twins in Lima, Peru, in 1694 transformed debates among doctors and natural philosophers in the viceregal capital about the boundaries between human, animal, demonic, and divine in the environment of the New World. Focusing on José de Revilla Bonet y Poeyo's *Desvíos de la naturaleza o tratado del origen de los monstruos* [Detours of Nature or Treatise on the Origin of Monsters] and linking this work to a series of other eighteenth century medical and theological texts, my work suggests that the ideas of the "monster" and the unusual birth raised profound questions about the ways in which the female body responded to a series of external influences in the New World, among them climate, the environment, the constellations, and the supernatural. Moreover, drawing on widespread beliefs about Afro-Peruvian women as prone to give birth to monsters, as well as a series of tales in early colonial chronicles about indigenous populations who created "monsters" by engaging in reproduction with animals, especially monkeys, doctors and natural philosophers envisioned a colonial world in which the ability of the rational soul to occupy all human (or partially human) bodies was a subject of considerable doubt. The ability of the Devil to occupy such bodies through his pervasiveness in the New World, however, remained a near certainty and a subject of philosophical and medical investigations.

Cecelia Watson

And My Picture, of Course, has Not Altered: John La Farge's Influence on the Psychology and Philosophy of William James

Before he enrolled in the Lawrence Scientific School, William James studied art under William Morris Hunt. James intended to make a career of painting, and he spent many hours studying and discussing art with his friend and fellow student John La Farge. La Farge became a well-known painter, stained-glass artist and art critic, and, although James decided to devote his energy to science, he and La Farge maintained a lifelong friendship. But their relationship was more than a simple social tie for James; it was a source of intellectual inspiration: James declared late in his life that ever since he and La Farge had studied art under Hunt, he had been contemplating La Farge's technique and his theories of art. James read each of La Farge's books, many of which employ DaVincian metaphors identical to those James uses in some of his psychological and philosophical writings. James also told La Farge that Delacroix's artistic philosophy as La Farge

described it mirrored James's own pragmatic philosophy. But despite these biographical, theoretical and literary intersections, little attention has been given to La Farge's substantive influence on James's psychology and philosophy; the few historians who have seriously considered the idea that James's art training influenced his psychology and philosophy do not fully explore the relationship between James and La Farge and their writings. My paper explores in detail La Farge's influence on James: I argue that the traces of it are unmistakable in James's scientific and philosophical ideas; and I consider what the parallel ideas of James and La Farge might reveal about art and science in general in the late 19th and early 20th centuries.

Nadine Weidman

Popularizing the Ancestry of Man: Dart, Ardrey, and the Killer Instinct

This paper explores the relationship between the South African paleoanatomist and anthropologist Raymond Dart and the American journalist, playwright, and Hollywood screenwriter Robert Ardrey. Renowned since 1925 for his discovery of the fossilized remains of the most ancient human ancestor known to that point, Dart had begun by the late 1940s to represent this proto-human ancestor not only as a hunter but as a bloodthirsty killer. Ardrey met Dart while on journalistic assignment in South Africa in 1955 and, much impressed by the logic of Dart's arguments and by his fossil evidence, became a publicizer and public defender of Dart's views on man's violent ancestry. The claim that human beings possess as their ancestral heritage an instinct for aggression exploded into the American popular media with the publication of Ardrey's best-selling book *African Genesis* in 1961. Written as a breathless narrative of personal discovery, *African Genesis* performed a remarkable feat: it removed Dart's fossil from its South African context and transformed it into the basis for what Ardrey proudly proclaimed was a new science of human nature. I will suggest that Ardrey accomplished this feat in three distinct steps: first, by gaining the trust of Dart and his anthropological colleagues; second, by inserting himself into the complex controversies that surrounded Dart's fossil; and, third, by integrating Dart's findings with other scientific traditions to present a unified and consistent picture of man's ancestry and nature. I will argue that Ardrey's popularizations, therefore, far from low status afterthoughts without impact on the "real" science, were a necessary part of the way that the science of human aggression in mid 20th century America constituted itself as legitimate.

