

Department III (Director: Hans-Jörg Rheinberger)

History of the material culture and practical dynamics of science lies at the center of the work of *Hans-Jörg Rheinberger's* research group. Our focus is on three aspects of that culture and dynamics: (1) the history and epistemology of experimentation; (2) the history of objects and spaces of knowledge and of mental equipment; (3) the uses of theory in the life sciences. Many of the individual projects, a selection of which is presented here, cover more than one of these aspects, and most of them concern the biological and medical sciences from the eighteenth to the twentieth century. The overarching interest is in the historical and epistemological conditions of scientific innovation.

History and Epistemology of Experimentation

Since Francis Bacon, experiment has been seen as the signature of modern science. Detailed analysis of forms of experimentation is, however, of relatively recent origin. Our aim is an encompassing historical as well as epistemological analysis of experiment. Our premise is that there are types of experimentation and that these have emerged and developed over time, acquiring different forms in different disciplines; and, second, that this variety is not peripheral but integral to the epistemology of the sciences.

Successive scientific accounts of living beings have moved, since the seventeenth century, from a classificatory *historia naturalis* through an anatomy of visible structures and a physiology of obvious body functions to the multidisciplinary investigative enterprise of late nineteenth- and twentieth-century life science. Its subject matter reaches in scale from biodiversity through the social behavior of organisms down to macromolecules. To each of these levels of organization and investigation there corresponds a phenomenology, a set of analytical approaches and experimental procedures by which its objects are shaped. To understand the epistemic activity of science at these levels, we ask how research fields and ultimately disciplines aggregate around ensembles of practices and technologies, including methods, concepts, and theoretical conjectures. Such aggregations appear to be underdetermined if viewed from a social or conceptual perspective alone. While, on the one hand, they lead to relatively stable configurations of epistemic power and explanatory relevance, these configurations, on the other hand, are usually historically transient and prone to disaggregation over time.

This view of scientific development may be called *pragmatogenic*. It requires that historical assessment begin with a reconstruction of the practical contexts in which particular concepts and associated theories gained momentum and eventually came to dominance. Central to this reconstruction is to show in detail that experimentation itself is a historically variable scientific form of life that has undergone decisive shifts of structure and content from the early modern period to the present. These shifts are best revealed through broad comparisons. The demonstrative experiment of the seventeenth century, for instance, contrasts greatly with the experiment as a more or less systematic extension of observation in the eighteenth century. Conversely, in the nineteenth century in many areas of science, observation becomes itself dependent on experimental exploration. Of particular importance in understanding the life sciences of the nineteenth and the twentieth centuries is a close inspection of what we call "experimental systems" as the smallest integral working units of research in laboratories and other places of knowledge production.

Beyond these macrohistorical changes, the practice of experiment at any given epoch has taken more than one form and, over the centuries, has become vastly diversified. This variety needs to be assessed. To take an example from the work of the Department in 1998–99 and continuing into 2000–01, special attention has been paid to the role in experiment of techniques and instruments of representation, such as electroencephalography (*Borck*), photography (*Geimer*), chronoscopy (*Schmidgen*), microcinematography (*Landecker*), and other methods of visualizing small-scale objects (*Métraux et al.*). All this work, and the comparisons it enables, has begun to

bear out our premise that studying the forms of experiment is integral to a comprehensive historical epistemology of the sciences.

The case studies and comparisons that are needed to realize this aim require new methodologies. These include careful comparative analyses of various genres of scientific writing such as research notes, lectures, published texts of various formats such as handbooks, textbooks, and research articles. They also require a semiotic approach to visualizations: from unpublished sketches to engravings, photographs, recordings of traces, and other inscriptions. Finally, these methodologies include study of historical laboratory structures, their architecture, the technological functioning of laboratories, the role of laboratory objects, their structuring impact on behavior, the trajectory of instruments, and not least the virtual reconstruction of historical experiments.

History of Objects and Spaces of Knowledge and of Mental Equipment

This area of investigation concerns two main aspects of the material culture of science: first, choice of objects and model organisms; second, the spaces and places in which these objects or organisms function as carriers of epistemic interest. Some of the projects also illustrate what may be called the mental equipment of the scientists who work in these spaces and investigate these objects. Just as the term “material culture” has been useful in characterizing work on the historicity of objects and knowledge spaces, so too the term “mental equipment” – originally developed by *Annales* historians – is meant to designate the historicity of thought habits of scientists and scientific communities.

Scientific Objects. Historical work on the laboratory is not confined to the form of the micro-study. It opens the perspective to long-range macrostudies of the material culture of science. It is evident that a decisive aspect of scientific innovation lies in choosing, shaping, reshaping, and sometimes also in abandoning scientific objects. Studying the history of these entities presupposes that they take on various forms in the different research contexts in which they acquire their epistemic virtues and powers. Embryos, brains, or macromolecules are not epistemic objects by themselves; they are things which become epistemically laden insofar as they locate monsters, memory, or messengers respectively in an assembly of practical and theoretical relations. Complementary to the analysis of concepts, we pursue the analysis of these impure epistemic entities in their impure settings, half-way between crude pieces of matter and rarefied ideal types – material enough to exert the characteristic resistance and resilience met with in the exercise of science and symbolic enough to serve the interests of a quest for knowledge.

In the life sciences, the choice of organism has always played and continues to play a decisive role. Since the end of the eighteenth century, the meaning of key biological concepts has been shaped by the availability of particular model organisms. Late eighteenth-century vitalism, for example, was by no means a purely speculative endeavor; it is unthinkable without the frog as a model and emblem of bioelectricity. The same animal, however, became crucial in other historical contexts in a quite different manner. It was instrumental to the establishment of physiology as a discipline in Germany around 1830; two decades later, it became the material carrier for the success of the Berlin organic physicists; around 1900, it helped to establish “Entwicklungsmechanik”; and in the second half of the twentieth century, it became one of the first higher organisms around which molecular biology developed. The history of genetics, to take another example, could be written almost in its entirety as a succession of model organisms: from humans to plants such as peas and tobacco, to the fruitfly, to molds and bacteria and back to higher organisms. The uses and scientific “careers” of certain organisms are bounded by a complex set of conditions. These include technicalities such as utility, disposability, aptness for laboratory work, and ease of manipulation; forms of everyday life; theoretical presuppositions; and, not least, contingency. In experimental medicine in particular – with its problem of identifying proper animal models for the

study of human diseases and for testing pharmacological substances – these conditions extend also to ethical and economical considerations.

Spaces of Knowledge. A natural object can become interesting for many reasons, but it only becomes epistemically relevant if it fits into historically specified real and symbolic spaces. Such spaces of knowledge production include naturalists' cabinets, botanical gardens, agricultural experiment stations, laboratories, the "field" of the anthropologist or the naturalist, the archive, which in its modern form is an invention of the nineteenth century, and, more recently, electronic environments with their potentials for modeling and simulation. A history of such spaces and places ought to reveal the strategies of inclusion and exclusion associated with them. Spaces of knowledge production mark the boundaries of epistemic objects and connect them to larger cultural settings, forms of art and architecture, and especially forms of scientific communication. In turn, these spaces receive their particular shapes from the chosen objects of study. Such mutual fitting of objects and spaces is not only characteristic of the microworld of experimental systems, but also of the macroworld of natural histories, anthropological and clinical classifications, and multidimensional scientific accounts of mass phenomena such as epidemics. That macroworld has been the subject of special interest in the Department in 1998–99 and continuing in 2000–01, through projects on such mass objects and spaces as population and environment (*Höhler, Jansen, Lachmund, Mendelsohn*).

Mental Equipment. Finally, to a material culture there corresponds the mental equipment of the scientist. In recent years, historically specifiable configurations of explicit and tacit knowledge, of skills, of bodily and mental discipline, and of gestural repertoires became of interest to historians of science as they recognized that the mastering of instruments and the training of the senses were integral to knowledge production. The concept of mental equipment encompasses these various aspects of the knowing subject and relates them to virtues, passions, mentalities, idiosyncrasies. The aim is thus to combine culturally shaped (self-)images and values of scientists with their concrete scientific practices. The scope reaches from the importance of sensibility in late-eighteenth-century life sciences and the role of heroism in romantic self-experimentation to attempts to include or exclude the participating observer in twentieth-century anthropology. In 1998–99 and in projects continuing in 2000–01, interest in the Department has been especially focused on the senses and the observer, as both subject and object of science in the nineteenth century (*Hagner, C. Hoffmann, Hyder, Métraux, Schickore et al.*).

Overall, the methodological concepts of epistemic object, space of knowledge, and mental equipment are aimed at overcoming such traditional dichotomies as internal and external factors of scientific development, experiment and observation, basic and applied research, scientific method and bricolage.

The Uses of Theory in the Life Sciences

These studies aim to assess the specificity and role of the "theoretical" in the investigation of living things. In part, it is the practical turn in the history of science itself that makes the question of the theoretical once again interesting and investigable from a new perspective. Concept formation and the function of generalizations in biology are analyzed from a number of different perspectives: the relation between physical and life sciences; the organizing function of concepts in both experiment and representation, especially over longer periods of time; the problem of the heterogeneity of biological discourses; and the historicization of analytical categories such as reductionism, vitalism, holism, and mechanism. Special emphasis is on the pragmatic aspect of how concepts and generalizations do work as tools in various historical contexts and on how they become embodied in practical configurations. Examples are the concept of information in molecular biology (*Brandt*); the concept of regulation in embryology (*Thieffry*); the concept of the cell (*Parnes*); the concept of the gene (*Rheinberger*, see project description of *Beurton*, p. 24). Such concepts appear

to fulfill their function without being firmly embedded in an axiomatic theoretical framework. Their fruitfulness even appears often to be bound to a certain lack of strict definition.

Each epoch came to draw the boundary between the realm of the living and that of the non-living differently and as the result of a negotiation that is in itself a first order problem for the history of science. Natural history and physiology in the eighteenth century drew this boundary in a distinctly different manner from how it was drawn by romantic biology around 1800, or by the biological and medical disciplines of the nineteenth century such as cytology, sensory physiology, and evolutionary biology. Today, the realm of the organic is conceived of as being the unique product of an evolutionary process and therefore irrevocably shaped by history. This may be one of the deeper reasons for the fact that in the history of the biosciences since the late nineteenth century “theoretical biology” or “theoretical medicine” has played a role different from that played by theoretical physics in the history of physics (*Laubichler*).

Another perspective on the problem of the theoretical derives from the complexity of the living as it has emerged fitfully and differently in various fields since the development of biology in the nineteenth century. As a consequence of this complexity, conceptualization of the living takes place on many different levels of organization. Access to and therefore definition of such levels has been largely dependent on technologies whose development has usually not been intrinsic to the development of the biological sciences themselves. The question as to how these levels of epistemic activity are connected thus becomes a pressing one. We suspect that the connections are largely ad hoc, due to historical contingencies. Heterogeneity of discourses results. Instead of joining the perennial quarrel over reducibility – of biology to physics at large, and of one level of analysis to another – we propose to investigate the historical dynamics of such heterogeneity in its own right (*Potthast*).

A further concern of studies in this section is historicization of categories that have often been used to characterize global attitudes toward the study of living beings. Among them are categories such as reductionism, holism, mechanism, and vitalism. Of special interest will be to analyze how these categories have been used in different historical periods by scientists themselves to demarcate their own approaches in an attempt to establish new research strategies and to gain the power of definition over certain domains of research. One of the most intriguing features of these categories is their pertinacity and their longevity under so many different guises (*Potthast, Mocek*).

Research Projects on the “History and Epistemology of Experimentation”

Strategies of Experimentation and Experimental Systems in Genetic Research in Germany, 1900–1950

Hans-Jörg Rheinberger

Following his detailed investigation of the history of protein biosynthesis research between 1945 and 1965 (*Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube*, 1997), *Rheinberger* has concentrated his research on a number of case studies designed to map the development of experimental genetics from the end of the nineteenth century to World War II. The general aim of the project is to have a close look at the material characteristics of different experimental systems and related strategies of experimentation and to understand the impact they had on the historical shape and development of genetics in Germany.

The first study deals with the corn and pea hybridizations which led Carl Correns to reformulate Mendel’s laws around 1900. This study is based on Correns’ research protocols and sheds new light on one of the founders of classical genetics. The work of Correns is then followed through the next two decades, 1900–1920. It will be shown that it was the strict pursuit of Mendelian genetics that eventually led Correns to the investigation of extrachromosomal phenomena. Correns’ strategies of experimentation are revealed to be closely related to the material characteristics of the breeding systems he used. A second case study investigates the establishment of an

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Da es Thatsache ist, dass caesia (weisse) + alba
 mehr weisse Körner giebt als alba caesia weiss + caesia
 weiss, so erklart sich das leicht, als durch einen Ein-
 fluss der alba bei caesia (u) + alba, durch den Einfluss
 der caesia (u) auf caesia (u).

Ist die Hälfte der Fruchtkörner bei Caesia (weiss) auf
 weiss, die andere auf blau bestimmt, so wird
 alba - Pollen daraus nichts ändern, caesia (u) Pollen be-
 gegen die Zahl der Caesia Körner vermehren. Dann
 nehmen wir an, 1/2 der Pollen Körner von Caesia (u) sei
 für weiss, 1/2 derselben für alba bestimmt, so wird,
 da wir gerade die weissen "Pollen" auf die weissen
 Narben, die blauen Pollen auf die blauen "Narben"
 gelangen werden, d. h. caesia "Narben" durch alba Pollen
 direkt nicht beeinflusst werden, die Kreuzun-
 gen $a^{\text{♀}} + a^{\text{♂}}$ weiss, dagegen $a^{\text{♀}} + c^{\text{♂}}$, $c^{\text{♀}} + a^{\text{♂}}$ als
 blaue Körner geben, die blauen Körner etwa 3/4
 statt 1/2 betragen müssen.

Zunächstwaarsatzgen zu den, wieviel Körner bei der
 Kreuzung $a + caesia\ weiss$ und $a + caesia\ weiss$ blau
 werden können. Da aber blau nicht etwas ändert, wie
 schon vorher, Kautschu die Zahl der blauen Körner bei der
 Kreuzung caesia (u) + caesia (u) nicht ganz 3/4 betragen.
 $a + caesia\ weiss$ u. $a + caesia\ weiss$ waren aber doch ein Ver-
 such, bei dem sich zeigen würde, wieviel alba in caesia (u) steckt.

Carl Correns: Note on maize hybrids

experimental system that allowed convergence of transmission genetics and developmental physiology. It looks at how Alfred Kühn and his coworkers came to analyze and conceptualize gene-action chains involved in pigment formation in the flour moth *Ephesia kühniella* between 1925 and 1945, thus laying the foundations of physiological genetics. The third case study is devoted to the establishment of tobacco mosaic virus as a model of combined physical, chemical, and biological investigation of genetic material at the Kaiser Wilhelm Institutes for Biology and Biochemistry around 1940. Further studies will include the experimental work of Max Hartmann on protozoa and of Fritz von Wettstein on the genetic basis of plant physiology.

Chronos and Psyche: The History of Psychological Time Measuring Experiments, 1850–1914

Henning Schmidgen

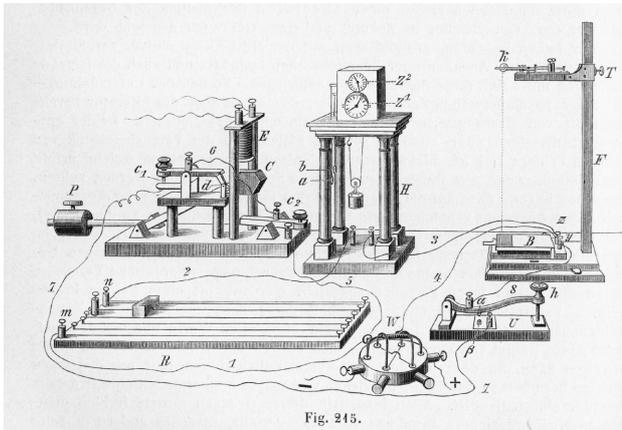


Henning Schmidgen

This project in the history of experimental psychology investigates the discursive and non-discursive practices connecting psychology to technology and architecture in the nineteenth and twentieth centuries. The focus is on competing forms of psychological time measurement in the second half of the nineteenth century. The goal is to elucidate the various material cultures of psychological chronometry and its epistemological preconditions – notably concerning the relation of subjectivity and time.

With the example of the chronoscope, Schmidgen traces the lineages of a psychological instrument and unveils surprising connections between psychology and disciplines such as physics and chemistry. Before entering psychological laboratories, the chronoscope was used in the teaching of physics to demonstrate the law of gravity. Moreover, the performative culture of experimental chemistry provided a model for psychological experimentation. Like the technology of experimental psychology, its architecture too played an important role in the development of research. Through the disposition of separate rooms for specific research topics, the laboratory expressed and reinforced a new organization of psychological research work. These dispositions

corresponded in part with the arrangement of topics in psychological textbooks. In the quest for disciplinary independence, psychological laboratories were defined against such spaces as the ward and the morgue and were made part of the discourse on the unity of the discipline.



Experimental setup for measuring reaction times

Finally, *Schmidgen* argues that a key epistemological precondition for measuring psychological time was to conceive of subjectivity as something essentially fluid or streaming. Here, the project explores relations between experimental psychology and philosophy. Following Kant's transcendental aesthetics, Johann Friedrich Herbart thematized "the oscillations and the flow of psychological facts". Wilhelm Wundt deviated from Herbart's attempts to mathematize the course of mental representations and turned to the experimental time study of psychological states. This shift decisively demarcates experimental psychology both from the cerebral localization practices of phrenology in the early nineteenth century and from neuropsychology in the twentieth.

Noise or Nature? Photography of the Invisible around 1900

Peter Geimer



Peter Geimer

This project looked at photography as a means of scientific representation and focused especially on what towards the end of the nineteenth century was treated as photography of the invisible. In various cases, photographs functioned as experimental proof of the existence of otherwise inaccessible phenomena like rays, waves, fluids, and souls. The study aimed at a description and analysis of this ambiguous function of photography above and beyond its value as a medium for representing the visible world. Thus it posed epistemological as well as aesthetic and art historical questions. Special interest derived from cases in which it was doubtful what exactly had inscribed itself on the photographic plate. Around 1900, chemists, biologists, physicists, and spiritualists debated whether the photographic medium recorded molecular processes in the developing bath or heat or human emanations, whether plates produced traces of external referents or presented traces of the photographic medium itself. Thus the project dealt with an experimental sphere of knowledge in which one and the same visual document oscillated between noise and nature, between accidental waste product and intended epistemological object.

This specific balancing between fact and artifact led *Geimer* to pay particular attention to those photochemical and optical effects that photographers as well as historians of photography had always neglected as waste, failure and accident (blurs, spots, halos, veils). These traces normally remain excluded from historical narratives, be they technical, iconographic, or aesthetic. And yet from the beginning, photographic accidents have been neither defects nor exceptional cases; on the contrary, they were constitutive manifestations of photography. The sensitivity of photographic plates gave birth to a double effect: it caused both production and destruction, appearance and disappearance of scientific representations. Moreover, what first appeared as disturbing accident could later serve as scientific explanation for otherwise inexplicable phenomena.

The project took initial steps toward a history of photography as an archeology of photographic (arti)facts.

The Emergence of the Electric Brain: Experimental Epistemologies of Electrophysiological Investigations of the Human Brain, 1920–1950

Cornelius Borck



Cornelius Borck

The shaping of the life sciences through the development of ever more sophisticated measurement and visualization techniques has become a main area of research in the history of science. Case studies have reconstructed distinct socio-cultural conditions under which specific experimental procedures emerged and created particular cultures of representation. *Borck's* research project investigates the nexus of psycho-physiological theorizing and electro-technical experimentation from the interwar period to the aftermath of World War II as the site for the emergence of the "electric brain", the conceptualization of the human mind as an electrical machine. The development of brain wave recording serves as a basis for reconstructing the heterogeneous cultural contexts of visualization in this field of electrical investigations into human psycho-physiology. The versatility of brain-wave recording, which combined techno-scientific ideals with ideas from occultist circles, formed new visions of human nature and of the human mind.

In the 1920s, the human brain became literally the power source of an experimental electrical circuit, and its output was registered via graphical recordings. By comparing the recordings with clinical symptoms, organic lesions, mental states, psychic functions, personality types, intelligence, or forms of behavior, the practices of brain-wave recording constructed a new, electric brain. The graph of the brain's electrical activity, the electroencephalogram (EEG), opened up a new two-dimensional space for the neuroscientific inscription of psychological functions, for representing human individuality and identity, and for situating and understanding the human mind in electro-technical terms.



The popular writer and physician Fritz Kahn likened the human sensory nerves to a radio set by depicting their function in the modern world of the 1920s.

Starting with an elucidation of the context of electrophysiology in Germany – from the commodification of electricity in Weimar culture to electrotherapeutic practices in general – *Borck* deals with the research of the first two German EEG groups and their different trajectories: Hans Berger in Jena and his holistic framework; and the neurophysiology group at the Kaiser Wilhelm

Institute for Brain Research at Berlin-Buch, where electrophysiology had to fit into the localization paradigm of the institute's director Oskar Vogt. The project then traces the spread of the technique in Europe and North America and the eventual domination of the field by researchers in the United States. Finally, *Borck* studies the effects of World War II on the cultural embedding of this branch of the neurosciences and the role of neurophysiology in the international postwar cybernetics movement.

Cellular Features: Tissue Culture and Time Lapse Cinematography

Hannah Landecker

The development of the technology with which to grow living cells excised from complex organisms outside of the body for extended periods of time – a technique known as tissue culture – coincided with the visualization of cellular life through the young medium of microcinematography. Populations of cultured cells were filmed with time lapse technique beginning in 1913; images were taken at regularly spaced intervals, and when the resulting film was projected, the movements and actions of living cells were seen at a greatly accelerated rate. This research project is designed to detail the history of biological microcinematography in France, Germany, England, and the United States between 1909 and 1935. Microcinematography and tissue culture in combination created an important epistemological shift in the understanding of the cell as a fundamentally dynamic element of bodily processes rather than a static element of bodily structure. By studying the specific case of biological microcinematography, this project also addresses larger themes, of the status of the cell as an object of twentieth-century experimental practice, and the understanding of the phenomena of life, senescence, reproduction, cancer, bacterial infection, and death as fundamental cellular processes.

Robert Musil's "Essayism" and the Epistemology of Experimental Procedures

Birgit Griesbecke

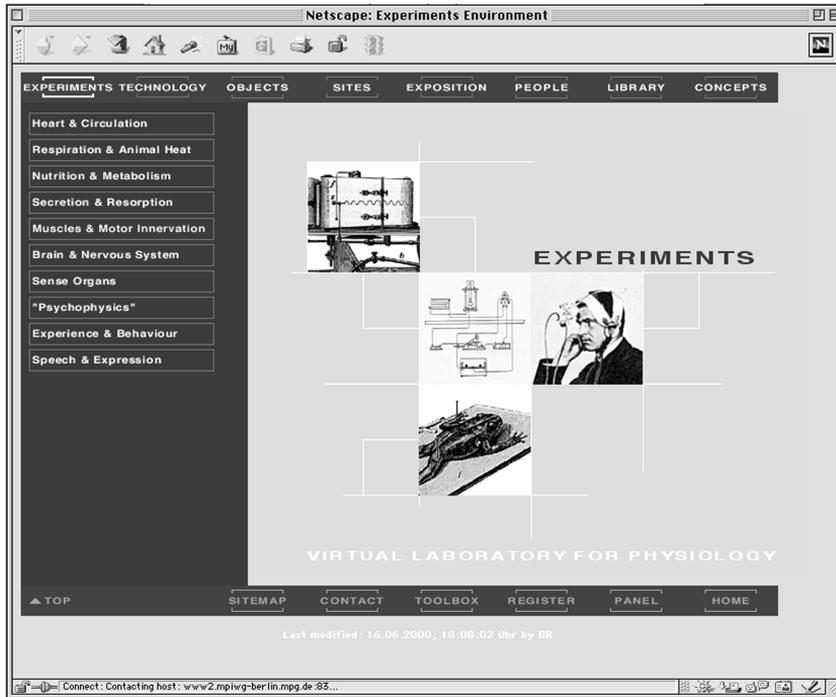
In his critical examination of Ernst Mach's writings, Robert Musil developed his methodological concept of *Essayismus*. The concept does not refer primarily to the literary genre of the essay. It centers on the open structure of experience and its correlation with innovative scientific leaps. Its tendency to transcend the boundaries of heterogeneous discourses is reflected in the methodology of *Griesbecke's* project. It aims to investigate current epistemological problems such as the dichotomy between "scientific" and "literary" cultures and the exclusiveness of the Occidental notion of science and the epistemic dominance of the West. These dichotomies are analyzed, in relation to essayism, on the basis of two historical case studies of Western and Japanese traditions. One concerns the introduction of surgical anesthesia (Crawford W. Long/Hanaoka Seishû), the other deals with texts of geographical and ethnographical exploration (Georg Forster/Arai Hakuseki). *Griesbecke* argues that the characteristics of Musilian essayism – attentiveness to the "lifeworld" as an indispensable resource of scientific questions, metaphoric and metonymic dynamics, interaction between precision and vagueness, between "Wirklichkeitssinn" and "Möglichkeitssinn" – can be traced in different research processes which led to remarkable medical achievements as well as in descriptions of foreign terrains and cultures which were even able to transform that culture's own familiar, stable categories.

Experimental Systems in Nineteenth-Century Life Sciences: The Virtual Laboratory for Physiology (VLP)

Sven Dierig, Jörg Kantel, Henning Schmidgen

General Goals

The Virtual Laboratory for Physiology (VLP) is an internet project aimed at offering a comprehensive documentation of the life sciences in the nineteenth century, with a special focus on the material culture of physiological and psychological research. The VLP is an electronic research



Main page of the Virtual Laboratory

tool enabling historians of science, technology and culture, museologists and collectors, and students actively to explore the history of the experimental life sciences. As a digital archive, the VLP gives access to a rich collection of hyperlinked texts and illustrations concerning the experimentalization of life between 1830 and 1930. It includes scans of journal articles, handbooks, monographs, catalogues of scientific instruments, and other historical records. In addition, the VLP is a platform for electronic publishing, on which results of ongoing historical research can be presented. Finally, the VLP is meant to encourage collective exploration of new ways of writing history. Taking seriously the potential of web technologies, the VLP establishes a multi-media way of reconstructing the past, a way in which images, sounds, and eventually moving pictures are fully integrated.

The holdings of the VLP are organized according to the following sections: experiments, technology, objects, sites, exposition, people, library, concepts. The archive will be complemented by a history forum (PANEL), in which people working with or within the VLP can prepare and present their studies, which may range from illustrated articles to stories crystallizing around virtual reconstructions of experiments. A prototype is planned to be placed on the World Wide Web in 2000. The prototype will demonstrate what a virtual laboratory can accomplish for research and teaching in the history of science.

Selected Hyperlinked Contents:

Experiments. This section of the archive presents typical experiments carried out in the life sciences in the nineteenth century. The focus is on visual representations of experiments. Under such headings as “Heart & Circulation”, “Brain & Nervous System”, and “Experience & Behavior”, a reader can access representations of classical experiments in physiology and psychology. In addition to the image of the experiment, the source of that image, and a short description of the experiment will be given. Other information includes instruments displayed in the image as well as circumstances described in the corresponding source text. A user also receives the complete bibliographical reference of the image. A short comment draws attention to the significance and the consequences of the experiment and to further historical questions to be explored. One of our aims in the section “Experiments” is to collect multiple historical images of one type of experiment and to present them in chronological series. Ideally, we anticipate being able to reconstruct the evolution of an experimental system over a time-span of 20, 30 or in some cases 50 years. Users will thereby be able to observe the various uses of the experiment and changes in its setup – additions, variations, shifting contexts.

Technology. This section mainly concerns instruments. It provides images of instruments used in physiological and psychological research yet also includes power sources as well as fittings and accessories. The material presented here is mainly taken from handbooks, but also from instrument-makers’ catalogues. Wherever possible, these images are arranged in chronological series. We also include recent photographs of extant historical instruments and information on the holder of those instruments, and the location of collections. Further information includes bibliographic references concerning the instrument, a description of the instrument and its experimental uses, the name of the instrument-maker, and historical problems worthy of further investigation.

Objects. Like the instruments, the objects of nineteenth-century physiology and psychology – frogs, rabbits, dogs, human beings – were integral to experiment. Disciplines and institutions in the life sciences crystallized around “model organisms”. Frogs, rabbits, and other animals were collected on the outskirts of cities, sometimes within them. Some were bred and housed in scientific institutes. Antivivisectionist movements in many countries condemned the use or misuse of animals in research and at times forced researchers to find other methods – for example, to miniaturize their objects or to move outside the cities. This rich history is documented here.

Sites. This section concerns sites of knowledge production. Here, users will find the places in which research was carried out: laboratories and institutes, but also field stations, museums, and hospitals. We provide a list of these sites and display building plans, charts, and architectural views. When possible, we also display the current state of the building or site. We understand sites of knowledge production in a broad sense and include sites dedicated less to research than to education, training, everyday work, or entertainment and leisure, such as the lecture hall, gymnasium, factory, theater, and railway station.

Further Projects Related to History and Epistemology of Experimentation

Using laboratory notebooks, *Andrea Loettgers* has undertaken a case study of the development of an astrophysical instrument of the late nineteenth century, Samuel Langley’s bolometer. The emphasis of this study has been on the relation between the development of the instrument and the experimental practices into which it was inserted. *Jérôme Ségal* is working on a project concerning the history of simulation in molecular biology. Taking protein folding as his case study, he focuses on the new experimental practices introduced by the use of computers, that is, on experimentation *in silico*.

Research Projects on "History of Objects and Spaces of Knowledge and of Mental Equipment"

The Ingenious Brain: On the History of Elite Brain Research in the Nineteenth and Twentieth Centuries

Michael Hagner

This project considers how and why the brain became both a scientific object and a cultural organ loaded with values and symbols. Whereas in *Homo cerebrialis. Der Wandel vom Seelenorgan zum Gehirn* (1997), *Hagner* analysed the coming into being of the brain as the organ in which various mental qualities were localized, he is now concentrating on the history of the investigation of brains of extraordinary individuals: geniuses in the arts and sciences, individuals of special talent, and criminals. The history of these skulls and brains is twofold: it comprises the establishment of a new epistemic object – the ingenious brain – as well as idealized types that became crucial for the modern understanding of the scientist. Scientists, though usually employed by the state as professors, academicians and teachers, nevertheless remained extraordinary figures with specific characteristics. Their genius was supposed to be visible in their work and – post mortem – in their brains.

The interest in ingenious brains reaches back to the late eighteenth century, when physiognomicists and physical anthropologists established cerebral parameters for explaining intellectual differences among human beings. Reports about extraordinary brains were part of biographical sketches, often delivered in celebratory obituaries. The utilization of brains and skulls for cultural portraits of scientists was in accordance with the then available methods and parameters for investigating brains. These skills presaged the beginnings of modern elite brain research in the 1850s. In this decade, the older interest in the brains and skulls of geniuses was transformed into a systematic and comparative exploration of the brains of extraordinary persons. The first systematic investigations of ingenious brains were quite disappointing, but the years between the 1860s and the 1920s witnessed a remarkable number of dissections of this kind. Although these investigations explicitly distanced themselves from older "mythological" enterprises, scientific curiosity was shaped by the cultural (self-)understanding of leading figures in society, including scientists – and not only in the famous cases of Lenin and Einstein. The study will show that extraordinary brains were central to twentieth-century scientific culture.



"Mars regiert die Stunde" (1916) by Max Slevogt

Ecce cortex: Contributions to the History of the Modern Brain

Michael Hagner in collaboration with *Cornelius Borck, Cristina Chimisso, Sven Dierig, Doris Kaufmann, Andreas Mayer, Andrew Mendelsohn, Alexandre Métraux, Helmut Müller-Sievers, Simon Schaffer and Henning Schmidgen*

The aim of this collaborative book project was to bring together various ongoing research projects within the Institute and to launch a discussion on the question of a cultural history of the modern brain. What seemed at first to be scattered individual interests turned into a common and overarching interest in the historicity of an object that is at once one of the most fascinating research areas in the sciences and among the most culturally vested organs in the history of modern man. This interwovenness invited us to rethink strict distinctions between scientific disenchantment and cultural reenchantment. Participants examined the extent to which the brain carried metaphors and values, symbols and meanings, and the extent to which it was bound to specific cultural, social, and political claims. Assuming multiple relations between these cultural dynamics and scientific practice in anatomy, psychiatry, anthropology, cognitive science, philosophy, and literature, the group tried to avoid traditional historiographical concepts such as “influence” and “reception”. Instead, participants examined the historical spaces and conditions that made possible new questions, theories, and practices. Ongoing discussions among participants both preceded and followed a workshop held August 30 – September 1, 1998. The book *Ecce cortex* appeared in the fall of 1999.

The Laboratory in the City: Urbanization, Industrialization, and the Place of Experiment in Nineteenth-Century Physiology

Sven Dierig



Sven Dierig

Laboratories are not isolated from the world; they have always existed in relation to the space around them. Like universities, museums, hospitals, botanical gardens, and other institutions of scientific research and education, laboratories have been and still are typically located in cities. And both laboratories and cities are subject to change. Using the example of Berlin and the institutionalization of experimental physiology by Emil du Bois-Reymond, this project places the laboratory revolution in physiology in the context of the transformation of urban space in the industrial revolution. This “urban history of physiology” seeks to understand how cities and laboratories “cooperate” in the production of scientific novelty. Emphasis is on the ways in which ongoing changes in urban life and society, industry, economy, and technology permeated the “walls” of physiological workplaces and yielded scientific knowledge. The study is organized topically rather than chronologically. Investigation of three topics – organisms, instruments, and laboratories – illustrates how urban culture and everyday life, urban organization of labor and commerce, and urban power sources and technology extended through the laboratory walls and became part of the social and material culture of experimental investigation.

Organisms: Research fields, experimental setups and instruments in nineteenth-century physiology accreted around model organisms such as frogs, cats, rabbits, and dogs. Assuming that the scientific career of an organism as an experimental tool depends not only on various features of the organism or the techniques employed, the project studies the role of Berlin’s weekly markets, zoos, aquariums, urban biotopes, and other urban places in providing physiological research with supplies of experimental organisms.

Instruments: This topic concerns the role of technology in the making of scientific novelty at the time when Berlin became a technological metropolis. Focusing on electrophysiology and the so-called graphical method, the aim is to ask how local conditions lead to substitution of one instrument or experimental setup for another and to unravel the interrelationships between the use of instruments, changes in instruments, and the evolution of urban technology systems: sys-

tems of power (water, gas, electricity), systems of transport (horse-drawn carriages, urban railways, electric street cars), and systems of communication (telegraph, telephone).

Laboratories: This focus of the project was inspired by work in the sociology of scientific knowledge showing the laboratory as a specific workplace, designed for the factorylike production of new experimental phenomena. The argument is that laboratories produce knowledge for a scientific market just as factories and their machines produce goods for a consumer market. Stages in the laboratory revolution in physiology in Berlin are analyzed in terms of the evolution from manual work to mass production in the industrializing city.

Some aspects of the project have been presented on the workshop "Physiological and Psychological Practices in the Nineteenth Century: their Relationships to Literature, Art, and Technology" organized by *Sven Dierig* and *Henning Schmidgen*, July 3 – 4, 1999. The workshop is documented in the Institute's Preprint No. 120.

Science and the City

Sven Dierig, Jens Lachmund, Andrew Mendelsohn

This project is dedicated to bringing together what have been all too separate fields of research: the history of science and the history of the city. The project takes the form of collaboration within the Institute, an international workshop, and a collective publication. The workshop will be held in December 2000. The results of the project will be published in 2003 as volume 18 of the History of Science Society journal *Osiris*. Through this group effort, we aim to show various ways in which practices and objects of science, on the one hand, and material and social forms of the city, on the other, were co-produced. The sciences to be represented in the project can be sorted onto a spectrum ranging from those which have the city as their main object of study (urban sociology, urban planning) to those only partly concerned with the city as such (public health, demography, epidemiology, urban ecology) to those which do not at all take the city as their subject (experimental physiology, zoology, clinical medicine). At one end of this spectrum, the workshop aims to examine the various forms of representation (maps, survey forms, statistics, narratives) through which knowledge of the city was encoded and how these functioned in the production and reproduction of the urban as a scientifically ordered phenomenon. At the other end of the spectrum, the workshop aims to include in an urban history of science those fields which are not directly concerned with the city, by exploring the ways in which the "walls" of the laboratory, the museum, and the clinic were highly permeable and even difficult to manage. These places of knowledge were embedded not only in society and culture, as historians have amply demonstrated, but also specifically in the city.

Science en Masse

Andrew Mendelsohn



Andrew Mendelsohn

This project aims to develop a theoretical and historiographical framework for understanding science in the mass dimension, that is, empirical inquiry into the nature and behavior of large-scale phenomena composed of many parts or individuals, be these phenomena organic, social, or physical. Thus the focus is less "big science" than the sciences of "big" objects. Through what practices, whether expert or everyday, do these come into being and hold together? The survey, the questionnaire, the map, the table and other instruments of data-gathering and representation have evolved in ways that deserve to be explored and compared. So too have the techniques, both qualitative and quantitative, used to model big objects. Framed deliberately wider than the capacities of a single historian, the project will take the form of a workshop and collective publication.

The project grew out of a case study of a massive bacteriological and epidemiological experimental campaign in Imperial Germany, which was sustained for a decade over a human population of several million and perceived by contemporaries as a vast "machinery" of scientific

Addressing this question has required a taxonomy of the various forms taken by the relation between knowledge and power, *Wissenschaft* and *Herrschaft*.

The second thesis is that the coming into being of the technocratic derived less from change in science or polity than from the emergence of a new kind of person. The expert as civic leader or statesman gave way to the expert as intervener from outside society and politics. One important result of research thus far was that social processes associated with modernity, such as specialization, professionalization, bureaucratization, and rationalization, fail empirically to describe this



Engineers of the Corps des Ponts et Chaussées on site: detail from painting by J. Vernet, 1774

difference in kind of expert and of expertise. Far more revealing are the concrete life patterns – and particularly the physical and cultural mobility – of prototypical figures involved in problem-solving for the state, such as the engineer, the social or physical surveyor, the district medical official, the navy or army doctor.

Constitution of Objects: Pest, Population, Race, Mass

Sarah Jansen



Sarah Jansen

Sarah Jansen's work focuses on developing a methodology to investigate the "constitution" of scientific objects that have been "successful" in shaping both scientific and non-scientific realities. Instead of treating entities such as "pests" and "populations" as natural categories studied by scientists, *Jansen* investigates how these objects take shape and how they become part of scientific, cultural, social and political realities. Her approach involves detailed analyses of the processes by which these objects emerge, become stabilized and perceived as existing independent of human agency.

Jansen's book "*Schädlinge*". *Geschichte eines wissenschaftlichen und politischen Konstrukts, 1840–1920* (in press) analyzes three interwoven processes: the emergence of the "pest" as a process of constituting a scientific-technological and political object, the formation of the discipline of economic entomology, and the self-shaping of the human actors as economic entomologists. The perspective is on the "pest" as an effect of pest control and not as its pre-discursive cause: "insects", "parasites" and "pests" circulate as collective symbols between scientific and political discourses, practices and institutions, absorbing and giving off elements of knowledge in the process. The book contributes to the field of historical and epistemological studies of science and technology as well as, by analyzing both practices and semantics of "pest" control as one of the conditions of possibility of later NS man murder undertaken with the insecticide Zyklon B to, the discussions about science, national socialism, and modernity.

In her ongoing project on population, race, and mass as objects of ecology, anthropology and demography, *Jansen* analyzes the constitution of "population" and related objects from 1870 to 1950. The project traces how people, but also groups of free-ranging animals were conceptualized as "populations" to be regulated and managed. By investigating the traffic between human popu-

lation sciences, including eugenics, racial anthropology and demography, and nascent ecology, the project enables a perspective on modes of regulation of both human and animal populations that takes into account their mutual impact veiled by today's disciplinary divide.

In a recent case study, *Jansen* has come to extend her methodology to include the role of “epistemic tensions” between related objects such as “race”, “mass” and “population” and the different forms of power inscribed in these objects. For a population to emerge, the individual members need to be identified in order to count as members of a collective to be regulated and to establish the boundaries of the collective. Typological species classifications were unsuited for establishing differences, in the given case, between different migrating herring schools. Around 1900, criminalistic and anthropometric concepts and practices were imported to fisheries biology, a field constitutive of population ecology. With the transfer of these concepts and practices, the object “race” with its hegemonic inscriptions, as well as identifications of the normal and the deviant, became an integral part of nascent ecology. Drawing on the literature on laboratory experiments, another focus of the work is the epistemological analysis of field experiments, their contribution to shaping the “population” objects, and their relationship to the laboratory.