Alex Wellerstein

Patenting the Bomb: Nuclear Weapons, Intellectual Property, and Technological Control

Nuclear weapons are usually taken as the most prominent symbols of secrecy in discussions about science and technology in the twentieth century, and patents are usually discussed as tools of openness in literature on intellectual property; conceptually these two modes of dealing with information would seem disconnected if not completely opposed. But paradoxically, the United States government pursued patents on the first nuclear weapons during World War II. Though this history has been almost completely neglected by present day historians, Manhattan Project administrators such as Vannevar Bush and General Leslie Groves pursued an aggressive policy of patent control over all aspects of nuclear weapon production "from the raw ore as mined to the atomic bomb." The patent policy manifested itself in three interconnected practices undertaken on a scale as massive as the project itself: contract-based patent clauses which attempted to secure for the government titles to any patents relating to atomic energy and nuclear weapons; the wresting of patent claims out of the hands of project scientists; and the monitoring and censoring of patent applications from non-affiliated inventors that related in any way to the wartime bomb work. My paper will give a brief overview of this patenting program, then propose answers to two central riddles: Why did they patent the bomb, and why does such an idea seem so utterly incomprehensible today? My answer—one part historical, one part methodological—makes the case for the importance of reevaluating the role and status of secrecy in the history of nuclear weapons, and emphasizes the practical legal and bureaucratic considerations which are usually omitted from retrospective histories of the bomb.

Jacqueline Wernimont
Refiguring the Literary Family Tree: Recognizing the Place of Mathematics in a History of Literature

During the seventeenth century, the history of rhetoric and the history of mathematics converged in spectacular fashion around the concept of the *mathesis univeralis*. Imagined as a language more perfect than natural language, the *mathesis univeralis* emerged as a legitimate alternative to alphabetic discourse. Jacqueline Wernimont's paper will consider how mathematics, as an *ars inveniendi* relates to rhetorical invention, asking how early modern intellectuals understood the two modes of knowledge production to function similarly or differently. One part of this consideration will be an attempt to understand what the relationship between the emergence of 'the literary' and the *mathesis universalis* project.

Christina Wessely
Fictional Objectivity: The 'cosmic ice theory' 1894-1945

In September 1894 Hanns Hoerbiger, an Austrian mechanical engineer, had a "spiritual experience" in the course of which he discovered the Welteislehre (cosmic ice theory), a cosmogonic theory stating that a large part of the universe consisted of ice. Although it was criticised by the scientific community as the dangerous, pseudo-scientific idea of a non-academic charlatan, the Welteislehre was highly successful in the 1920s and fascinated thousands of people. In the 1930s the National Socialists adopted the Welteislehre and institutionalised it in their research organisation Ahnenerbe (ancestral heritage). The paper will mainly focus on the diverse interrelations and references of science and fiction within the Welteislehre. This scientific story-telling was not just the basis of a 'strategic dilettantism' that introduced intuition and creativity as the new epistemic virtues but was in fact the basic principle of the theory's epistemology. The use of charts, curves and tables indicated the presence of 'objective facts' while attached illustrations, drawings and photos presented science as a spectacular narrative, a field of fantasy and visual sensations. By inseparably linking these two systems of knowledge production Hoerbiger positioned his theory as the Other of modern science and established a new epistemology based on fictional objectivity.