Mapping Urban Nature: Ecological Expertise and Urban Planning in Germany since 1975

Jens Lachmund



Jens Lachmund

This project is a historical-sociological case study of the rise of urban ecology in Germany. In the past three decades issues such as the protection of species, habitats, soils, water, and more generally of “sustainable development”, have created new roles for ecological experts as advisors in urban planning affairs. At the same time, the ecology of the city has evolved as a distinct interdisciplinary research field closely related to environmental planning. Drawing upon a notion of the city as a “space of knowledge”, the project examines the various ways in which the epistemic practices of this discipline have been mutually connected to the material and cultural history of the urban environment.

With Berlin (West) as its focus, the project examines the historical career of these urban ecological surveys. Although there is a long tradition of ecological surveys outside the cities, systematic urban ecological surveys of cities did not emerge before the late 1970s. Particularly, from the mid-1970s onwards in most cities of the FRG, and after unification also in the former GDR, so-called “biotope-mapping” was conducted for local municipalities. These were comprehensive surveys of plants, animals and their habitat structures, which were considered a basis for nature promotion measures and more ecological town planning.



Map of biotope types of the City of Berlin (West) 1984

The project seeks to shed light on the social and material practice of ecological expertise in its urban context. It examines how biotope mapping came into being as a nexus of heterogeneous activities moving across various institutional domains and implying specific modes of epistemic and political ordering. By tracing the historical development of urban biotope mapping, it

addresses the various processes that have shaped the construction and "stabilization" of biotope mapping as a field of ecological expertise. Instead of the diffusion of an existing body of scientific expertise into the contexts of its application this was far more a process of mutual adaption or "co-construction" in which new modes of producing knowledge about urban spaces and new modes of political regulation were inextricably interwoven.

Accordingly, biotope maps are not treated as merely neutral means of representing pre-existing features of the environment. Rather, the project seeks to show how biotope maps were actively involved in the construction of "urban nature". It is a mosaic of various "biotopes", some of them considered to be relatively "natural", others to be highly "artificial". By delineating these regions and by making visible the relations between them, biotope mapping called them into existence as new objects of knowledge. Urban woods and parks as well as wastelands, residential areas, and industrial sites were classified and mapped according to ecological criteria. This has had far-reaching implications for the definition of the nature-culture divide: whereas nature had long been the "other" of the city, biotope mapping inscribed "naturalness" into the urban environment itself.

Great Expectations: Oceanographical and Meteorological Research as Spatial Frontiers after 1900

Sabine Höhler



Sabine Höhler

This project deals with the conceptualization and colonization of space in twentieth-century oceanographical and meteorological research. The general aim is to understand spatial imaginations and processes by which these scientific fields render "space" an object and an effect of knowledge. The focus is on the construction of space as a resource in Weimar Germany and ways in which scientifically motivated oceanic and aerial survey expeditions after World War I were connected to the politics and especially the popular geographic image of "Lebensraum". Postulating that space gains depth through production of spatial knowledge and effective spatial control, *Höhler* examines how oceanic and atmospheric spaces were made available through techniques of surveying, data collecting, and mapping, in which sounding techniques were central. The concept of frontier will be used to analyze the aspects of migration and colonization involved in such research endeavors.

Apparatuses of the Senses: Measuring the Senses as Part of Experimental Settings in the Early Nineteenth Century

Christoph Hoffmann



Christoph Hoffmann

Christoph Hoffmann's project explores an epistemological rupture in the knowledge of the human senses in the early nineteenth century. Although the optics of the eye and the limitations of human vision were well known in the eighteenth century, the function of the senses was understood as reliable and controllable by the mind. Around 1800, the organs of vision and of hearing became opaque objects which themselves seemed to intervene in perception. The organs thus achieved the status of an investigable "epistemic thing". This rupture can be located in physiological research on subjective visual phenomena, at least in the German context, but also in the measurement and observational practices of the physically oriented sciences. They became the subject of a separate line of research. The project focuses on three "Entstehungsherde" (Foucault with Nietzsche) of this shift:

(a) In 1823 the astronomer Friedrich Wilhelm Bessel found individual differences between astronomers who observed the transit of a star over the meridian. In the following years, these observations were corroborated. Registering individual differences became a regular practice at observatories and displayed the senses of the observers as objects of ongoing measurement and experimentation. (b) Ernst Heinrich Weber's study "*De subtilitate tactus*" (1834) reported differences in tactile sensitivity in different areas possessing this sense. In serial tests Weber measured

the smallest perceivable differences in spatial distance at several places on the skin. Today these experiments are recognized as the basis of the so-called Weber-Fechner law. Yet in the 1830s Weber also linked his experiments with a theory of the organization of sensory organs and of the nervous transmission of sensation. Thus he inscribed the epistemological framework of his research on the senses as sensible instruments of measurement into anatomical and physiological structures of the body. (c) In the summer of 1835 Weber visited his brother Wilhelm in Göttingen. In the experiments of the brothers Weber, an electric circuit was used as a telegraph: signals were sent by the induction of currents and received by the skin. The instrument-maker Carl August von Steinheil later provided a bell-ear module as signal-receiver. Understanding the senses as parts of a technological “setup” was nothing new to Steinheil. Trained by Bessel in the early 1820s, he had worked on an automatic time-registering device for astronomical transit observations, a device meant to substitute for the ear of the observer. Thus, in workshop practices around 1830 such as these, the senses had become interchangeable parts of experimental instruments.

These three “Entstehungsherde” provide a detailed picture of epistemological and practical changes in knowledge of the senses after 1800. Whereas anatomical and physiological research tended to sharpen the “subjectivity” of sensations, the approach to the senses in the physical sciences focused on their “instrumentality” and “functionality”. When after 1850 the notion of “sensory apparatus” was commonly and self-evidently used by physiologists in modeling the senses experimentally as technological apparatuses, it was after all the performance of the preceding epoch of research and practical measurement that had turned the senses and technological apparatuses into *one* scientific object.

The Microscopic Anatomy of the Retina and the History of Vision Studies

Jutta Schickore



Jutta Schickore

This project in the history of the study of vision focuses on microscopic investigations of the finer structure of the eye carried out in the first half of the nineteenth century. To analyze nineteenth-century studies of sense perception and vision, historians have directed their attention mainly to Johann Evangelista Purkyne and Johannes Müller’s subjective sensory physiology, or else to the experimental physiology of the mid-nineteenth-century “organic physicists”. By contrast, the general aim of *Schickore*’s project is to assess the significance of micro-anatomical studies of the sensory organs in this context.

The first part of the study concerns attempts in the 1830s – especially by Gottfried Reinhold Treviranus – to determine the microscopic structure of the retina and to locate its light-sensitive elements. It turned out that newly discovered facts of retinal structure could not be interpreted in terms of a theory of vision and remained a constant challenge for physiologists who sought to elucidate the function of the retina. The second part of the study examines how two microscopists, Ernst Brücke in Berlin and Heinrich Müller in Würzburg, made fresh starts on these questions in the late 1840s. Their respective styles of microscopical research reveal that both were representative of the drive toward experiment in the life sciences. A third study examines how in the second third of the nineteenth century, microscopists developed methods of preparation which were based on new ideas about how a proper microscopic object should look like. The example of the introduction of chromic acid reflects a dramatic transformation of microscopy from a practice of preserving to an experimental enterprise.

These case studies indicate that microscopic anatomy escapes the common historiographical distinction between emergent experimental physiology, on the one hand, and observational and morphological approaches in microscopy, on the other. Consequently, *Schickore* is now shifting the emphasis of her work to methodology in nineteenth-century microscopy. She is concentrating on manuals of microscopy as the outcome of the microscopists’ immediate concern with the possibilities and limitations of microscopic analysis and investigating connections between the

microscopists' methodological writings and practices and the contemporaneous discussions on the productive and erroneous observer.

Phenomenological Space and Measurement

David Hyder



David Hyder

While writing his thesis on Wittgenstein's *Tractatus* and its nineteenth-century scientific background, *David Hyder* took interest in the analogy between Wittgenstein's notion of a "logical space" and the view, prevalent among many workers in sense-physiology, that all sensibilia were organized in spatial structures – the color-space, sound-space, tactile continua, and so on. The young Wittgenstein had made use of *his* notion to explain how linguistic expressions could have determinate meanings even when the referents of these expressions did not exist: he argued that propositions were like "addresses" of locations in a space, which might or might not be filled. Helmholtz, who had done the basic physiological research leading to the manifold theory of perception, had himself used this theory in an analogous way in his writings on non-Euclidean geometry. He too had had to explain the sense in which non-Euclidean geometries were conceivable, even if they were not, as he conceded, realized in fact. For both Helmholtz and Wittgenstein, positing a deep spatial structure of experience made it possible to preserve intensional meaning in the absence of concrete referents. This conception of sensation – in some sense an extension of Kant's spatio-temporal manifold to cover the whole field of human experience – is to be found in the philosophical writings of scientists such as Mach, Poincaré, Boltzmann, and Weyl, as well as in Wittgenstein and Carnap. For all these authors, the ultimate meaning of linguistic expressions – both those of everyday language and those of the various sciences – was to be found in their reference to the elements of such a primitive data-space. The history of this conception sheds light not only on the epistemology of the Vienna Circle, the first "philosophers of science," but also on strong phenomenological tendencies in the German-speaking scientific community at the turn of the century.

Invisible Architectures: On Small-Scale Entities in the Life Sciences

Alexandre Métraux in collaboration with *Christoph Gradmann, Sarah Jansen, Ohad Parnes, Marc Ratcliff, Hans-Jörg Rheinberger, Jutta Schickore and Judy Schloegel*

This collaborative project brought together researchers at the Institute working on various aspects of visualizing small-scale entities – single cells, germs, parts of tissues, microscopically minute animals – in the life sciences since the eighteenth century. The group sought to demonstrate the ways in which biological seeing did not catch the "naturally given" morphological properties of living matter, but rather presupposed the management of bodies by various techniques such as slicing, applying dyestuffs, filtering light rays, and so on. In such management, scientists continually faced problems. Could one be sure of having achieved the selective visibility of relevant or potentially relevant features under such constraints? How could one exclude or reduce the likelihood that the manipulations had created artefacts? Gathering visual data in contexts both of selective visibility and manipulative uncertainty had furthermore to be coupled with the conceptualization of life processes. Hence the target objects were assessed both in terms of theoretical plausibility and in terms of a secondary, technically produced visibility masking their pristine, hidden "naturalness". A third aspect, beyond technical questions of representation and theoretical considerations, concerned the education of the eyes. To include the mindful eye of the observer – and hence the culturally determined scopic regimes under which life scientists have been and are still working – turned out to be a challenging topic of historical reconstruction. A workshop took place October 13–15, 1998. The contributions are being published as a special issue of *Science in Context* in 2000.



Judy Schloegel

Conventional Experiment in Unconventional Spaces

Nani Clow

This project studies the ways in which the practices, methods, and instruments of experimental physics were employed in the investigation of a wide variety of psychic phenomena – thought transference, spirit manifestations, cross correspondence, telekinesis – from the late 1880s to the 1920s. Methods of scientific conduct and observation were imported into seances in order to establish control over events, to designate criteria for evidence, and to standardize modes of behavior and witnessing. Experimental methods and instruments were used to control the medium (in order to prevent fraud) as well as to measure, record, and document phenomena. The project aims at a comparative study of telepathy in Britain, France, and Germany. Such comparison ought to enable deeper insight into the ways in which epistemological worldviews drove experimental practices in different local cultures and in turn shaped and transformed the understanding of psychic phenomena.

Further Projects Related to the History of Objects and Spaces of Knowledge



Jonathan Simon

Jonathan Simon studied the isolation and naming of a poisonous plant extract, strychnine, by two French pharmacists, Pierre-Joseph Pelletier and Joseph-Bienaimé Caventou, in 1818. The general aim was to use a historical case of scientific research to address a well-established philosophical problem: the relationship between words and things in identification procedures. *Judy Johns Schloegel* worked on the history of protozoan genetics and more generally on protozoology and microscopy in the late nineteenth and twentieth centuries. She was concerned primarily with the history of genetic determinism in relation to choice of organisms, and with the epistemological consequences of affective relationships between biologists and their research organisms. *Bruno J. Strasser's* project dealt with the transition from molecular biology to biotechnology. Taking the history of restriction enzymes as his case study, he aimed at showing how things (enzymes) first taken as *objects* of an experimental investigation can later become *tools* used in another experimental setup.

Research Projects on "The Uses of Theory in the Life Sciences"

Agents of Life and Disease

Ohad Parnes



Ohad Parnes

Ohad Parnes's dissertation aims to trace the origins of the fundamental concepts of microscopical biology in the period 1830–1870. At the core of the project stands the redefinition of physiology and pathology in terms of causal relations between specific material agencies and corresponding specific effects.

The project consists of two main parts. In the first part, the work of Theodor Schwann, leading to his formulation of the cell theory in 1838, is analysed. In contrast to previous historiography, *Parnes* locates Schwann's cell theory in the context of his earlier research on muscle contraction (1835), stomach digestion (including the discovery of pepsin in 1836), and fermentation (1837). All these investigations were driven by an attempt to explain the dynamics of life in terms of causal agents, without recourse to vital forces. Schwann believed that if one could construct the right experimental setting, it should be possible to discern specific material agents for each physiological process. This part of the work is largely based on the analysis of Schwann's unpublished research notes, hitherto hardly consulted by historians.

The second part of the project deals with the aftermath of Schwann's work, specifically with the way this new experimental and conceptual regime took over in the period 1840–1870. In this part, *Parnes* retraces the interconnections between developments in physiology and those which

took place in the pathological realm. In this period, not only did cell theory take over the microscopical-anatomical imagination, but the conception of the cell itself as an agent of life and disease underwent major changes. In medicine, a growing emphasis was observed on the specific etiology of diseases. *Parnes* argues that this etiological point of view by and large preceded the bacteriological revolution and was not, as is often argued, its result. This part of the project includes an analysis of the work of the physiologists Emil du Bois-Reymond and Carl Ludwig and of the pathologists Jacob Henle and Ludwig Traube.

Toward a History of the Notion of Genetic Regulation and its Bearing on Embryology

Denis Thieffry



Denis Thieffry

This project traced the main conceptual shifts that occurred as experimental embryology yielded to developmental biology over the course of the twentieth century. The concepts of "regulation" and "regulatory network" were central to these shifts. Since the notion of "regulation" is important in contemporary biology, previous authors have investigated its history, especially with respect to the emergence of the concept of a "regulatory gene" in molecular genetics at mid-century. Yet the notion of "regulation" is far older, and its history involves a variety of disciplines, from chemistry to physiology to embryology.

The project followed versions of the notion of regulation as implied in embryological concepts such as "induction", "field", "epigenesis", and "canalization", up to recent interpretations of embryonic development in terms of a spatio-temporal control of gene expression. Under the new molecular biology, most of these embryological concepts went through an eclipse in the 1960s-70s. But some of them, notably "gradient", continued to inspire the research of theoretically inclined biologists as well as that of some experimentalists working on regeneration and insect development. More recently, several of these concepts ("gradient", "epigenesis") were redefined in molecular terms and were used in the description of cell differentiation and embryonic development, whereas others ("canalization") have remained marginal. Aiming to understand how the uses and successes of these concepts related to specific experimental settings, model organisms, disciplines, and local cultures, this analysis emphasizes polysemy and shifts of meaning.

The work of the Belgian embryologist Albert Dalcq, who attempted to give a general "causal" account of early animal embryogenesis in the late 1930s received special attention. Subsequent emphasis was on the development of the notion of the "regulatory gene" and that of the "operon" by Francois Jacob and Jacques Monod. Finally, the historical reconstruction highlighted the ways in which the study of embryogenesis was remodeled so as to be integrated into the new molecular framework. This research forms the basis of a book on the respective contributions of geneticists, molecular biologists, and embryologists to our present understanding of embryonic development.

Metaphors and the Dynamics of Science: Research on the Tobacco Mosaic Virus in Germany, 1940–1960

Christina Brandt



Christina Brandt

As a project situated between the history of biology and literary studies, *Brandt's* dissertation integrates textual analysis and historical reconstruction. The focus is on the role of metaphors in the dynamics of knowledge production. *Brandt* explicates how the language of molecular information transfer, which entered the life sciences in the 1950s and fundamentally shaped the discursive structure of molecular biology, was inscribed in a local experimental and institutional setting: tobacco mosaic virus (TMV) research at the Max Planck Institutes in Tübingen between the late 1940s and early 1960s.

Whereas philosophers of science have often discussed the constructive role of metaphors in science with regard to similarities between metaphors and models, analogies or pre-theoretical

frameworks, the literary approach behind this study opens a different perspective on the problem. Arguing that the fruitfulness of the information concept was not due to the transfer of an information theoretical framework, *Brandt* stresses instead the changing and flexible meanings of information metaphors. Emphasis is thus on the heterogeneous ways in which these metaphors were embedded in different sites of knowledge production. Close attention is paid to the linguistic arrangement of knowledge in various genres of scientific texts and to the relations between these texts and experimental practices. The first part of the dissertation describes the beginnings of TMV research at the Kaiser Wilhelm Institutes for Biochemistry and for Biology. The second part focuses on theoretical work on the “genetic code”, while the third part explores the popular and semi-popular uses of the information concept. The fourth part analyzes the key experimental events and their dynamics: the sequence analysis of the viral coat protein and the shift of interest to the viral RNA and its mutagenesis. The following two parts compare the representation of this work in different genres of scientific texts and the subsequent conflation between these levels of representation. Only around 1960 did the language of information and code enter the realm of experimentation as TMV became a tool for deciphering the genetic code. Finally, in the 1960s, the information concept became a kind of philosophical core of the new biology, around which long-standing questions concerning the essence of life were reevaluated.

Between Philosophy and Experiment: A History of Theoretical Biology, 1900 to World War II

Manfred D. Laubichler



Manfred Laubichler

Theoretical biology became an established field only in the mid-1930s. Since the late nineteenth century, however, experimental biologists and philosophers had participated in ongoing discussions on the topic. The discourse of theoretical biology was centered primarily on the question of the conceptual, epistemological, and methodological foundations of biology. Other themes included the relation of biology to physics and metaphysics, the specificity of biological processes, and the representation of biological knowledge. The emergence of theoretical physics served as a model for similar developments in biology. However, an inclusive theoretical biology could only emerge at the beginning of the twentieth century after certain crucial events had fundamentally transformed biology. Among these were the Darwinian theory of natural selection, cell theory, the causal-mechanical theory of development, and the rediscovery of Mendel in addition to developments in physics such as the theory of thermodynamics and the theory of electromagnetism.

Analyzing the discourse on theoretical biology in these decades helps provide a historical understanding of the epistemology of biological theory and practice. Theoretical biology appears to be especially suited because it was *not* an established discipline with its own specific set of questions. It served rather as a forum for reflection among biologists from different disciplines, such as genetics, cell biology, physiology, comparative anatomy, and “Entwicklungsmechanik”. In these discussions, three aspects may be distinguished: the interpretation of experimental results, the development and analysis of a system of fundamental biological processes, and methodological problems of biology. Conceptually, theoretical biology was simultaneously a part of biological research of the time and a critical (or meta-theoretical) analysis of biology as such.

Theory Formation in Developmental Physiology in Germany in the 1930s–40s

Reinhard Mocek

“Entwicklungsmechanik” as an approach to the analysis of animal organisms was introduced by Wilhelm Roux in the 1880s. Originating in the fields of embryology and morphology, it proposed to elucidate laws of animal morphology in ontogenesis. From its inception, “causal morphology,” as “Entwicklungsmechanik” was also called, combined an experimental approach to the problem of morphogenesis with a strong element of conceptualization. The experimental results of Roux

and Driesch led to two different theories of development. They in turn gave rise to a new form of the old controversy between mechanism and vitalism. The first decades of the twentieth century saw the successive development of gradient theory, field theory and organizer theory. These theories constituted key features of an organismic biology which claimed to do justice to the uniqueness of life, all while remaining faithful to the methods of physical and chemical analysis. This enterprise was severely challenged in the 1930s when developmental physiology was confronted with successful approaches involving genetics and biochemistry. *Mocek's* project aimed at a detailed historical analysis of this process, thus expanding his earlier book-length study: *Die werdende Form: Eine Geschichte der kausalen Morphologie* (1998).

Ecology, Evolution, and the Ethics of Nature

Thomas Potthast



Thomas Potthast

This project concerns the specific historical junctures of biology and ethics that preceded and eventually contributed to the founding of the discipline of bioethics around 1970. The focus is on the two major environmental fields of biology – ecology and evolutionary biology – and on their relation to an ethics of nature, as it was articulated in the later twentieth century. Attention is paid to normative agendas of scientists, institutions, and disciplines as well as to theory formation and research practice. The goal is to understand the hybrid connection between moral and epistemological elements in the constitution of biological disciplines and of bioethics. Though the project mainly concerns biology and ethics in Germany, comparison with Britain and North America promises to reveal more general patterns by which ecology and evolutionary biology did or did not mingle with an ethics of nature in the period 1930–1970, that is, before the zenith of environmentalism. To what extent has the development of these biological disciplines and of bioethics differed in each of these countries? Is there a German “Sonderweg” in the environmental and organismic disciplines of biology with respect to the ethics of nature?

At the core of the project is a close study of networks around two influential mid-twentieth-century German ecologists: the freshwater biologist August Thienemann and the zoologist and entomologist Karl Friederichs. These ecologists' national-conservative conceptions of nature and society as organic wholes contrasted with dynamic and evolutionary views of nature and society as dominated by the individual struggle for existence, views which were held especially by experimental physiologists and geneticists. Within German ecology, tensions appeared as well. On the one hand, ecological research was oriented toward practical application to fisheries, forestry, and water hygiene. On the other hand, ecology was presented as a unifying enterprise and even as a metascience unifying natural science, the humanities, and ethics in a synthetic, holistic account of nature. Experimentalization and quantification were regarded as inadequate to the task of gaining knowledge about nature, thus leading to severe conflicts with powerful experimental biologists in Germany, who went so far as to question whether ecology should be included in biology at all. In these debates, the overall cultural and moral significance of biology was contested and redefined. Opponents regarded each others' epistemologies as morally wrong ways of doing science and being a scientist. These conflicts stretched from the Weimar period through the Third Reich to the Federal Republic.



Berna Kılıç Eden

Further Projects Related to "The Uses of Theory in the Life Sciences"

Berna Kılıç Eden studied Gottlob Frege's anti-psychologism. *Eden's* research project aimed at an exploration of the scientific and cultural context for the rise of anti-psychologism within the framework of late-nineteenth-century theories of “man.” *Abigail Lustig* explored issues in protozoology and its systematics in the late nineteenth and twentieth centuries. The focus of her project was on a conflict between the German evolutionary theorist August Weismann and the French-Algerian protozoologist Emile Maupas over the interpretation of the meaning of sex and death

among the ciliates, a debate that reflected profound differences over the methodology of evolutionary theory. *Maria Yamalidou's* project investigates the emergence of a “molecular” discourse in physiology in the mid nineteenth century as a case of interaction between the physical and the life sciences. She focuses on debates surrounding the “molecular physiology” of John Hughes Bennett at Edinburgh.

Other Projects

Neurosciences in Germany, 1930–1950

Michael Hagner and Cornelius Borck

This project asks how dramatic changes in a national political framework affected the scientific work of a group regarding itself as part of an international community and a scientific elite. Physicians' role in the murderous activities of the National Socialist regime has been known since the Nuremberg trials, and scholars have often avoided a discussion of scientific research practice in biomedicine under the Third Reich. Ironically, historical scholarship has thus implicitly followed the argument of the defendants at Nuremberg, by separating properly “scientific” research of international standard from the misled and “unscientific” activities of certain individuals. Overcoming this dichotomy requires a more complex reconstruction of science under National Socialism using the methods of cultural history. The main task is to draw a network of experimental practices, scientific conceptions, political activities, and historical contingencies. For the field of neurosciences, we aim to reconstruct (a) the main strands of and thematic changes in neuroscientific research and neuropsychiatric practice during the period; (b) the ways in which leading neuroscientists situated brain research in the public domain; (c) the course of international cooperation over the entire period; (d) the involvement of neuroscientists in the war through war-related research projects and such other roles as psychiatric advisors; and (e) continuities of research lines after 1945 and postwar reorganization of brain research both within and outside the Kaiser Wilhelm/Max Planck Society. The project is connected to the Max Planck Society's ongoing research on its forerunner, the Kaiser Wilhelm Society, under National Socialism.

In her project on “Surrationalism and its Obstacles,” *Cristina Chimisso* investigated the relation between science and morality in the philosophy of Gaston Bachelard. *Antonio García Belmar* analyzed the development of a genre of scientific writing, the chemistry textbook, in France in the first half of the nineteenth century. *Janina Wellmann* has begun a project on the *Encyclopédie* and its plates, focusing on the constitution and transmission of knowledge incorporated in and moving between text and image.



Janina Wellmann

Conferences

Postgenomics? Historical, Techno-Epistemic, and Cultural Aspects of Genome Projects (July 8–11, 1998)

The conference was organized by *Hans-Jörg Rheinberger* in cooperation with *Lily Kay* (Harvard University), sponsored by the German Human Genome Project, and attended by about 80 participants, including molecular biologists, historians of science, cultural historians, and science studies scholars from the United States, France, Great Britain, and Germany. The aim of the conference was to explore the epistemic, technical, and cultural challenges of genome research – especially human genome research – and to set them in historical context. Genome sequencing, as it has been practiced during the past decade, is increasingly seen – by participants as well as critics – as a transient episode on the way to a postgenomic biology that is still largely conjectural. Developmental biology, evolutionary biotechnology, and rational drug design are elements of this distant vision.

Max Planck Institute for the History of Science, Berlin

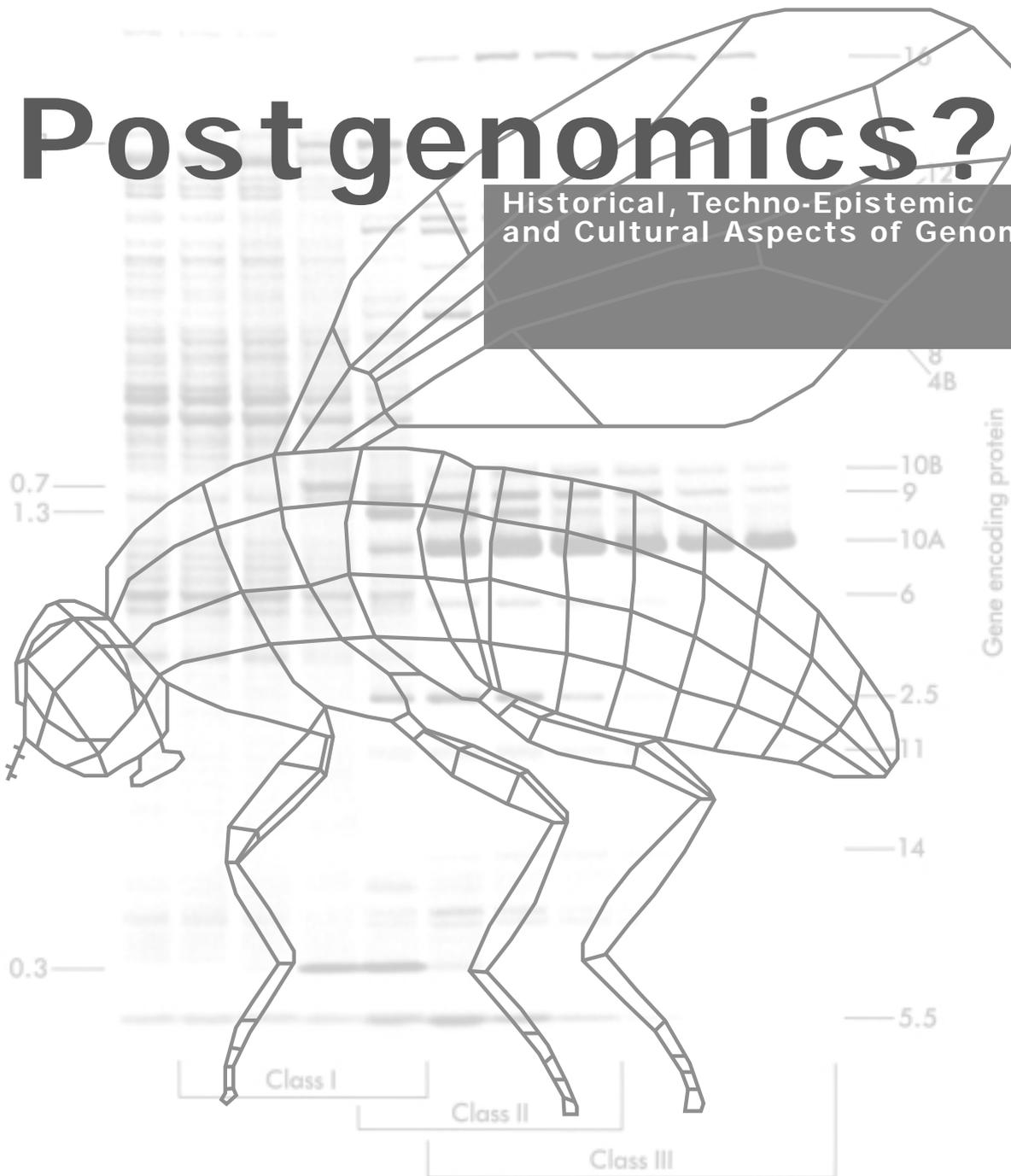
July 8-11, 1998

International conference organized by
Hans-Jörg Rheinberger,
MPI for the History of Science
in collaboration with **Lily Kay,**
Harvard University (1997-'98)

Project initiated by Jürgen Renn, MPI for the History of Science
and financially supported by the
Bundesministerium für Bildung, Wissenschaft, Forschung und Technologie
as part of the Deutsches Humangenomprojekt

Postgenomics?

Historical, Techno-Epistemic
and Cultural Aspects of Genome Projects



For further information please see: [http://www.mpi-hps.mpg.de/1998/07/08-11/1998](#)

The historical frame of the conference was large enough to allow attention to genetic discourse throughout the twentieth century as well as to recent debates. Of special current interest was the revelation of a troubling discrepancy between growing expert appreciation of organismic complexity and ever more sophisticated scientific gene discourse, on the one hand, and a trend toward naive genetic determinism in the public and economic spheres, on the other. The conference went on to pose the question: "Whose Genome?" Since its inception, and to some extent contrary to its original impetus, genome research has become a variegated enterprise including, besides the human genome in its diversity, a whole array of other organisms. Finally, participants made an effort to contemplate and rethink the techno-epistemic and cultural dimensions of these developments, which have led to remarkable new constellations of basic and applied biological research. The results of the conference are summarized in the Institute Preprint No. 110.

Reworking the Bench: Research Notebooks in the History of Science
(November 11–14, 1998)



Frederic L. Holmes

The general aim of this workshop, organized by *Jürgen Renn*, *Hans-Jörg Rheinberger*, and *Frederic L. Holmes* (Yale University), was to investigate research notebooks as a form of documentary evidence of processes of discovery. Another aim was to explore broader historiographic issues concerning research notes as sources for narratives of the history of science. First, notebooks were compared to other non-printed sources, to printed documents, and to contextual information not contained in print or writing. Second, the diverse structure of research notes was analyzed. Third, it was asked whether notebooks could usefully be considered as a distinct genre of scientific writing and as a tool for rather than a trace of research. A further point of concern was how to integrate the micro-information on investigative pathways provided by notebooks into broader narratives of the experimental and cultural practices of science. Finally, it was asked whether research notebooks could be used to reveal general patterns – not to say a “logic” – of the “context of discovery.” The conference was organized so as to maximize context and comparison: between historical periods, from early-modern to twentieth-century science; among the many major fields of scientific investigation in which research notes played a role; and, finally, between the sciences and other areas such as technology, design, and architecture. In a joint effort following the conference, the organizers are working on a comprehensive volume on the uses of research notes in the history of science.

The Organization of Visibility: Photography in Science, Technology and Art
(January 14–16, 1999)

For several decades, historians of science have stressed the fact that visualization plays an important role in the production and distribution of knowledge. This workshop, organized by *Peter Geimer*, focused on the nineteenth and early twentieth centuries and on one specific technical medium – photography – and thus allowed both for detailed case studies and for comparative understanding of photographic visualization in science, art, and technology. Contributors agreed that the referential function of photography is not fixed and ahistorical, but was constantly produced and reproduced, defined, interpreted, and explained. Moreover, organizing visibility included the possibility that such organization could fail. Photographic information had to be defended against competing means of representation.

A subtheme of this discussion on visibility was invisibility. From its beginnings, the camera was perceived as an instrument able to see more than human eyes could see. Increasingly, photography assumed the function of recording the invisible. In all cases, the photographic plate recorded that which had no appearance beyond the plate itself. Photographic devices thus furnished images without perceptible models. In some cases, these images were the only available proof of the existence of the recorded phenomena. The information given by these recordings was

difficult to control, since no referents were available for comparison. In short, the workshop studied “visibility” and “invisibility” as variables that emerged, coincided, and shifted only in concrete experimental systems and in aesthetic discourses rather than forming fixed identities. Some of the contributions will be published in a volume on the role of photography in science, technology, and art.

The Brain and its Sciences in the Twentieth Century (November 25–27, 1999)

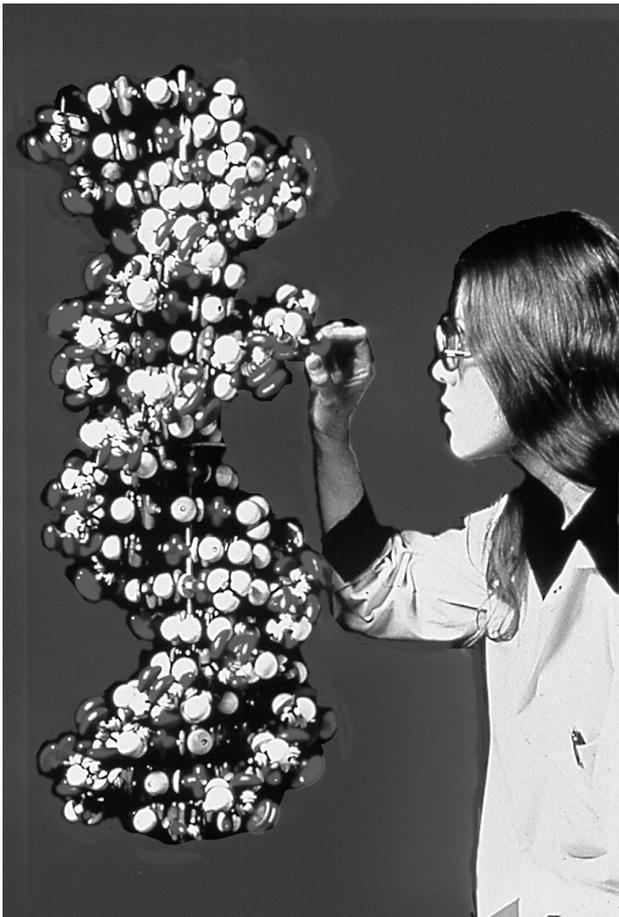
Organized by *Michael Hagner* and *Cornelius Borck*, this conference took the end of the “decade of the brain” as an occasion to review trajectories of neuroscientific research in the last century by convening historians of science, social scientists, philosophers, linguists, and neuroscientists. Aiming to historicize current neuroscientific developments, the conference identified continuities and traditions and discussed them according to apparently contrasting themes: mind/brain (psychosomatic links and connections versus cognitive sciences and artificial minds); the human condition (emotions versus language); and the role of technology (representation and intervention versus consumption and control). A second aim was to understand the historical dynamics of these dichotomies. The neurosciences have been full of promises throughout the past century: from psychosurgery to psychoactive drugs, from cybernetics to artificial minds, from holistic and integrative medicine to psycho-neuro-immunology. An important result of the conference was the realization that the proleptic anthropological and philosophical claims of the neurosciences had remained stable for at least a century: the recent advent of new visualization techniques showed that the “big questions” are not yet answered but open new horizons of expectation and new promises of imminent breakthroughs. Revised versions of several papers will be published as a separate issue of *Science in Context* in 2002.

Independent Research Group I (Director: Ursula Klein)

Project 1: Representing Invisible Objects in the Laboratory Sciences

Ursula Klein (responsible) in cooperation with *Eric Francoeur*, *Peter Ramberg* and *Sara Vollmer*
General Goals of the Project

This project, which began in January 1999, studies the tools and modes of representing invisible objects of research (such as electromagnetic waves, energy, molecular structures, chemical processes) in nineteenth- and twentieth-century laboratory sciences. We are interested in “external” representations as a collective scientific work of constructing signs on paper (or any other medium) standing for the objects under investigation. In the foreground is not the traditional epistemological question of correspondence and truth, but representation as an everyday activity situated in the laboratory or closely related to it. We take it for granted that laboratory scientists want to represent their invisible objects under investigation and do not ask whether this claim is justified. Rather we ask how scientists performed this kind of work; what kind of collectively available “tools of representation” (sign systems) they applied; how the semiotic dimensions of these tools enabled and constrained scientists in the construction of representations; how scientists created “robust fits” (Hacking) between various modes of representation; how they matched representations with experimental marks and data; what kind of broader cultural values specific modes of representation took on; and, above all, how the tools of representation shaped the goals of



Researcher assembling a model of the DNA structure

research, propelled the coming into being of new research objects and contributed to conceptual development. To answer these questions we apply conceptual resources taken from semiotics, epistemology, art history, historiography of science, and sociology of science. Our overall

approach assumes that representations and conceptual development in laboratory sciences can be studied with the same analytic resources as earlier have been applied to laboratory instruments and experimental interventions. The specific focus of the project are representations in the history of nineteenth- and twentieth-century chemistry and biochemistry. Chemistry is a core laboratory science, in fact the oldest laboratory science; and more than any other laboratory scientists, chemists and biochemists have used a broad variety of different modes of representation. Therefore, chemistry and biochemistry are a fertile ground for studying the above mentioned questions. Until recently, historians and philosophers of science took it for granted that verbal language and mathematics were the principle modes of representing the invisible objects of experimental research. This view has been challenged by studies on diagrammatic representations (“pictorial turn”). The history of nineteenth- and twentieth-century chemistry and biochemistry sheds some new light on this problem. In chemistry and biochemistry a broad variety of modes of representation have been in use: verbal language, mathematical formulas, tables (e.g., affinity tables, taxonomic tables, the periodic table), diagrams (e.g., structural formulas, molecular orbital diagrams, molecular orbital energy diagrams), photographs, three-dimensional physical models (ball-and-stick models, space-filling models); and especially the unique symbol system invented by chemists – the various kinds of chemical formulas – that became as emblematic for their science as flasks, beakers and distillation columns. Moreover, in the last twenty years, chemists were pioneers in the development of computer based modeling and digital image processing, such as scanning tunneling microscopy.



Mary Jo Nye

The special research topics of all four participants of the project make it possible to cover the entire range of tools and modes of representation in the history of nineteenth- and twentieth century chemistry. Other colleagues, in particular from the US, have been involved as visiting scholars and/or as participants of the conference “Types of Paper Tools and Traditions of Representation in the History of Chemistry” (organized by *Ursula Klein*), which was held at the Institute from December 2–4, 1999. The fifteen speakers – most of them were historians of science, philosophers, or chemists – discussed topics which included the various productive functions of chemical formulas in nineteenth-century chemistry and chemical industry (*Klein, Ritter, Travis, Ramberg*), the epistemological role and cultural value of three dimensional molecular models (*Francoeur, Meinel*), the visual representation of Mendeleev’s Periodic System (*Bensaude-Vincent, Scerri*), and the interrelation of mathematical, diagrammatic and linguistic representations in quantum chemistry (*Nye, Park*), etc. More than twenty additional guests, among them many chemists, participated in the conference; they came from various countries, such as Denmark, Germany, Japan, Poland, Portugal, Switzerland, and the USA. An edited volume containing the conference papers is planned for spring 2001.