Robert Westman
Cognizing the Copernican Revolution

Andersen, Barker and Chen (hereafter ABC) have proposed a tightly-argued and provocative rehabilitation of both Kuhn's less-well-considered theory of concepts and what they take to be his matured--as opposed to his early representation--of incommensurability. Foregrounding Kuhn's debt to and development of Wittgenstein's notion of "family resemblance" and stressing the compatibility of t his idea with recent work in cognitive science (Rosch and Barsalou), ABC argue that Kuhn's mature account of concepts is actually in accord with the way that people use language and concepts--if not all the time, then at least most of the time. They oppose their account to what they present as the conventional representation of a concept, one inflexibly grounded in necessary and sufficient conditions. Moving from this naturalistic account of concept-formation and -application, they propose to revisit and rehabilitate--indeed, virtually, to exhume--Kuhn's much-battered notion of incommensurability. Rejecting as a misreading the totalistic account of incommensurability as a complete breakdown of communication between conceptual structures, they hope to restore a nuanced and credible view of Kuhnian revolutions in science. In the halcyon days of the 1960s, there was the prospect of a hopeful and interesting marriage between the History and Philosophy of Science. By the 1980s, this marriage had broken up on the rocks of Edinburgh and the arrival of the Kingdom of Leviathan. This book seeks to revive not only the body but the soul of the original Kuhnian project. It proposes to show by detailed historical examples and streamlined analytic resources that Kuhnian revolutions can be successfully modeled. One of these cases is that of the Copernican Revolution. My comment will devote special attention to that example.

Jeffrey Wigelsworth
The Natural Philosophy of Thomas Morgan (d. 1743): Deist and Overlooked Newtonian

When historians of science engage with early-modern English deism, analysis frequently begins and ends with John Toland (1670-1722). The unblinking gaze given Toland's work has resulted in very little study of other deists especially

those who were active towards the middle of the eighteenth century. What is more, the historiographical consensus is that because Toland might be seen as somewhat hostile to Newtonian philosophy so must every deist for whom Toland is presented as the archetype. However, such an interpretation ignores the multifaceted and diverse intellectual opinions held by deists. In the writings of the physician and self-proclaimed deist Thomas Morgan (d. 1743), we see that he endorsed Newton's natural philosophy and much of Newton's theology. While Morgan deviated from other deists in his interpretation of Newton, he continued to share theological assumptions with these authors. What is more, through a comparison of Morgan's writings with those composed within the genre of public science, we see that his view of Newton was not unique. This assertion challenges our understanding of deism and the dissemination of Newtonian philosophy. It is not the case that deists, writ large, were opponents of Newtonian philosophy and the way in which Morgan understood Newton was the way most eighteenth-century British intellectuals did.

Kelley Wilder

Trusting the Photochemical Trace: Creating Quantitative Data from a Photographic Plate

This paper addresses the employment of a particular type of photography – the photochemical trace – for scientific observation. Disguised under the titles of phosphorographie, autoradiography, photogrammetry, spectrography, photology, skiagraphy and many other 'ologies' and 'ographies', this particular use of photography has flourished from the late 18th century to today, all the while maintaining an uneasy relationship with lens-based photographic imaging. The paper discusses the refinement of photochemical tracing between the 1890's and the 1970's, roughly paralleling the time period from Röntgen's discovery to the onset of digital technology. At issue is not only the increasing dependence of certain types of observing on the photochemical trace, but also the adaptation of the resulting visual image into quantitative data.

Travis Williams

Courtly Identity and Early modern Mathematics: Hyperbolical Multiplication in "The Merchant of Venice"

This paper elucidates part of the process of emergence of mathematics as a distinct discipline that was frequently and openly distanced from economic concerns by understanding early modern mathematics as a discourse that remade itself through the strategies and preoccupations of Renaissance civic humanism. Renaissance humanists recognized the importance of mathematics to efficient and ethical governance, but also wrestled with its placement between the active life and the contemplative life familiar since antiquity. The evidence of cultural production, particularly literary texts, suggests that while the benefits of mathematics were considered necessary to all ranks, the activity itself was considered inconsistent with upper rank, courtly identities. Concomitantly, mathematical activity was tainted by association with the lower ranks, apprentices, manual trades, and fools. This paper will disrupt what is, of course, a stereotype by examining the mathematical activity represented in Shakespeare's The Merchant of Venice (1596-7). In this play, facility with mathematics stands for more general facility with language and rhetoric, and how those skills shape and support courtly, sociable identities and socially generative relationships such as friendship and marriage. At the same time, however, those characters who are most mathematically proficient cannot be easily aligned with the ideal ethical stance of earlier humanist accounts of mathematics and its central role in civic life. The Merchant of Venice is thus a site (one of many) where we witness the cultural re-orientation of mathematics and its acquisition of an ethically neutral character, one component of its modern disciplinary form.