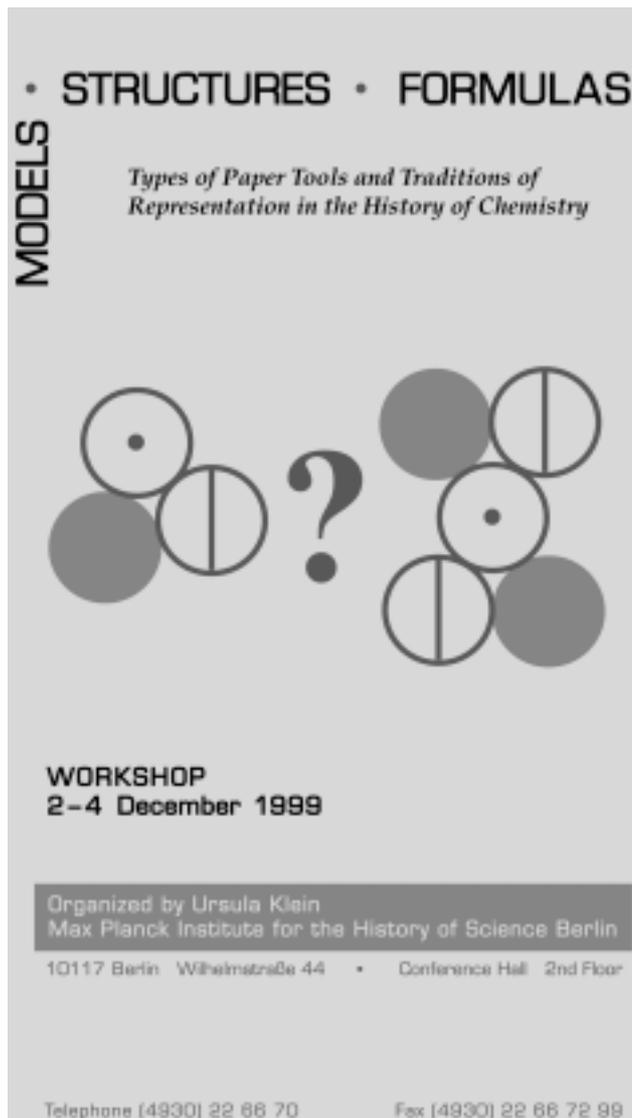
Research activities related to project 1:

Physical and Computer Modeling of Chemical Structures (Twentieth Century)

Eric Francoeur

The development of structural theories in nineteenth-century chemistry was concomitant with the development and adoption of techniques for textually describing and graphically portraying molecular structures. Another related representational practice whose development has been historically parallel to that of graphical techniques has been the use of physical structures to represent the structure of molecules, a practice commonly referred to as physical, or mechanical, molecular modeling. The recent decades have also seen the development of computer generated interactive molecular graphics as yet another representational practice. The historical development of these two practices is the focus of this project.

The first part is the continuation of research performed for his doctoral dissertation. It aims at exploring the role of physical models in twentieth century chemical research through a study of



their use in specific areas of research, notably stereochemistry, conformational analysis and protein structure. The cases documented so far show clearly how such models have been central for the process of defining, exploring and intervening in the domain of molecular structures by providing mechanical embodiments of these structures, simulation devices on which “experimental” inquiries could be performed. A further step at this stage will be to explore the epistemic significance of these modeling practices and how they could shed a new light on notions of representation, simulation, and experimentation. In parallel, further studies on the development of specific modeling tools, notably space-filling models, are also being performed.

The second part of this project is still in its early stages and is being conducted in collaboration with *Jérôme Ségal* of Department III. It is a study of the origin and development of interactive molecular graphics, a practice which has recently become central and ubiquitous in the study of molecular and macromolecular structures. The current focus is on the early period of this practice (1965–1970), with a special emphasis on the work of Cyrus Levinthal and his collaborators at MIT in the mid 1960s. The first results of this work will be submitted for publication shortly, and it is hoped to expand this study to the investigation of later developments in this field, as well as its integration in areas of research such as x-ray crystallography of macromolecular structures, protein conformation studies and rational drug design. Wider issues to be considered include the role of visual representation in computer modeling and simulation.

The Various Functions of Chemical Formulas as Paper Tools in Early Nineteenth-Century Chemistry

Ursula Klein

From the late 1820s onward, chemical formulas (such as H₂O for water), introduced by Jacob Berzelius in 1813 as a shorthand for representing the composition of chemical compounds according to the theory of proportions, became enormously productive paper tools for representing chemical reactions in organic chemistry, for modeling the constitution of organic substances, and for creating a new taxonomic order based on such models. Moreover, the chemists' work on paper with Berzelian chemical formulas generated new chemical concepts and new domains of research under the headings of substitution, valence, chemical structure, and so on.

The first part of the project, which reconstructs the semiotic and epistemological dimensions of Berzelian formulas, their application by European chemists from the late 1820s until 1840, and their impact on the transformation of the natural historical culture of vegetable and animal chemistry into an experimental culture, was completed in spring 1999. It resulted in a "Habilitationsschrift" and contained the following five parts:

1. Two Cultures of Organic Chemistry in the Nineteenth Century
 2. Experiments on the Periphery of Vegetable Chemistry
 3. Formula Models and Model Objects
 4. The Disintegration of the Natural-Historical Culture of Organic Chemistry and the Formation of a New Experimental Culture
 5. The Semiotic Aspects and Practical Applications of Berzelian Formulas in the 1830s and 1840s.
- The second part of the project will explore the stabilization and expansion of the new experimental culture of "substitutions" in European organic chemistry after 1840, which included the further application and modification of chemical formulas as tools to model the reaction and constitution of chemical substances. This experimental culture created a new world of artificial substances not existing in nature outside the laboratory, and an associated world on paper embracing algebraic formulas and various types of diagrammatic symbols. It had a strong impact on the chemical industry and went hand in hand with a new cultural image of synthetic chemistry as the most progressive science for changing the architecture of the modern world.

The Meaning and Purpose of Chemical Formulas in Stereochemistry (1874–1913)

Peter J. Ramberg

This project concerns the fundamental change in the meaning of chemical symbol systems from structural to stereochemical formulas during the last quarter of the nineteenth century. The major part of this project is the completion of a book-length manuscript on the incorporation of spatial principles into chemical theory between 1874 and 1914. The book will first outline the theoretical and cultural context of the near simultaneous proposal of the tetrahedral carbon atom by J. H. van't Hoff and J. A. Le Bel in 1874, and follow the research traditions created by their discovery in the chemistry of Johannes Wislicenus, Arthur Hantzsch, Victor Meyer, Carl Bischoff, Emil Fischer, and Alfred Werner. It will show the emergence of stereochemical ideas as a natural continuation of established research traditions in chemistry, while also illustrating the novel characteristics of stereochemical formulas and ideas, especially the unprecedented use of mechanistic and dynamic principles in chemical explanation.

Part of this project is the completion of two essays on broader issues in the philosophy of chemistry. The first essay on the prediction of non-existent compounds by chemical theory was initially presented 1999 at the Institute's workshop on Paper Tools and Traditions of Representation in the History of Chemistry, and will be rewritten for the published workshop proceedings. It explores how chemists decide to isolate a previously non-existent compound predicted by the structure theory. The second essay will address the curious historical fact of how nineteenth-cen-

tury chemical theory became increasingly sophisticated theoretically without a concurrent introduction of new instrumentation by forming an epistemology of chemical experimentation in which the chemicals of the laboratory are considered as instruments or exemplary models, much as organisms such as fruit flies or rats have been considered as instruments in biology. A third essay will trace the early history of the Walden Inversion, that is, Paul Walden's discovery during the 1890s that the optical rotation of a compound could be inverted by a sequence of substitution reactions, and the early unsuccessful attempts to explain it by such chemists as Emil Fischer and Alfred Werner.

Scanning Tunneling Microscopy and the Meaning of Observation

Sara Vollmer

This project is concerned with a new observational technique developed in the early 1980s, the technique of scanning tunneling microscopy (STM). Like x-ray crystallography and electron microscopy, STM permits the creation of images of the shapes of molecules. However, the way in which it produces these images is radically different from any previous method used to image molecules. In STM, a tiny probe explores the surface of an object. When the probe is within a certain minimal distance of the object, electrical conductivity rapidly increases. The increase indicates the location of the "surface" of the object, and a computer interfaced with the probe records coordinates at which the electrical conductivity increases. The computer then creates an image (or images) that represent the object. This technique permitted the creation, for the first time, of images of individual atoms – as opposed to, in the case of x-ray diffraction, images of lattices of atoms. These new images were not unlike photographs of atoms showing, among other things, the surfaces of atoms as portions of spheres. In materials such as graphite and gold, these spheres could be seen to be arranged symmetrically, each sphere packed neatly amongst others.

This development in observational methods raises epistemological questions. When we create images of molecules by scanning probe microscopy, it would seem that we observe the molecules that are imaged. Yet, observation is clearly not unmediated; there are a wide range of instrumental effects that come into play in scanning tunneling (and other scanning probe) microscopy. Theoretical interpretations are also critical in the transition from a series of coordinates at which conductivity increases, to the formation of an image of the object.

The project analyzes the different epistemological elements involved in scanning tunneling microscopy and how they interact to form an image. One of the goals of the project is to develop an account of observation at a level of generalization that can be meaningfully applied to observation that relies on a wide range of different physical principles, including observation when no image is observed, observation by electron microscopy, by x-ray microscopy, and by scanning tunneling microscopy. The project's aim also includes a study of the history of the invention of scanning tunnel microscopy, and an investigation of the importance of this invention in a technological and institutional context, as well as a consideration of its broader social ramifications.

Project 2: Cultures of Chemistry in the 18th Century

John Dettloff and Sarah Lowengard

General goals of the project

This project studies the interrelations between science and workshops in eighteenth-century Europe. It asks how the technical equipment and other materials for performing scientific experiments and for producing economic goods, respectively, were exchanged; how various types of knowledge – ranging from technological know-how and skill to theoretical assumptions – were flowing from workshops to scientific practices and vice versa; what kinds of intermediate practices or subcultures were established; what role the state played in these practices, etc. Again, the focus

on chemistry is especially appropriate for studying these questions. Several eighteenth-century chemical practices were situated in areas where scientific practices and economic production overlapped, thus displaying intermediate features of both scientific cultures and workshops; some of these practices, such as color making, drug manufacturing, and saltpeter production, exhibit a peculiar internal structure and dynamic – social, political, material, and epistemic – and were stabilized to such a degree that we can conceptualize them as specific cultures or subcultures.

Research activities related to project 2:

Chemistry in the Garden, the Arsenal, and the Academy

John Dettloff

The project engages in a comparative investigation of the scientific and social patterns of chemical practice that formed in and around academic laboratories, mines and metallurgical ateliers, arsenals, and gardens. By using places as the focus of historical analysis this study scrutinizes the ways in which the materials and structures, institutional designs, and social roles available to chemical practitioners at various sites provided chemists with different sets of incentives, resources, and constraints as they fashioned the objects and purposes of their research, the tools and techniques of their inquiries, the social and political alliances that supported their activities, their conceptual frameworks, and their claims of cultural authority. In this way focus is shifted away from individual biography and intellectual chronology toward study of the pressures and dynamic interactions of different forms of chemical practice as they evolved in specific local cultures.

One phase of the project examines the chemistry developed in pharmaceutical and natural-history gardens, like the Parisian *Jardin royal des plantes médicinales* and the *Jardin des apothecaries*. In botanical gardens apothecaries gathered, studied, and prepared herbal and chemical medications; chemists practiced and taught analysis and synthesis of mineral, plant, and animal substances; physicians learned the *materia medica* of their profession and the effects of medicines on the body; natural historians collected, described, organized, and investigated specimens from the three kingdoms of nature. The admixture of personnel and pursuits in gardens created fertile ground to nurture theories relating to the chemistry of life and the historical transformation of nature. Chemistry became rooted in a site devoted to understanding vitality, natural order, and the interchanges among natural species over time. This project describes the techniques chemical practitioners devised to explore these subjects, the obstacles they encountered, as well as the novel concepts of chemical classification, structure, and action they articulated in the course of their research.

A second phase of the project investigates one of the major insurgent movements of eighteenth-century French chemistry – the effort of savants and administrators to harness chemical knowledge to the industrial, fiscal, and military aspirations of the French state. The project tracks these dynamics by following the practices and theories developed around arsenals and mines as chemists intervened in the production of commodities like saltpeter, iron, and steel. In particular, it focuses on the ways in which the military and industrial imperatives of the French state made some research questions particularly pressing in the chemical community and the wider culture. Moreover, it follows the efforts of chemists to establish decisive criteria to determine investments, settle labor and mercantile payments, and reform industrial operations. It thus explicates the relationship between precision instrumental measurement and theory in the chemical laboratory and the procedures used to gauge work and commodities in the arena of economic production. In this way it reveals the domestic and geopolitical pressures that impelled collaborations among chemists, financiers, and royal administrators and fostered a culture in which particular quantitative chemical practices and theories attained cultural authority.

Color in the Workshop – Color in the Laboratory

Sarah Lowengard

The focus of this project is eighteenth-century understanding of color: what it was; how it was made; who had “the best” (and why); how to improve the color making process and how to interpret its physical phenomena. As a topic of considerable interest and conjecture then (as now) for specialists and non-specialists alike, it proves to be uniquely suited to examination of the relationship between workshop or production-oriented goals and those of the academies. Eighteenth-century rhetoric stressed the combination of intellectual and economic value that might result from the application of philosophical ideas to practical endeavors. A body of knowledge about color, established by natural philosophers or physicists, supported investigations of new techniques as well as new theories. Scientific investigations of the arts and trades would provide groundwork for the improvement of established branches of industry and lead to the creation of new ones.

Throughout the eighteenth century, experiments with pigments, glazes and dyestuffs, and efforts to deepen understanding of these materials, offered obvious links between investigations into the natural world and improvements in the man-made one. A related question concerns eighteenth-century efforts to systematize color, and the role played by color making practice on theoretically derived color lines, wheels, triangles, spheres and pyramids.

The thrust of the research has been to refine and expand the previous results of a doctoral thesis, which considered these connections in Britain and France, adding to it information from academic societies and commercial concerns in Germany. To this end, the research included: the development of a deeper fluency with eighteenth-century technical writing about color and color production, particularly that coming from or intended for Germany-based or German-speaking communities; the formulation of a clearer picture of the eighteenth-century intellectual and commercial communities in Germany; and the location of relevant archival sources to provide a clearer insight into personal and public beliefs and practices that may not have been appropriate to formal publication media.

Independent Research Group II (Director: H. Otto Sibum)

Experimental History of Science

In 1998–1999 *H. Otto Sibum* continued his research project on the history of experiment and its significance for the production and communication of knowledge. He also collaborated with *Lorraine Daston* on the “Scientific Persona” project (see p. 39). In his book-length manuscript he focuses on the genesis and development of a scientific fact, the mechanical equivalent of heat, which became the building block of nineteenth century thermodynamics and energy physics. One of the central issues is that of opening up the material culture of science to scrutiny. Instruments, machines, space (physical and symbolic) and even the actors’ economy of the senses have all become objects of historical investigation. The approach is based on the assumption that it is the use of technologies that gives them their historical meaning. Among historians the different means of investigating the actual uses of instruments within different cultural traditions have recently become a major concern. *Sibum’s* studies make a distinctive contribution to this research. In addition to undertaking close analysis of literary and graphical resources, *Sibum* has developed a performative historiography which reworks experiments by performing them with replicas of historical apparatus. Complementing the traditional means of scholarship, this method enables a



Exploring breakdown of James Joule's paddle wheel experiment during the performance of trial with replica

considerable enrichment of our knowledge of the language of laboratory events. The reworking of James Joule’s paddle wheel experiment to determine the mechanical equivalent of heat (1850) has shown, for example, that the experimental techniques of heat measurement on which Joule’s trials depended were neither recorded in Joule’s publications nor in his own notebooks. Nevertheless they could be reconstructed through research on the interfaces between the experiment, its literary representations, and the different cultural traditions in which Joule worked. This is because the

performance of historical experiments through reworking enables us to uncover experimental techniques and forms of knowledge which are often essential to an experiment, but which have become blind spots in laboratory reports – because they have been taken for granted through constant repetition and familiarity. It therefore demonstrates very clearly the importance of non-literary forms of communication that are simply beyond the scope of conventional studies of the laboratory.

Among other things, the approach focuses on the connections between sensual experience and the conceptual development of science, a problem that Michael Polanyi first highlighted in his concept of “tacit knowledge”. Yet in Polanyi’s work, just as in a more recent historical study which explicitly points to the key importance of sensual experience, this knowledge remains hidden from us. Performative historiography allows the researcher to comprehend the experiment as a spatio-temporal event and thereby brings the character of knowledge production as a process into the center of consideration. The working knowledge of the experimenter is embodied in the actor’s performance. In the process of experimentation the action functions as a medium of cultural memory, comparable with ritual or the transfer of craft skills from master to apprentice. *Sibum* has described this performative knowledge, bound to the concrete craft actions of an individual or group of people, as gestural knowledge. The unusual combination of concepts in gestural knowledge seeks to break away from the traditional, static conception of scientific knowledge based on a bodiless spirit, in favor of a conception that finds knowledge in the process of genesis and development, as something dynamic and continuously in interchange with respective forms of action and communication. “Skills” or manual capabilities are to be regarded as a constitutive part of the knowledge of the experimenter. What we encounter in written reports of the experiment is then only one, symbolic part of an essentially more complex gestural knowledge, which the historical experiment is able to bring to execution. What Michael Polanyi designated as “tacit” or “personal” knowledge now proves itself to be a form of expression for a historical, gestural knowledge which either resides in the actors’ performances themselves or is expressed to some degree in the form of an artefact, but is nevertheless historically reconstructable.

In further historical explorations the research could show that James Joule had no possibility of acquiring the techniques necessary for his temperature measurements in the elite scientific culture of his time – since they did not exist there. *Sibum* was able to locate the source of Joule’s unique skills in the long overlooked connection between such apparently autonomous practices as the experimental sciences and the local craft skills of the brewing industry, then undergoing radical changes; and in which Joule had worked actively for twenty years. The experiences of this performative historiography clearly show that laboratory events – the actors’ use of practical and theoretical technologies of knowledge production – can be described as a historical cross-section of actions and structures in the field of cultural production. Further research on the process of publishing Joule’s results has shown that the manuscript underwent important changes up until it was printed. In the published text the experiment was described as giving empirical evidence of the existence of a constant relationship between mechanical work and heat. But Joule saw deeper implications in his study, which were edited out by his referees. Further studies enabled *Sibum* to identify a research collective which had developed forms of gestural knowledge that led Joule to propose a dynamic theory of heat as a result of his experiments. This research methodology, however, also makes it possible for us to grasp the process of the communication of experimental knowledge in an improved way. The critical reappraisal of the way in which Joule’s experiment was replicated in selected centres of science makes explicit a continuing process of struggle – of forty years duration – over the practices involved in determining this scientific fact and its conceptual meanings. The results of these micro studies of exchange processes amongst the emerging subcultures of the nineteenth century exact sciences will make an important contribution to the current discourse on the suitability of different models of knowledge transmission.

In October 1998 *H. Otto Sibum* was invited to plan and set up an independent research group which began its work in April 1999. Current members mainly focus on the investigation of

research practices and their meaning for the development of the physical sciences from the 17th until the twentieth century. The expression “Experimental History of Science” refers in part to the historiographic approach developed in previous years by the Director. In particular, the recent research on experiment as a non-literary knowledge tradition in science with specific means of acquiring and communicating knowledge has important historiographical consequences. Firstly, we have to rethink the often exclusive use of texts and images as sole historical sources and pay much more attention to the material objects – silent representatives of the past – and appropriate modes of investigation. This involves revising our understanding of knowledge as merely textual. Instruments, three-dimensional models, architectural spaces have all to become objects of historical investigation in order to account for other forms of knowing. Secondly, when studying scientists’ practices performed in the laboratory or in the study we have to investigate the productive role of the human body, i.e. to integrate sensuous experience as a cultural sensorium in its historical development. Thirdly, studying scientists at work requires bridging the gap between epistemology and practice. Experimental history of science aims to show how this divide could historically have emerged in the various endeavours to make sense of practitioners’ knowledge. By carving out the specific relations between forms of knowledge and their social bearers we can identify the canonical limits of an emerging field of knowledge.

In the first year, project members have begun to investigate the tensions between knowledge derived from literary sources and knowledge embodied in practical engagement in experiment in, for example, the arts, crafts and engineering. Concern with this tension itself has a long and multifaceted history, which the project wants to trace and relate to the emergence of science. The changing meaning and relation between knowledge and skill is of particular importance here. *William T. Lynch* from Wayne State University has finished a book manuscript which examines the significance that shared Baconian methods had for the emergence of the early Royal Society and its earliest published books, and has also begun an investigation of the epistemological status of craft knowledge as displayed in surveying as opposed to natural philosophical knowledge. Contrary to the Royal Society opinion, which differentiated between knowledge and skill and conceded to the craftsmen and artisan only a rather passive role in knowledge production, i.e. as providing merely the fertile soil for science, *Lynch* aims at reconstructing the material practices of surveyors in order to judge their epistemological value. He concentrates on the Irish land survey project of William Petty, later a member of the Royal Society of London. *Lynch* has begun a material reconstruction of surveying both to test ideas derived from the historical record about the form the survey took and to explore in an ethnographic fashion the kinds of skills or tacit knowledge necessary to carry out similar techniques with historically accurate tools today. This part of his study is particularly important because Petty sought to circumvent the biggest obstacle to his plan – the craft nature of surveying – through the division of labor. Secondly, the study wants to answer questions such as what kinds of information did the surveys provide to what kinds of actors? How were legal judgments and practical possession of the land affected? This project of carving out the tension between knowledge, material practices and skill will certainly contribute to a better understanding of the establishment of seventeenth century experimental natural philosophy.

Several members of the research group focus on a second major period of historical transformation – the turn of the eighteenth to the nineteenth century – in which the tension between knowledge and skill became an integral part of the formation of experimental science. Eighteenth century French experimental philosophers, for example, commented on the consequences of limiting oneself to deriving knowledge from literary sources alone, and juxtaposed this knowledge of the savants with knowledge derived from the manipulation of instruments. Seeking to precisely convey the working knowledge of the experimentalist, German experimental philosophers established the power of using demonstration devices in experimental lectures in this same period. But this tension between manual and mental work in research did not only remain an academic affair; it reflected a much broader cultural problem of the time. This year, project members concentrated on experimental work and their findings indicate already that research practices did not follow



Annik Pietsch

strict disciplinary boundaries. Experimental knowledge was generated mainly outside Universities in the mechanical arts, crafts, engineering and industry. Its integration into the academic landscape was a process of long duration, in which the emerging divide between practice and epistemology or knowledge and skill was one important issue.

Annik Pietsch, a Ph.D. student of art history, contributes to this investigation by work describing the change of painting techniques from the eighteenth to the nineteenth century as a history of changing binding media. Her exploration of practices of art production in Berlin promises to provide insights into the development of the arts and sciences from an unusual perspective. Her close studies of materials and techniques in preparing and using colors allow the reconstruction of the practitioners' knowledge and displays the interdependence of arts, craft and industry and science.



19th century painting tools: palette with oil paints; scetch indicating colour positions; paper envelopes with pigments

The art historian *Kilian Heck* began his investigation of the connection between visual perception and scientific development by studying an extremely limited context: the city of Berlin after 1815. Berlin came to be part of the broader project of remodelling Prussia from an absolutist state to a nation that was conceived to be represented by the *Bildungsbürgertum*. *Heck* explores mutual connections between educational programs of academic institutions and museums (particularly drawing and perspective), the architecture and decoration of spaces of learning, and the broader intellectual discourse.



Kilian Heck

The perspective of the art historian complements a research project undertaken by *M. Norton Wise* (a short term visiting fellow) on the emergence of laboratory science and the role of graphical representations in the physical sciences in modernizing Prussia. Overlapping interests in artistic and scientific drawing sparked the plan for a workshop to be held in December 2000 on "What's in a line: Drawing as Intelligence" convened by *L. Daston*, *H. Otto Sibum* and *M. Norton Wise*. The aim of the workshop is to examine the phenomenon of drawing in science within a broader context that embraces artistic and technical drawing, addressing two themes: the intelligibility of drawings and the form of intelligence that drawing presupposes and cultivates.

Gerhard Wiesenfeldt, another member of the research group, began his exploration of this period of transformation from natural philosophy to physics and the related tension between knowledge and skill by studying the change of visual representations of experimental practices in electrical research. He analyzes differences in the manner of illustrating natural philosophy and physics as expressions of a changing conception of experimental science. The project is based on the thesis that both the experimental practices and the visual representations have been constitutive for natural philosophy and physics. In this respect, attempts to demarcate contents and disciplines, which can be found in the field of galvanism or in the controversy between German *Naturphilosophen* and academic scientists, are being analyzed.



Gerhard Wiesenfeldt

H. Otto Sibum studied how "the art of experiment", traditionally the province of artisans rather than scholars, became the core of a new scientific identity, the experimentalist, in the exact sci-

ences during the late eighteenth and early nineteenth century. Since the early modern period scholarly opinions range from denying that experiment has any epistemological value to the (nineteenth century) conviction that this form of inquiry is the only way to make sense of natural causes. One of the underlying issues in these controversies about the meaning of experiment was that the physical manipulation of objects, “the art of experiment”, was not seen to belong to the scholarly tradition in which a clear distinction between doing and knowing still predominated. Even enlightened philosophers like Diderot, who described the arts as a form of knowing, conceded that this knowledge operates outside the enlightened discourse. His encyclopaedic project was one answer to the dilemma of how to give the practitioners’ knowledge a language, which could be understood by anyone. But his approach (as well as many other literary approaches of the rising bourgeois culture) reduced these complex forms of knowing to visual representations or descriptions of manual techniques, thereby creating myths about practice that maintained the boundary between epistemology and practice. Therefore the eighteenth century engineer, with his training in manual operations and technical drawing, was seen for a short time as the ideal candidate, the “third man”, in bridging theory and practice. However, with the rise of laboratory space and the development of precision instrumentation around 1800, experimentalists whose cultural origins often go back to the artisanal and engineering world faced similar problems in communicating their special knowledge. In order to understand the process of gaining authority and credibility through experimental work we have to study the mediation between experimentalists and scholars in this period of major cultural transformation. By the late nineteenth century the process of differentiation within the sciences had driven a wedge between the humanist scholar and the natural scientist.

Finally we follow the relation between skill and knowledge to the period around 1900, the birth of modern physics with its clear distinctions between experimental and theoretical sciences. Two historians of physics cover this field through their work on early relativity theory and quantum physics. Both fields are usually regarded as products of the newly emerging sub-discipline of theoretical physics and therefore treated as exemplary academic philosophical knowledge. However, experimental history of science aims at investigating the laboratory of theory, i.e. the research practices and material culture of these endeavours.

Richard Staley investigates the interplay between instruments, experiment and theory in the physics community. The main focus of his present research has been a close study of the genesis of Albert Michelson’s interferometer, describing the relations between experimental work on the velocity of light, ether-drift, spectroscopy and metrology in the development of a new class of instruments. During his stay to date he has completed a chapter on this topic, “Travelling Light”. For his book project “Physics circa 1900” he is investigating experimental work on electron theory and the co-creation of “classical” and modern physics in the early development of relativity. The reconstruction of hitherto neglected experimental and instrumental trajectories offers a new footing for an examination of the emergence of relativity (together with specific accounts of its history) out of a complex disciplinary theater.



Richard Staley

Karl Hall’s project stems from his Ph.D. thesis on the history of Soviet theoretical physics during the interwar period. He explores the changing practices of theoretical physics in Soviet culture. *Hall* traces the theorists’ development of programs of research in local cultural disputation, but also their roles as spokesmen for basic science and reluctant interpreters of the philosophy of modern physics. His main project of the past year concentrates on Michael Polanyi’s laboratory collaborations with the Soviet physicist Abram Joffe in the late 1920s. Their work on dielectric breakdown dealt with a hideously complicated bulk phenomenon far removed from the quantum mechanics of single particles, but after the initial successes of the quantum mechanical electron theory of metals there was considerable hope that it might yet be incorporated into a larger synthesis of solid state theory. Breakdown became an unexpected laboratory site for contesting a complex set of experimental, theoretical, industrial, economic, ideological, and cultural concerns. The aim of *Hall’s* project is to explain the historical constitution of Polanyi’s influential postwar ideas



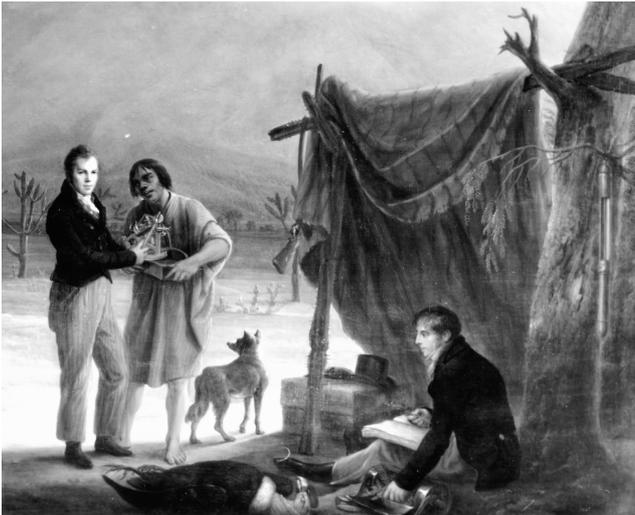
Karl Hall

about tacit knowledge, which he developed in response to the challenge of adequately representing in semantic terms how knowledge is produced in the experimental workplace.

Instruments, Travel and Science: Itineraries of Precision in the Natural Sciences, 18th–20th Century

Marie-Noëlle Bourguet, Christian Licoppe, H. Otto Sibum

A second related project concerns the emergence in Europe of a new instrumental and measurement culture with its changing cognitive practices between the mid-eighteenth and the twentieth century. In collaboration with *Marie-Noëlle Bourguet* (Paris) and *Christian Licoppe* (Paris), work-



Alexander von Humboldt at the foothills of the Chimborasso, painted by Weitsch (detail)

shops were organized with the aim of publishing a book titled “Instruments, Travel and Science: Itineraries of Precision in the Natural Sciences, 18th – 20th Century”. The diversity of local knowledge traditions in this period raises the question of how these “local” world-views were progressively replaced by a new “global” and universalist approach based on different cognitive practices. In this process, the increasing use of quantifying practices, the displacement and voyages of instruments across the globe, and the circulation and appropriation of skills played an essential role. Reconstituting their history, from the standpoint of investigating material practices, would thus throw new light on an essential question of the history and philosophy of science relating to the emergence of a universalist conception of nature and of a science which describes it. The scope of the project involves both a long-term approach and a resolutely comparative perspective. The authors will discuss French, German and British initiatives, as well as the relationship between these initiatives and the knowledge and techniques of travellers in other cultural spaces (India, Africa, Southeast Asia and North America). As for periodization, the specificity of the subject calls for a transgression of the usual historical division between early modern and the modern period. Authors and topics are as follows:

Simon Schaffer (University of Cambridge, UK): Golden Means: Assay Instruments and the Geography of Precision in the Guinea Trade

Christian Licoppe (Centre National d’Études de Télécommunications, Paris): The Project for a Map of Languedoc in Eighteenth Century France at the Contested Intersection between Astronomy and Geography

James Bennett (Museum of the History of Science, Oxford): The Travels and Trials of Mr. Harrison’s Timekeeper

Marie-Noëlle Bourguet (Université de Paris VII): Why Should Naturalists Carry Instruments?

Giuliano Pancaldi (CIS, Università di Bologna): Appropriating Invention. The Reception of the Voltaic Battery in Europe

Christophe Bonneuil (Centre Koyré, CNRS, Paris): The Accurate Species

Kapil Raj (CNRS, Paris): When Human Travellers become Instruments: The Indo-British Exploration of Central Asia in the 19th Century

H. Otto Sibum (Max Planck Institute for the History of Science): Fieldwork of a Modern Physicist

Richard Staley (Max Planck Institute for the History of Science): Travelling Light

David Turnbull (Deakin University, Australia): Travelling Knowledge: Narratives, Assemblages and Encounters

Max Planck Society Research Fellowship for Outstanding Women Scholars

Emma Spary

The work carried out by *Emma Spary* since her appointment in July 1998 has concerned two distinct areas: European natural history in the eighteenth century and the history of food, eating and taste prior to the development of an institutionalized “nutrition science”. Each project is concerned with the problem of scientific authority and its negotiation in relation to political, social or material media of presentation of scientific knowledge, as a route into a better understanding of the processes of change, continuity and credibility which enable us to speak meaningfully of “scientific knowledge”. It is a general assumption of both projects that, because scientific facts are cultural objects, a thorough cultural history of the historical period concerned is a necessary preliminary to meaningful analysis of the formation of scientific authority.

Project 1: European Natural History in the Eighteenth Century

The history of eighteenth-century natural history remains an underexplored field, colored by the assertions of an earlier generation that the eighteenth century was a period of stagnation in scientific enterprise and by subsequent emphasis on the experimental sciences. Many major issues concerning the recruitment of scientific credibility by naturalists, the manipulation and creation of material settings and tools such as cabinets, specimens or books, or the manufacture of relations between the external world (natural and social) and the internal order of the collection are currently being investigated. Naturalists performed a complex epistemological switchback in constructing classificatory systems, the characteristic enterprise of natural history. They needed to convert the world into orders whilst retaining the legitimacy conferred upon the orderer by the appeal to nature. In part this was to be achieved through the meticulous policing of what counted as a faithful (re)presentation of nature, but it also involved attention to self-presentation and appeals to a literate public and improving rulers to invest resources – and engage – in natural historical practice.

Current research activities:

Parisian Natural History in the Revolutionary Years

During the spring and summer of 1999, final revisions were carried out on a book project entitled *Naturalising the Tree of Liberty: French Natural History from Old Regime to Revolution*. The primary concern of this work is to create a new basis for institutional history which presents the scientific institution as a contingent product of cumulative social negotiations among actors both within the field of natural history and outside. The specific example chosen is the Muséum d’Histoire Naturelle, founded in Paris by the staff of the former royal natural history garden as a response to the new political world created by the French Revolution. Its survival during the troubled years of the 1790s poses a problem for understanding the nature of political engagement by scientific practitioners, as well as challenging earlier interpretations of the political significance of natural history in eighteenth-century France. The book will be published by the University of Chicago Press in the summer of 2000.

Chapter headings:

Introduction

Chapter 1: The Place of “*Histoire Naturelle*” at the Jardin du Roi

Chapter 2: Acting at a Distance: André Thouin and the Function of Botanical Networks

Chapter 3: Revolutionary Culture: Generation, Degeneration and

Regeneration in the Jardin du Roi

Chapter 4: Patronage, Community and Power: Strategies of Self-Presentation in New Regimes

Chapter 5: The Spectacle of Nature: The Muséum d'Histoire Naturelle and the Jacobins

Conclusion: Possible Futures

A Semiotics of the Collection

Research also continued on a study of the relations between specimens, illustrations and descriptions in collections and books of natural history. Using as examples the Parisian ornithological collections maintained by René-Antoine Ferchault de Réaumur, a powerful figure in the early eighteenth-century Académie Royale des Sciences, and Georges-Louis Leclerc de Buffon, director of the Jardin du Roi, it is possible to demonstrate marked contrasts between modes of representing and creating such material, visual or textual objects of natural history. Different classificatory orders, correlated with different accounts of the social and natural worlds, could be sustained by different systems of rules for the depiction, description, observation and collection of natural objects which directed the viewer to specific sets of characteristics to be taken as “natural”. This study also suggested that the tacit existence of such rules may explain how scientific texts enforce particular interpretations upon readers, by tying appropriate and inappropriate modes of viewing illustrations to particular cultural assumptions about the nature and function of a given genre of publication or illustration. A model of semiotics derived from the work of Roland Barthes was useful to display the problems at stake in making and representing the collection, but was also open to challenge by the application of certain important criticisms of structuralism drawn from Derrida and gender analysis.

New Historiographical Models of Scientific Illustration

In the interpretation of scientific images, insights drawn from art history enable us to comprehend the style and genre of a particular illustration, as well as permitting the analysis of iconographic and gestural references. But a large proportion of scientific images do not contain such references; their depictions are not of persons or practices but of objects, in particular natural objects. For natural history this is a particular problem. Depictions of naturalia were supposedly self-sufficient, with the link between the image and “real nature” guaranteed by a battery of disciplines imposed by authors upon artists. Even so the “natural” quality of illustrations was hotly contested, and if illustrations were demonstrated to be inauthentic, the associated classificatory projects or claims concerning nature generated by the author could be undermined by critics. The rules of depicting naturalia were thus crucially important for defining nature and affirming the authoritative status of the investigator of nature. At the same time, they were rarely discussed in works of natural history, since to do so was to undermine the self-evidently natural quality of images.

A wide-ranging study of conchological and other natural historical works published from the late seventeenth to the nineteenth century was carried out, covering materials from France, the Dutch Republic, and different German and Italian states. This showed, first of all, that criteria for generating natural history illustrations were culturally local: the adoption of specific criteria could be traced via direct cultural contacts between groups of practitioners. Secondly, whilst such criteria were implemented slightly differently in different cultures of collecting, they preserved a demonstrable underlying unity even after the explicit theoretical grounds for subscribing to such design criteria had been abandoned. Efforts were made to analyze the justification for this persistence of particular rules of design by the study of changing accounts of taste, artistry and natural theology. This opens the way to a discussion of Latour’s model of scientific knowledge as “black-boxed”. It seems likely that many forms of scientific practice and representation are adopted from

generation to generation as part of a “style” of science which may be specific to one discipline or subdiscipline, which facilitates communication among practitioners, and which is taken for granted as the expected format for presenting and ordering new knowledge. The process of conversion of field or laboratory notes and other similar materials into these “appropriate” modes of presentation is another important example. The fact that such styles may never be explicitly discussed or related to the activities of particular practitioners or the concerns of particular works suggests a need for further research into tacit rules of communication of scientific knowledge, which may go unrecognized by the researcher except through such broader surveys of primary materials.

Project 2: The Sciences of Food in the Eighteenth Century

A genuine, institutionalized science of nutrition emerged only in the 1840s, and its authoritative status was swiftly adopted by European researchers, medical practitioners and the general public. Yet from the last decades of the seventeenth century to the early decades of the nineteenth, scientific practitioners from a variety of different disciplines – chemistry, pharmacy, medicine, surgery, natural history, agronomy, and political economy in particular – asserted their right to present themselves as expert commentators on the subject of food, taste and dietary choice, both before literate audiences from the polite elite, and as mediators between government and the illiterate poor in cities and countryside, where political self-expression was closely tied to the availability and quality of food. The activities of scientific practitioners in this sphere have not been investigated for any European country. This project takes France as a case study for exploring the problems associated with the assertion of scientific and medical authority in a domain lacking institutional or disciplinary identity and which was central to the everyday lives of all. By drawing together subjects usually considered separately, a history of food acts as a means of exploring hitherto ignored relations between medical and scientific disciplines. Many food reformers were active in several different areas, but by tracing their movements from one discipline to another by means of their comments on food, the continuity between personnel, practices and reforming agendas can be demonstrated. This highlights the importance of viewing eighteenth-century scientific practitioners as multi-disciplinary: the self-presentation of such individuals was, first and foremost, as members of polite society with all the improving political aims that such a role implied in this period and culture.

Current research activities:

Surgery and the “Extraordinary Eater”

In publications aimed at both scientific and general audiences in the second half of the eighteenth century, well-known surgeons described cases of the extraordinary consumption of food, either in terms of quantity or in terms of the nature of the substances consumed (chalk, leather, wood, etc.). Such interest can be related to a long tradition of study of marvels and the extraordinary, but for surgeons, the particular function of the study of extraordinary eaters was closely tied to their emerging scientific identity as a profession. The modes of description and re-description of the extraordinary eater’s body reveal that such individuals were categorized and anatomized precisely because they posed an epistemological problem for surgical self-presentation and the redefinition of the surgeon’s corporeal skills. At the same time, the fostering of Royal connections enabled the Paris surgical community to constitute itself as an elite with power over the practice of surgery throughout the country. As such, extraordinary eaters became the centre of a conflict between provincial surgeons, who supported curious modes of making knowledge, and central surgeons, who increasingly attempted to “normalize” extraordinary phenomena as merely rare natural events. Surgical writings, ironically, whilst writing extraordinary eaters out of the picture of corporeal

skills, also provide the only source of detailed knowledge of the lives of these marginal individuals, enabling a better understanding of the function of their corporeal skills at different social levels.

Taste and the Reform of Regimen

Research was commenced into perhaps the best-known aspect of scientific and medical accounts of food during the early modern period: the Hippocratic-Galenic regimen. Customarily presented as a theory which dominated medical accounts of the body until the end of the eighteenth century without change, classical regimen nonetheless had a history of transformation and adaptation during the eighteenth century which enabled physicians to assimilate contemporary developments in chemical and mechanical medicine. Boerhaave's iatromechanism entered France by way of the enormous success of Swiss medical writing and practice from the 1760s onwards, and generated a renewed interest in regimen. The Genevan Tronchin and the Lausanne practitioner Tissot were particularly renowned as the physicians to philosophes and salonnières. Both became involved in the Genevan and Parisian debate over the moral status of the writings of Jean-Jacques Rousseau. Decisions among the *philosophes* and *salonnières* concerning dietary choices confronted both the relation between eating and intellectual activity, discussed in Boerhaavian and neo-Hippocratic writings on health, and also the split among savants over the implications of Rousseau's writings for government of the self and of the nation. Further research into this subject will throw light upon the ways in which forms of knowledge become detached from their local social and political meanings in order to take on the status of universal natural truths, and on the strategies employed by outsiders in attempting to legitimate their activities within the conflicted and corporative medical world of eighteenth-century Paris, by means of an appeal to Nature.