Robert Wilson

A Bird's Eye View of North America: Avian Migration Studies and Waterfowl Management, 1920-1960

This paper examines bird migration studies by the U.S. federal government in the early to mid-twentieth century. The federal government first demonstrated concern with protecting migratory birds at this time by establishing wildlife refuges and passing the Migratory Bird Treaty in 1916 with Canada. At the center of this effort was the U.S. Bureau of Biological Survey (BBS), an agency devoted to studying and managing wildlife. I argue that avian migration studies should be seen as an attempt to make bird flight paths visible to facilitate government management of these species. Using scientific techniques such as bird banding, federal biologists delineated broad migration routes for North American birds called

flyways. The BBS succeeded where other bird banding efforts by centralizing the processing of bird banding data in Washington, D.C. In effect, the BBS offices became a 'center of calculation' for avian migration research. Once the agency created flyway maps, it used them to help select refuge sites along regional bird migration routes.

William Wimsatt
Did Punnett Invent the Punnett Square?

A square tabular array was introduced by R. C. Punnett in 1906 to visualize systematically and economically the combination of gametes to make genotypes according to Mendel's theory. This mode of representation evolved (thru 5 stages in 8 years) in notation and interpretation in response to changing theoretical perspectives as Mendel's "factors" became materially embodied genes on chromosomes. Though earlier and later forms were logically identical, a "gestalt switch" in how they were read accompanied an explosive growth in their use. In this new form, contingent choices became "frozen" as the "chessboard method" became standardized as the canonical way to represent like problems in genetics. Constructed in diverse forms for different applications,in all one could simply "read off" answers to questions simply from the visual representation of the problem, and represent multiple problems, and multiple layers of problems in the same diagram.Alternative modes are considered to illustrate why these particular forms came to dominate.

Alison Winter
A Science of Expectation: Martin Orne and the Invention of 'Demand Characteristics' in the Design of Psychological Experiments

In the postwar decades, researchers became increasingly concerned about subtle factors of interpersonal communication in the design and implementation of human subject research. A key figure in the development of conventions for representing and managing the communication between experimenter and subject was Martin Orne. In the 1950s and early 1960s Orne developed the notion of "demand characteristics" -- as he defined it, "the totality of cues which convey an experimental hypothesis to the subject [and] become significant determinants of subjects' behavior." Orne's methodological warning, and others like it (for instance, Rosenthal's "experimenter effect") gave new meaning and significance to what was known and not known by experimenter and experimental subject alike. This paper reconstructs the development of "demand characteristics" and related concepts (such as Rosenthal's "Experimenter effect"), placing them in the broader context of the changing meaning of deception, ignorance, and illusion in human experiments.

Roland Wittje
Nuclear Physics Instrumentation in Norway: 1933-1955

Through the late 1940s and the 1950s, nuclear scientists, technologists and administrators in Norway were deeply split about the nation's goals, organisation, politics, and - essentially related to this - research instrumentation for nuclear science. One faction was determined to build Norway's first nuclear reactor, while another did not want a reactor at all. Whereas the first faction consisted of statesmen of science and research technologists, the second comprised academic scientist, most of whom had started their research career in nuclear physics in the 1930s. In order to understand this conflict, I will follow the development of research and instrumentation in nuclear physics both inside and outside Norway from the early 1930s to the mid-1950s. This period covers the time when scientists and engineers started to develop large-scale research instrumentation for nuclear physics research, followed by wartime experience and the American, British and German nuclear weapon projects, and ends with the beginning of the Cold War. The onset of the Cold War was characterised by secrecy in nuclear technology, the rise of the military-industrial-academic complex, particularly in the USA, and the beginning of European large-scale scientific co-operations. My overview will begin with early design and construction of particle accelerators by Odd Dahl and Rolf Widerøe, and follow the building of the first accelerator in Trondheim in the mid-1930s, the involvement of Norwegian scientists and engineers in wartime research and nuclear espionage, and the post-war accelerator programs at the Norwegian universities. I will then look at the dispute about the building of the first research reactor, which went critical in 1951. My narrative will conclude with the early stages of Norwegian CERN cooperation up to the mid-1950s.