Provision of Matériel, Equipment and Working Space

The Facility

At present, the Institute works in rented offices in the building of the Embassy of the Czech Republic and in some additional rooms in the neighborhood needed for the growing holdings of the library. Conference rooms can be used as far as they are not needed by the embassy itself. The Max Planck Society is planning a new building close to the Max Planck Archives and the campus of the *Freie Universität* in Berlin-Dahlem. Subject to approval by the governmental authorities the Institute hopes to move into its new building around 2003/04.



The Institute's building in Berlin Mitte

Library and Documentation Unit

Headed by *Urs Schoepflin*

The Library is the central information unit of the Max Planck Institute for the History of Science. Its task is to assist research by providing literature, reference and modern information services in any form. This includes the acquisition and delivery of traditional printed sources like books or journals, microfiche and microfilms, bibliographic reference files, and extends to electronic documentation and electronic archives. Along with electronic documentation, the Library supplies not only reference information and sources in history of science, but also the appropriate tools to search and handle the wealth of electronic information available in-house and worldwide. The collections of printed books and journals are presented for open access and arranged systematically according to the Dewey Decimal Classification to meet user requirements for browsing. The Library offers a reading area with Intranet and Internet connections as well as a casual reading corner for newspapers. These areas can be configured for discussion groups and receptions. Local and Internet electronic resources are made available through the Library's homepage. The Library is permanently accessible for members of the Institute, including evening hours and weekends.

Library Developments.

The development of the collections was continued and concentrated on reference works, major source works, and critical standard editions along with a selection of secondary literature. The Library benefited from the partial acquisition of the private library of Ernst Florey, from donations of the private library of Ernst W. Böhm and from older holdings of the Max Planck Institute for Biology. Due to the limited space available to the Library in the main building, additional quarters had to be found in a near-by office building to house part of the holdings. The collection of printed books – current holdings of over 35,000 volumes – is arranged in the following divisions:

- Reference collection

- Lorenz Krüger collection
- Source works
- Secondary literature
- Rare books

As a further information resource, 130 current journals belonging to the core literature in the research areas of the Institute are available. These include a selection of current newsletters of the major learned societies and institutions in history of science.

The Library's microform source collection (e.g., Landmarks of Science, Newton's Manuscripts and Papers and Einstein's Collected Works) was further expanded and now holds some 12,000 historical works, journals, and manuscripts. Microfilm readers, reader-printers and reader-scanners are provided to take full advantage of this strategic resource for research at the Institute (see Project "Computer-Aided Source Collection in History of Science" p. 103).

The Inter Library Loan (ILL), another service priority to support research at the Institute, has been expanded to serve the new research groups and has gained a high level of acceptance. It provides bibliographic reference and document delivery from the major research libraries in Berlin, Germany and abroad. ILL also provides copies of journal articles as well as microfilms of books and other documents. Provisions are made for receiving remote documents in digitized form. Catalogs of the lending libraries can be consulted on microfiche, electronic files, and through the Internet as a part of the Library's reference service.



The Institute's library

Electronic resources

The Library's electronic resources were considerably expanded and now include over 1,600 scholarly electronic journals, bibliographic reference and full-text databases, encyclopedias, and electronic library catalogs. Catalog information on all the Library's collections and holdings is provided via an internal Online Public Access Catalog (OPAC) available through the Intranet. Databases on CD-ROM can be searched on individual workstations.

A selection of remote bibliographic databases are available for direct searches. These include table of contents files (Current Contents, Online Contents) as well as subject databases (History of Science and Technology, Web of Science, Philosopher's Index, Historical Abstracts, Dissertation Abstracts, Biosis, Medline, etc.). For mediated searches in a wide range of other databases the Library has access to the networks of the Dialog host services.

All local and remote electronic services are integrated in the Library's World Wide Web homepage providing a unified access to the various electronic resources. This page lists links to the

Institute's library resources (catalog of holdings, new acquisitions lists, current journals), as well as to major library catalogs in Germany and abroad, to bibliographic information, to text archives, or to relevant sites in the history of science field.

Besides continuous support in library, archive, and bibliography matters, the Library periodically offers structured introductions to the collections and services. Special courses are taught in the use of remote bibliographic databases, library catalogs on the Internet, and in the use of personal bibliography makers (EndNote). Support is also provided for problems with reformatting various bibliographic software.

Staff development was accompanied by training schedules covering systems administration, search techniques in bibliographic databases, Internet training, and language courses. Staff members were also delegates at conferences and exhibitions relevant to the information field.

Project "Computer-Aided Source Collection in History of Science"

Since the institute is not endowed with an old library of gradually expanded holdings, many of the historical sources have had to be acquired in the form of microfilm. To date, these microfilm archives store over 12,000 works and manuscripts. To offer state-of-the-art access to this resource, a digital library was conceived. This digital library includes tools for the management and access of electronic facsimile documents, as well as a digitization unit with paper and large-scale microfilm scanners. The Computer-Aided Source Collection in History of Science is a joint project of members of the research groups, the Computing service unit, and of the Library.

The document server so far holds over 300 source documents. Care was taken to use widely available standard software for access and browsing (Web browser), both to immunize against dedicated and platform-dependent software solutions and to guarantee flexibility for future developments.

The digitization unit consists of a heavy-duty paper scanner for documents on paper and a SunRise microfilm scanner. We plan to scan the core documents of the microfilm archive to make them available on the Intranet. The films will be digitized to gray-scale images in order to give the most detailed reproduction of the original possible. Production will be supported by temporary assistants.

In parallel, the Library has begun to acquire relevant source works in high quality image scans to overcome traditional restrictions in the availability of rare books and archival material. Integration into professional networks.

Particular attention was paid to the further integration of the Library's concepts and developments into professional networks. Besides participating in national and international conferences, the head of the Library regularly attended the librarians' meetings of the Max Planck Society to discuss policy and technical issues.

Other foci were new concepts of information provision and service development. Urs Schoepflin was a member of the task force preparing a proposal for a Center for Information Management for the Max Planck Society (CIM). He also investigated advanced concepts of information provision of source works in digitized form with other libraries such as the Herzog August Bibliothek (Wolfenbüttel), the State Libraries in Göttingen and Munich, the British Library, and the University of Pennsylvania Library (Philadelphia).

Finally, the Library is involved with the Institute of Library Science at Humboldt University, Berlin, where concepts, services, and the organization of the Library are regularly presented at seminars.

Scholarly activities at the library

In addition to his duties as head of the Library, Urs Schoepflin has also carried out scientometric research in the areas of scientific communication structures and reception processes of scientific literature.

In an ongoing study (in cooperation with Wolfgang Glänzel, Information Science and Informetrics Research Unit at the Library of the Hungarian Academy of Sciences, Budapest) the differences in reception between fields of science were further investigated. Previous studies of the project focused on the differences in the aging of journal literature in science and the social sciences. Recently a serious shortcoming of bibliometric studies based on the Social Sciences Citation Index (SSCI) was studied: the lack of a universally applicable subject classification scheme for individual papers, because their assignment to broader subject categories, e.g. of a journal, are misleading. A special method for an item-by-item subject classification was developed. The empirical results of this approach proved reliable to overcome the shortcomings in the SSCI database. Applications will be further extended to fields in the humanities where citation based studies (e.g. evaluation of research performance) have up to now encountered even more difficulties. It is expected that the method will shed a new light on reception processes in scientific communication and also on special limitations of the established bibliometric methods in the fields where the Institute is particularly active.

Computing Service Unit

headed by *Jörg Kantel*

Computing activities are essential to fulfilling the Institute's research mission. Besides standard computer applications, more sophisticated functions are being increasingly used. These tasks include:

- acquisition of historical sources by scanning and, occasionally, by optical character recognition,
- computer-assisted analysis of texts and images,
- publication of documents (texts, images, structured data, computer animations, digital movies etc.) on the World Wide Web.

Although computer-based research activities play an ever-growing role in the Institute's work, the above activities can only be supported to the extent that the computer department (2 people plus 3 part-time students) can cope with the routine tasks required to keep up with the Institute's expanding IT infrastructure:

- planning and acquiring the computing equipment necessary for the Institute's research projects, administration unit, and the library
- periodically upgrading and supporting the Institute's internet connection
- supporting and expanding the Institute's Local Area Network (LAN)
- providing routine IT support to the research projects
- providing IT training to collaborators and guests
- providing support by designing the computing facilities of the Library and Documentation Unit of the Institute, as well as supporting the computing facilities of the Administration Unit (SAP)
- designing future computing facilities for the Institute

Hardware

As mentioned in the last Research Report the standard environment for the Institute's staff and visitors consists of Apple Macintosh computers. However, due to the growing needs of specialized soft- and hardware it has been necessary to also install other kinds of machines and operating sys-

tems. Now a growing number of workplaces work with Windows (95/NT) machines as well as with Linux boxes installed at the Institute. In addition, the need for specialized server machines is growing. High-end servers for internet purposes as well as for various cpu time-consuming tasks are still available (Windows NT, Linux, Solaris, Irix, and high-end Macintosh computers).

The number of central servers has also increased during the last two years. Backup-, database-, calendar-servers, servers for providing information through the http-protocol (WWW) for intranet as well as for internet have been installed. Most of these are Apple Macintosh computers but a growing number are Linux boxes, especially the http-, mail- and dns-servers. The external WWW-server for the Institute can be visited at <http://www.mpiwg-berlin.mpg.de/>.

In order to obtain better support for the Linux boxes, we have arranged for a support agreement with the Gesellschaft für Wissenschaftliche Datenverarbeitung, Göttingen (GWDG).

The administration unit's server has changed from a SINIX machine to a Windows NT Server, and the workstations for SAP applications have been upgraded by the Max Planck Society's central IT unit from Windows 3.1 to the Windows 95 operating system.

Network

Together with the growing number of workplaces the network has also been redesigned and expanded. The Local Area Network (LAN) now covers more than 200 workplaces. With the skillful help of the GWDG, the Institute's LAN was anchored in a 1 GBit FDDI backbone (instead of 100 MBit in the past). Six hub-systems have been installed to provide a star topology network with a 100-MBit Ethernet (previously 10-MBit) frontend connection from the nearest hub-system to every workplace. Also the newly occupied external rooms for the library in the Glinkastraße facility are connected transparently by a routing system to the Institute's LAN.

The Administration Unit's network was updated to 100 MBit from a separate hub-system. Due to security reasons it is still an isolated system without any connection to the research network.

The permanent connection to the Fritz Haber Institute in Berlin-Dahlem has been upgraded from a 64kBit ISDN-Link to a 2-MBit permanent line. From the FHI, the Institute is connected to a 155 MBit line direct to the internet via the German Research Net (Deutsches Forschungs Netz, DFN).

Project support and training

The Computing Unit has provided key support to the following research activities:

- the Virtual Laboratory for Physiology (see p. 63)
- an image and text database supporting the research on engineering and mechanical thinking (see p. 20)
- the Cuneiform Digital Library Initiative (see p. 31)
- the Computer-Aided Source Collection in History of Science (see p. 103)
- The computing service unit has also provided several training sessions for users, e.g.
- Internet for Beginners
- Scanning Images and Working with Optical Character Recognition
- Working with the eXtensible Markup Language (XML)
- HTML, Java, and CGI – The Languages of the Web.

Junior Scientists and Guest Scientists

The Institute's Visiting Scholars and Research Fellows

Considerable areas of the Institute's research program are covered by visiting scholars and research fellows funded by the Institute and by a growing number of other institutions. Their contributions encompass individual projects, contributions to workshops and conferences, and cooperation in context of the departments' long-term research activities. Most of these activities are described in the reports of the departments and research groups above and not in the following list. For specific information on the work of individual researchers, please use the name index.

Prof. Dr. Mohamed Abattouy (Visiting Scholar, Université M. Ben Abdellah, Fes, Morocco, April 14 – 30 and June 18 – December 17, 1998; April 5 – 23 and July 2 – December 26, 1999)

Dr. Oscar Joao Abdounur (Lorenz Krüger Postdoctoral Research Fellow, Universidad de Sao Paulo, Brasil, October 1, 1999 – September 30, 2000)

Dr. Gadi Algazi (Visiting Scholar, Alexander-von-Humboldt-Stiftung; Dept. of History, Tel Aviv University, Israel, July 21, 1998 – September 30, 1999)

Dr. Carrie Asman (Postdoctoral Research Fellow, Humboldt-Universität zu Berlin, October 1, 1999 – June 30, 2000): Habilitation on "Schmuck und Scham: Grenzen des Körperlichen 1500/1800": a history of pearls in cultural and scientific context. Pearl-like spherical shapes are ubiquitous in astronomical, chemical, and crystallographic models from at least the 17th century. The project explores visual components of cross-disciplinary patterns of influence based on models implementing one particular form borrowed from nature (see p. 44).

Prof. Dr. Mara Beller (Visiting Scholar, The Hebrew University of Jerusalem, Israel, September 1 – October 15, 1999)

Dr. Jutta Berger (Postdoctoral Research Fellow, Technische Universität Berlin, April 1 – June 30, 1999) reworked a chapter of her dissertations for publication: "Statistische Deutung Chemischer Reaktionen in der Chemie des 19. Jahrhunderts."

Charlotte Bigg (Predoctoral Research Fellow, Darwin Trust of Edinburgh; Cambridge University, UK, April 1 – May 15, 1999)

Katja Bödeker (Predoctoral Research Fellow, FU Berlin, November 1, 1999 – October 31, 2001)

Dr. Christophe Bonneuil (Postdoctoral Research Fellow, CNRS; Université Paris 7, France, March 1, 1997 – February 28, 1998)

Dr. Cornelius Borck (Karl Schädler Postdoctoral Research Fellow, Liechtenstein Fonds for the History of Science; Institut für Wissenschafts- und Technikforschung, Universität Bielefeld, April 1, 1998 – March 31, 2001). Project description see p. 61.

Dr. Francesca Bordogna (Postdoctoral Research Fellow, Department of History, Northwestern University, Evanston, USA, October 1, 1998 – June 30, 1999)

Prof. Dr. Robert Brain (Visiting Scholar, Department of the History of Science, Harvard University, Cambridge, USA, June 15 – July 25, 1998) Book on the graphic method in the natural sciences during the 19th century: why methods of self-recording instrumentation became a central feature of science, technology, and medicine, and ultimately one of the primary means of visualization in the sciences, across many disciplines. The study also contributes to the history of computing and calculation using analog (continuous) quantities rather than discrete or digital quantities.

Christina Brandt (Predoctoral Research Fellow, October 1, 1996 – March 31, 2000). Project description see p. 75.

Gerhard Brey (Visiting Scholar, November 30 – December 11, 1998 and April 14 – May 1, 1999)

Prof. Dr. Alberto Cambrosio (Visiting Scholar, McGill University, Montreal, Canada, October 1 – November 30, 1999) completed and presented a chapter on morphological and immunological approaches to the diagnosis of leukemia for a book he is writing with Peter Keating, tentatively

entitled *Biomedical Platforms: (Re)Producing the Normal and the Pathological in Late Twentieth Century Medicine*.

Jimena Canales (Predoctoral Research Fellow, Harvard University, Cambridge, USA, October 10 – November 10, 1998)

Dr. Jordi Cat (Postdoctoral Research Fellow, University of California at Davis, USA, October 1, 1997 – September 30, 1998)

Kevin Chang (Predoctoral Research Fellow, DAAD; University of Chicago, USA, October 1, 1998 – September 30, 1999)

Dr. Cristina Chimisso (Postdoctoral Research Fellow, Department of History and Philosophy of Science, University of Cambridge, UK, October 1, 1997 – October 31, 1998). Project description see p. 78.

Prof. Dr. Giovanna Cifoletti (Visiting Scholar, École des Hautes Etudes en Sciences Sociales, Paris, France, May 1 – June 30, 1998)

Dr. Nani N. Clow (Harvard University, Cambridge, USA, Predoctoral Research Fellow, March 1 – June 30, 1999, Postdoctoral Research Fellow September 1, 1999 – August 31, 2001). Project description see p. 74.

Dr. Elisabeth Crawford (Visiting Scholar, Université de Strasbourg, France, May 17 – 21, 1999)

Prof. Dr. Olivier Darrigol (Visiting Scholar, CNRS; Equipe REHSEIS (UPR 318), Paris, France, October 1, 1998 – March 31, 1999)

Prof. Dr. Claude Debru (Visiting Scholar, Université Louis Pasteur, Strasbourg, France, May 1 – July 15, 1999) worked on and presented papers on topics in the philosophy and history of biology. One topic concerned the category of the “possible” and its realization in biotechnology; the other, Helmholtz’s psychophysiology of time.

Dr. John J. Dettloff (Postdoctoral Research Fellow, Smithsonian National Museum of American History, Washington, USA, July 1, 1999 – June 30, 2001)

Prof. Dr. Bruce Eastwood (Visiting Scholar, University of Kentucky, Lexington, USA, July 19 – August 19, 1999)

Dr. Berna Kılıç Eden (Postdoctoral Research Fellow, University of Chicago, USA, September 1, 1997 – September 30, 1998). Project description see p. 77.

Prof. Dr. Robert Englund (Visiting Scholar, University of California at Los Angeles, USA, June 15 – July 31, 1999)

Prof. Dr. Raphael Falk (Visiting Scholar, The Hebrew University of Jerusalem, Israel, February 9 – March 14, 1999) worked with *Peter Beurton* and *Hans-Jörg Rheinberger* to complete the editing of a book on “*The gene concept in evolution and development*”. He also worked on and presented papers on the gene concept and on scientific racism.

Dr. Fa-ti Fan (Postdoctoral Research Fellow, University of Wisconsin-Madison, USA, September 1, 1999 – August 31, 2001)

Dr. Patricia Fara (Postdoctoral Research Fellow, Australian National University, Canberra, Australia, October 1, 1998 – September 30, 1999)

PD Dr. Johannes Fehr (Visiting Scholar, Collegium Helveticum, Zürich, Switzerland, September 16 – September 29, 1998) formulated a project on the history of experimental phonetics. The project aims to trace intellectual exchange between the academic field of linguistics and the practical and entrepreneurial world of communication technology – exchange which began in the 19th century and culminated in the reorientation of linguistics through the collaboration of electrical engineers, mathematicians, cryptologists, and linguists during World War II in developing information and intelligence technologies.

Dr. Eric Francoeur (Postdoctoral Research Fellow, Centre de Sociologie de l’Innovation, École Normale Supérieure des Mines, Paris, France, May 1, 1999 – April 30, 2001)

Raymond Fredette (Visiting Scholar, Centre interuniversitaire de recherches sur la science et la technologie, Montréal, Canada, March 27 – April 3, 1998 and March 9 – May 3, 1999)

Prof. Dr. Gideon Freudenthal (Visiting Scholar, Tel Aviv University, Israel, July 27 – September 4, 1998 and August 1 – 31, 1999)

Prof. Dr. Daniel Garber (Visiting Scholar, University of Chicago, USA, March 23 – March 30, 1998)

Dr. Antonio García Belmar (Postdoctoral Research Fellow, CSIC; Inst. de Estudios Documentales e Históricos sobre la Ciencia, Universitat de València, Spain, September 1, 1997 – August 31, 1998). Project description see p. 78.

Prof. Dr. Rodolphe Gasché (Visiting Scholar, State University of New York at Buffalo, USA, June 13 – July 15, 1999) pursued various topics in philosophy and hermeneutics, especially the work of Martin Heidegger, Jacques Derrida, and Jan Patočka on the philosophical notion of “Europe”, on which he presented a paper.

Dr. Peter Geimer (Postdoctoral Research Fellow, Philipps-Universität Marburg, June 1, 1997 – January 31, 1999). Project description see p. 60.

Prof. Dr. Alfred Gierer (Visiting Scholar, Max-Planck-Institut für Entwicklungsbiologie, Tübingen, November 1 – November 30, 1998)

Prof. Dr. Catherine Goldstein (Visiting Scholar, CNRS; Université de Paris Sud, France, April 1 – July 8, 1998)

Dr. Christoph Gradmann (Visiting Scholar, Universität Heidelberg, Institut für Geschichte der Medizin, February 22 – March 19, 1999) worked on medicine and microbiology in Germany, 1870-1910, focusing on Robert Koch.