Gabriel Wolfenstein

Recounting the Nation: The General Register Office and Victorian Bureaucracies

"And be it enacted, That it shall be lawful for His Majesty to provide a proper Office in *London* or *Westminster*, to be called "The General Register Office," for keeping a Register of all Births, Deaths, and Marriages of His Majesty's Subjects in *England* . . . ." On August 17, 1836, a new office was formed by Parliamentary Act: The General Register Office (GRO). The GRO quickly became one of the central points for the creation and dissemination of official statistics in England, and Britain, and as such occupies a central point in the statistical landscape. But if its role in the history of statistics is widely known, less understood is its importance in the history of modern bureaucracies. This paper will suggest that the history of the GRO, especially in its early years, illuminates the manner in which modern state institutions became unquestioned parts of the social and political landscape. I intend to explore the ways in which a previously unknown governmental bureaucracy quickly, and perhaps shockingly, smoothly integrated itself into the life, death, and day-to-day (and decennial) actions of the British people. The Church had been part of the life cycle since time immemorial (as at least some people felt and the Anglican Church vehemently believed.) However, reporting to a central, Civil authority through its local officers was – more or less – a new and strange business. Yet the movement from church and chapel to the state seems to have been relatively smooth, and thus begs for further study. I do not want to overstate the case: for all the importance of registration, this transformation was neither immediate nor complete. While Parliament may have said, "let there be civil registration," those words did not immediately transform into reality. Nevertheless, births, deaths, and marriages did indeed begin to be registered, recorded, and preserved by a central bureaucracy. Finally, I will suggest that it is not an accident that the history of statistics coincides with the formation of modern bureaucratic structures. Rather, the flood of printed numbers was a constitutive component of Victorian (and modern) state building.

Stefan Wolff

German Physicists in World War I – The Role of Wilhelm Wien

German political and military leaders expected a war of only a few months. Therefore no plans existed for supply under such conditions or even for incorporating science into German war efforts. At the end of 1914 situation had changed. Historiography has had its focus on the chemists because of their evident contributions. But also the physicists played a role. Many of them offered their competence. However, they met with ignorance and only a small number worked on problems of weapon technology. Rather late in 1917 it was tried to organise a coordinated mobilization of science. An exception had been Wilhelm Wien and his institute in Würzburg. When in spring 1916 the navy asked Wien for his support to improve amplifiers which were used for communication devices he was able to start an extensive cooperation. This included not only the navy but also the army. Wien got some physicists from other places like Laue from Frankfurt and not less than 20 glass-blowers were working in his institute. The whole research was devoted to the development of tubes which served as amplifiers. Moreover Wien was deeply concerned about politics. He was very active in the "war of minds" like many other scholars but with special accentuation. Wien wrote a so-called "Aufforderung" which demanded that English scientists should not be quoted more than Germans. Discussing the role of Wien will give some insight in the way German physicists contributed to war efforts in technology as well as in propaganda.

Chen-Pang Yeang

How Much Wave Theory Did Radio Ionospheric Sensors Need?

How much wave theory did designers of wave sensors have to know? This paper addresses this question by examining the development of radio ionospheric sensors in the 1930s-50s. Apparently, the instruments did not need the theories beyond a minimum level. Although the invention of the radio sounder (the first major radio sensor of the ionosphere) in the 1930s was a direct consequence of wave propagation studies in the three prior decades, the interactions between instrumentation and theory were not close. On the one hand, the leading wave theorists in Britain, France, and Germany were preoccupied with subtle behaviors of radio waves in the ionosphere, such as the geomagnetic field's effects on splitting waves into "ordinary" and "extraordinary," and the interplay of waves, electrons, and molecules. On the other hand, the American engineers developing radio sounders focused on technological improvements of data acquisition, automatic recording, and visual representation of results. The wave theory they used was the twenty-year-old ionic refraction theory; and the complex wave phenomena theorists were studying were minor to the engineers. Nevertheless, the situation began to

change in the 1940s. The demands for finding not only the heights of ionospheric layers but also the distribution of electrons over the layers led to data interpreting and processing schemes that drew more heavily on the geomagnetic effects. Moreover, the rush of probing the lower ionosphere, in which ionic refraction was quite weak, gave rise to a new type of instruments—the incoherent scattering sensor—that required a more sophisticated wave theory than the one underlying radio sounders. In both cases, minor phenomena or weak background signals in an existing wave sensor were converted, with the assistance of more complicated wave theories, into new means of probing previous inaccessible parts of nature. Therefore, the history of radio ionospheric sensors suggests that the answer to the question "how much wave theory did designers of wave sensors have to know" consists of what they wanted to see with the wave sensors.

Suzanne Zeller

Wild Life: The Animal Stories of Ernest Thompson Seton (1860-1946), the Canadian North, and Post-Darwinian Biology

This research offers a historical case study in the transition and transmission of scientific ideas and sensibilities. During the late 19th- and early 20th c., the world-famous artist-naturalist Ernest Thompson Seton's "realistic" animal stories and paintings conveyed to generations of devoted readers his post-Darwinian understanding of nature's survival ethic. Seton imbibed this view while growing up in Toronto, Canada under the mentorship of Dr. William Brodie (1831-1909), a remarkable local naturalist and entomological authority of international stature. Through local nature walks, Brodie imparted to Seton and his friends a precocious interest in the flora and especially the fauna they observed as historic representatives of complex ecological communities living in dynamic interaction with their environment. Inspired by Brodie, Seton extended his local natural knowledge to the wild animals of the Canadian north, blending science, art, fiction, and a passionate appreciation of aboriginal knowledge to challenge humanity's conventional stance outside of nature. His work marked a fundamental shift away from traditional imperialist assumptions to promote not an anthropomorphic (as has traditionally been claimed) but rather a radically zoomorphic understanding of nature.

Katie Zimmerman

A Comparative Reception of Darwin: The Botanical and Sociological Work of Lester Frank Ward

The publication of Charles Darwin's *On the Origin of Species*, a synthesized work by a natural historian, coincided with the emergence of increasingly specialized disciplines in the 19th century. This paper aims to reveal the relationship between disciplinization and the reception of new theories among emerging disciplines by focusing on the work of Lester Frank Ward, a prominent 19th c. paleobotanist who worked jointly for the U.S. National Museum and the U.S Geologic Survey in Washington, DC. By analyzing how Ward integrated the principles of Darwinian evolution into his botanical and sociological work, I will compare and contrast the differential approaches Ward took towards Darwin in his work and will evaluate how two very singular and distinct disciplines, with their specialized topics, methods, goals, etc., affected one scientist's application of a new theory. A central figure in both disciplines – Ward's dual-career can provide much insight for accomplishing the general task of demonstrating how disciplinization as a process in both the historical and social sciences affected the interpretation, integration, and application of Darwin's theory of evolution in those fields beyond Ward's own experience.

Judith Zinsser

Mme Du Châtelet and the Historians

Although the marquise Du Chatelet was acknowledged in her own day as a philosophe and geometre, by the end of the nineteenth century, she had been forgotten, except for her association with France's great hero of the Revolution, Voltaire. This, despite her inclusion in a number of collected biographies, and the significance of her institutions de physique and her translation of and commentary on Newton's *Principia*. My talk will explore this process of "forgetting" and the ways in which Du Chatelet was "discovered" and finally in the last decades of the twentieth century, restored to her place as a respected member of the Republic of Letters, and an important natural philosopher of the first half of the Enlightenment.