Prof. Dr. Gerd Graßhoff (Visiting Scholar, Universität Bern, Switzerland, July 12 – August 20, 1999)

Birgit Griesecke (Postdoctoral Research Fellow, August 1, 1999 – July 31, 2001). Project description see p. 62.

Prof. Dr. James R. Griesemer (Visiting Scholar, Department of Philosophy, University of California at Davis, USA, May 4 – 31, 1998) worked on a book that will present a new concept of the units of evolution, unifying hereditary and developmental aspects of reproduction. He presented papers on his new theory of reproduction, on the history of Weismannism, and on the philosophical analysis of scientific diagrams.

Dr. Niccolò Guicciardini (Visiting Scholar, Dipartimento di Filosofia, Università degli Studi di Bologna, Italy, May 23 – 30, 1998)

Dr. Karl Hall (Postdoctoral Research Fellow, July 1, 1999 – June 30, 2000)

Dr. Michael Hau (Schloßmann Postdoctoral Research Fellow, University of Iowa, USA, February 1, 1999 – January 31, 2001) “The Humane Expert: Physicians, Empathy and the Crisis of Modern Medicine during the Weimar Republic” deals with the attempts of Weimar physicians to introduce a new form of expertise based on empathic healer personalities, as opposed to the modernist expertise based on the standardization of services, scientific knowledge, and technical skills. This movement arose in response to the challenge of alternative medical practitioners and to some extent appropriated the discourse of pre-war medical reform movements.

Dr. Kilian Heck (Universität Hamburg, Rathenau Postdoctoral Research Fellow, October 1, 1997 – December 31, 1998; Postdoctoral Research Fellow, June 1 – September 30, 1999)

Dr. Ton van Helvoort (Visiting Scholar, Dept. of History, Maastricht University, Netherlands, April 1 – 30, 1998 and March 1 – April 15, 1999) worked on topics in the history of cancer research in Germany, especially on the cancer institute at the Charité in Berlin.

Dr. Alain Herreman (Postdoctoral Research Fellow, Université de Paris VII, France, October 1, 1997 – September 30, 1998)

Dr. Elfrieda Hiebert (Visiting Scholar, September 15 – November 15, 1998) and *Prof. Dr. Erwin N. Hiebert* (Visiting Scholar, Harvard University, Cambridge, USA, September 15 – November 15, 1998): “Helmholtz on Music: The Role and Limits of Scientific Analysis” deals with the Berlin setting of Helmholtz’s studies, his experiments and publications in the physics and physiology of acoustics, leading to the publication of the *Tonempfindungen* (1863). The project also examines the responses to Helmholtz’s views on the science and aesthetics of music on the part of music his-

torians, musicologists, performers, scientists, mathematicians, instrument builders, and composers.

Sabine Höhler (Postdoctoral Research Fellow, July 1, 1999 – June 30, 2001)

Dr. Christoph Hoffmann (Karl Schädler Postdoctoral Research Fellow, Liechtenstein Fonds for the History of Science; Europa-Universität Viadrina Frankfurt/Oder, April 1, 1998 – March 31, 2001). Project description see p. 71.

Prof. Dr. Frederic L. Holmes (Visiting Scholar, Yale University, New Haven, USA) made several short visits to the Institute in 1998–99. Together with *Jürgen Renn* and *Hans-Jörg Rheinberger*, he organized a conference on “Reworking the Bench: Research Notebooks in the History of Science” see p. 81, and is now involved in preparing a volume on this topic.

Prof. Dr. Blahoslav Hruška (Visiting Scholar, Czech Academy of Science, Prague, August 1 – September 30, 1999)

Marion Hulverscheidt (Predoctoral Research Fellow, Heinrich-Böll-Stiftung; Georg-August-Universität Göttingen, May 1, 1998 – December 31, 1999) worked on her dissertation on clitoridectomy and its representation in 19th-century German medicine and anthropology.

Prof. Dr. Sarah C. Humphreys (Visiting Scholar, University of Michigan, Ann Arbor, USA, January 1 – April 30, 1998)

Dr. David Hyder (Lorenz Krüger Postdoctoral Research Fellow, September 1, 1997 – August 31, 1998; Postdoctoral Research Fellow, Research Council of Canada; September 1, 1998 – June 30, 2000). Project description see p. 73.

Prof. Dr. Myles W. Jackson (Visiting Scholar, Alexander-von-Humboldt-Stiftung; Department of History, University of Chicago, USA, December 1, 1999 – August 20, 2000)

Dr. Michel Janssen (Postdoctoral Research Fellow, Boston University, USA, July 1 – August 31, 1998 and July 19 – August 26, 1999)

Prof. Dr. Lily E. Kay (Visiting Scholar, Harvard University, Cambridge, USA, May 15 – August 15, 1998) co-organized with Hans-Jörg Rheinberger the conference “Postgenomics?” see p. 78. and worked on a new research project in history of neuroscience: Warren S. McCulloch’s calculus of mind, or the introduction of logical representations of brain activities as neural nets in the 1940s and 1950s.

Dr. Elke Kazemi (Lorenz Krüger Postdoctoral Research Fellow, Universität Konstanz, October 1, 1998 – March 31, 2000)

Prof. Dr. Evelyn Fox Keller (Visiting Scholar, MIT, Cambridge, USA, January 1 – June 30, 1998)

Prof. Dr. Elaheh Kheirandish (Visiting Scholar, Harvard University, Cambridge, USA, August 31 – September 4, 1998)

Jari Kirsilä (Predoctoral Research Fellow, Université Louis Pasteur de Strasbourg, France / University of Joensuu, Finland, October 1 – October 31, 1999) worked on the topic “Analysis versus Synthesis – Alternative Approaches in late 19th Century Organic Chemistry.”

Dr. Alexei Kojevnikov (Visiting Scholar, Institute for the History of Science, Moscow, Russia, June 26 – July 26, 1998)

Prof. Dr. Deepak Kumar (Visiting Scholar, Jawaharlal Nehru University, New Delhi, India, April 25 – May 9, 1999)

Dr. Morgane Labbé (Postdoctoral Research Fellow, CNRS; Laboratoire de Démographie Historique, EHESS, Paris, France, October 1, 1996 – September 30, 1998)

Dr. Jens Lachmund (Schloßmann Postdoctoral Research Fellow, October 1, 1998 – January 31, 2001). Project description see p. 70.

Prof. Dr. André Laks (Visiting Scholar, Université Charles de Gaulle, Lille, France, September 1, 1998 – January 15, 1999)

Dr. Hannah Landecker (Postdoctoral Research Fellow, October 1, 1999 – September 30, 2001). Project description see p. 62.

Prof. Dr. Pierre Laszlo (Visiting Scholar, Université de Liège, Belgium, October 1 – October 31, 1999) worked on various projects in the history of chemistry and biology, especially the relation of

Kenneth D. Roeder's studies of insect behavior to advances in electronic instrumentation, on which he presented a paper.

Dr. Manfred Laubichler (Postdoctoral Research Fellow, Princeton University, USA, June 1 – July 15, 1998 and August 1 – December 31, 1999). Project description see p. 76.

Dr. Andrea Loettgers (Postdoctoral Research Fellow, Deutsche Forschungsgemeinschaft; Universität Göttingen, March 15 – December 31, 1999). Project description see p. 64.

Dr. María Luz López Terrada (Visiting Scholar, CSIC; Instituto de Estudios Documentales e Históricos sobre la Ciencia, Universitat de València, Spain, June 1 – July 31, 1998) studied the relations between 16th-century Spanish and Central European naturalists, especially around the figure of Carolus Clusius. Her project focused on the key role of Renaissance Spain in the introduction of American nature into European science.

Dr. Sarah Lowengard (Postdoctoral Research Fellow, State University of New York, USA, April 15, 1999 – April 14, 2000)

Dr. Carmen Loza (Postdoctoral Research Fellow, Ecole des Hautes Etudes en Sciences Sociales, Paris, France, October 1, 1997 – March 31, 2000)

Dr. sc. Karlheinz Lüdtke (Visiting Scholar, Universität Jena, July 1, 1997 – December 31, 1998) worked on and presented a paper on the early history of virus research.

Dr. Abigail Lustig (Postdoctoral Research Fellow, University of California at Berkeley, USA, September 1, 1997 – October 31, 1998 and September 1, 1999 – August 31, 2001). Project description see p. 77.

Dr. William Lynch (Postdoctoral Research Fellow, Cornell University, Ithaca, USA, January 1 – August 21, 1999)

Christopher Martin (Predoctoral Research Fellow, University of Pittsburgh, USA, August 1 – August 31, 1998)

Dr. Michael May (Postdoctoral Research Fellow, April 1, 1997 – March 31, 1998)

Dr. David McGee (Postdoctoral Research Fellow, September 1, 1999 – August 31, 2001)

Dr. Peter McLaughlin (Visiting Scholar, Universität Konstanz, April 1 – May 31, 1999) worked with *Hans-Jörg Rheinberger* on 18th-century natural history and on early modern theories of heredity. Planning was begun for a long-term cooperative project on the cultural history of heredity. He also worked on and presented a paper on the concept of “design” in contemporary philosophy of biology.

Dr. Alexandre Métraux (Visiting Scholar, Otto-Selz-Institut, Universität Mannheim, September 1, 1997 – February 28, 1998) organized a group project in Department III on visualizing small-scale entities in the life sciences and participated in the project “Ecce cortex” see p. 66. He also carried out research on topics in the history of neurophysiology and psychology, including the history of color tops from Newton to Edward Titchener.

Dr. Hélène Mialet (Postdoctoral Research Fellow, University of Oxford, UK, September 1, 1998 – August 31, 1999)

David Millett (Predoctoral Research Fellow, University of Chicago, USA, July 1 – September 30, 1998): Dissertation (University of Chicago) on “Instrumentation and Representation in Brain Physiology: From the Excitable Cortex to the Electro-encephalogram”: how brain mapping and functional localization once again became important topics of scientific inquiry.

Prof. Dr. Gregg Mitman (Visiting Scholar, University of Oklahoma, USA, September 1, 1999 – June 30, 2000)

Prof. Dr. Reinhard Mocek (Visiting Scholar, October 1, 1998 – December 31, 1999). Project description see p. 76.

Dr. Javier Moscoso (Postdoctoral Research Fellow, University Autónoma, Madrid, Spain, June 15 – September 15, 1998)

Prof. Dr. Gabriel Motzkin (Visiting Scholar, Department of History, Hebrew University of Jerusalem, Israel, August 17 – September 13, 1998)

- Prof. Dr. Helmut Müller-Sievers* (Visiting Scholar, Northwestern University, Evanston, USA, August 1 – September 3, 1998) worked on his book on the role of anatomy in Georg Büchner's writings and participated in the group project of Department III "Ecce cortex" see p. 66.
- Dr. Staffan Müller-Wille* (Postdoctoral Research Fellow, December 1, 1997 – May 31, 1998)
- Dr. Michelle Murphy* (Postdoctoral Research Fellow, Cornell University, Ithaca, USA, September 1, 1999 – August 31, 2001)
- Tara Nummedal* (Predoctoral Research Fellow, DAAD; Stanford University, USA, October 1, 1998 – June 30, 1999)
- Prof. Dr. Mary Jo Nye* (Visiting Scholar, Oregon State University, Corvallis, USA, November 20 – December 18, 1999) presented a paper on "Michael Polanyi" at an informal colloquium of the Institute, was a speaker at the conference "Types of Paper Tools and Traditions of Representation in the History of Chemistry" (Dec. 2–4, 1999), and contributed to project 1 of the independent research group of *U. Klein* (see p. 83).
- Prof. Dr. Kathryn M. Olesko* (Visiting Scholar, Georgetown University, Washington D.C., USA, October 1 – December 31, 1998)
- Prof. Dr. Dorinda Outram* (Visiting Scholar, University of Rochester, USA, July 12 – August 13, 1999)
- Ohad Parnes* (Predoctoral Research Fellow, July 1, 1997 – June 30, 1998 and September 1 – December 31, 1999). Project description see p. 74.
- Dr. Hans Pols* (Rathenau Postdoctoral Research Fellow, Department of the History of Science, Harvard University, Cambridge, USA, October 1, 1998 – August 31, 1999 and June 1 – September 30, 2000): "Psychiatry, Technology, and the Law" charts the transformation of American psychiatry from a medical sub-specialty concerned with the institutionalization of the mentally ill to a much broader discipline concerned with mental health and adjustment of virtually everybody, touching upon a great many aspects of everyday life (see p. 120).
- Dr. Marcus Popplow* (Postdoctoral Research Fellow, October 1, 1997 – September 30, 2001)
- Prof. Dr. Theodore M. Porter* (Visiting Scholar, Department of History, University of California at Los Angeles, USA, June 15 – July 15, 1998)
- Dr. Matthew W. Price* (Postdoctoral Research Fellow, Cornell University, Ithaca, USA, September 1, 1999 – August 31, 2001)
- Prof. Dr. Robert Proctor* (Visiting Scholar, The Pennsylvania State University, USA, June 1 – December 31, 1999)
- Dr. Helmut Puff* (Visiting Scholar, University of Michigan, Ann Arbor, USA, September 1 – July 31, 2000)
- Dr. Marc J. Ratcliff* (Postdoctoral Research Fellow, Schweizerischer Nationalfonds, Université de Genève, Switzerland, October 1, 1997 – August 30, 1998): Book on the history of the language of the natural sciences, as well as publications in the history of psychology, 18th-20th centuries (see p. 32).
- Dr. Ulf von Rauchhaupt* (Reimar-Lüst-Postdoctoral Research Fellow, October 1, 1998 – September 30, 2000)
- Andreas Renner* (Postdoctoral Research Fellow, Universität Bielefeld, October 1, 1998 – September 30, 1999)
- Prof. Dr. Joan L. Richards* (Visiting Scholar, Brown University, Providence, USA, January 5 – 16, 1998, May 20 – June 30, 1998 and December 8 – 13, 1999)
- Prof. Dr. James Ritter* (Visiting Scholar, Université de Paris 8, France, April 1 – July 8, 1998)
- Prof. Dr. Alan Rocke* (Visiting Scholar, Case Western Reserve University, Cleveland, USA, May 1 – May 30, 1999) presented a paper at the Institute's colloquium entitled "Giessen on the Seine: French Academic Chemical Laboratories, 1830–1870" (May 5, 1999); and he contributed to both projects of the independent research group of *U. Klein*.
- Prof. Dr. Abdelhamid Sabra* (Visiting Scholar, Harvard University, Cambridge, USA, August 29 – September 13, 1998)

Prof. Dr. Sahotra Sarkar (Visiting Scholar, University of Texas at Austin, USA, June 1 – August 31, 1998) worked, first, on a comparative history of biological conservation, emphasizing the variety of traditions of applied biology (resource ecology, forestry management) and the variety of cultural traditions and attitudes towards the natural world; and, second, on a history of evolutionary genetics, envisioning that field as a bridge between evolutionary theory (including formal population genetics) and biochemical genetics.

Dr. Britta Scheideler (Visiting Scholar, Johannes Gutenberg Universität, Mainz, September 14 – October 2, 1998)

Dr. Jutta Schickore (Postdoctoral Research Fellow, April 1, 1997 – August 31, 1999). Project description see p. 72.

Prof. Dr. Londa Schiebinger (Visiting Scholar, Alexander von Humboldt-Forschungspreis; The Pennsylvania State University, USA, June 1, 1999 – June 30, 2000)

Dr. Mark Schiefsky (Postdoctoral Research Fellow, Harvard University, Cambridge, USA, January 1 – December 31, 1999)

Dr. Judith J. Schloegel (Postdoctoral Research Fellow, Indiana University, Bloomington, USA, October 1, 1997 – October 31, 1998). Project description see p. 74.

Dr. Henning Schmidgen (Postdoctoral Research Fellow, March 1, 1997 August 31, 2000). Project description see p. 59.

Prof. Dr. Erhard Scholz (Visiting Scholar, Gesamthochschule Wuppertal, November 30 – December 31, 1998)

Prof. Silvan S. Schweber (Visiting Scholar, Brandeis University, Waltham, USA, March 13 – March 19, 1998)

Dr. Anne Secord (Visiting Scholar, Wellcome Unit for the History of Medicine, Cambridge University, UK, January 25 – January 31, 1999)

Dr. Jérôme Ségol (Postdoctoral Research Fellow, CNRS; Centre Marc Bloch, March 1, 1999 – June 30, 2000). Project description see p. 64.

Prof. Dr. Steven Shapin (Visiting Scholar, Department of Sociology, University of California at San Diego, USA, June 1 – June 30, 1999)

René Sigrist (Predoctoral Research Fellow, Université de Genève, Switzerland, October 1, 1999 – January 31, 2000): Dissertation on “La République des Lettres et l’essor des sciences expérimentales: exemples genevois, 1670–1820” (Université de Genève, Switzerland): Characteristic experimental methods developed by Genevan scientists, including laboratory practices, experimental strategies, and rhetorics of proof and persuasion (see p. 44).

Dr. Skúli Sigurdsson (Postdoctoral Research Fellow, Icelandic Research Council; Harvard University, Cambridge, USA, August 1, 1997 – December 31, 1998) continued his work on the history of the electrification of Iceland.

Dr. Jonathan Simon (Postdoctoral Research Fellow, University of Pittsburgh, USA, September 1, 1997 – August 31, 1998). Project description see p. 74.

Christopher Smeenk (Predoctoral Research Fellow, University of Pittsburgh, USA, August 1 – August 31, 1998)

Prof. Dr. Thomas Söderqvist (Visiting Scholar, Roskilde University, Danmark, May 17 – June 20, 1999)

Prof. Dr. John Stachel (Visiting Scholar, Boston University, USA, June 1 – July 15, 1998; December 15 – December 22, 1998; December 7 – December 16, 1999)

Dr. Richard Staley (Postdoctoral Research Fellow, June 1, 1999 – May 31, 2001)

Dr. Joan Steigerwald (Visiting Scholar, DAAD; Norman Bethune College, York University, UK, July 1 – August 31, 1999) examined material on physiology and Naturphilosophie around 1800, especially in contemporary journals such as the *Archiv für medizinische Erfahrung*, material which will be integrated into her larger project on Naturphilosophie, Kant, and Schelling, on which she presented a paper.

Claudia Stein (Predoctoral Research Fellow, Studienstiftung des Deutschen Volkes; Universität Stuttgart, October 1, 1997 – November 30, 1999) Dissertation on “Die Franzosenkrankheit im frühneuzeitlichen Deutschland 1495–1630” (Universität Stuttgart, Germany): traces the specifically early modern conception of the disease in the context of qualitative pathology and the cosmology of a divinely-created microcosm-macrocosm, using vernacular German tracts and archival material from hospitals in imperial Augsburg.

Bruno J. Strasser (Predoctoral Research Fellow, Schweizerischer Nationalfonds; Institute Louis-Jeantet for the History of Medicine, University of Geneva, Switzerland, October 1, 1998 – September 30, 1999). Project description see p. 74.

Dr. Bernhard Thöle (Postdoctoral Research Fellow, September 1, 1997 – October 31, 1998)

Charles R. Thorpe (Predoctoral Research Fellow, University of California at La Jolla, USA, January 1 – September 30, 1999)

Carsten Timmermann (Predoctoral Research Fellow, The Wellcome Trust; University of Manchester, UK, July 1 – September 20, 1998) carried out research for his dissertation on the controversy over a so-called “crisis of medicine” in Germany in the 1920s.

Prof. Dr. Sabetai Unguru (Visiting Scholar, Tel Aviv University, Israel, September 1, 1997 – February 28, 1998)

Matteo Valleriani (Postdoctoral Research Fellow, University of Padua, Italy, October 15, 1998 – December 31, 2000)

Dr. Fernando Vidal (Visiting Scholar, Schweizerischer Nationalfonds; University of Geneva, Switzerland, September 1, 1999 – August 31, 2000)

Dr. Sara H. Vollmer (Postdoctoral Research Fellow, Dept. of Philosophy, University of Maryland, USA, June 1, 1999 – December 31, 2000)

Till Wahnbaeck (Predoctoral Research Fellow, University of Oxford, UK, October 1, 1999 – March 31, 2000) Dissertation on “The Luxury Debate in the Italian Enlightenment: The Shaping of Political Economy in Eighteenth-Century Lombardy and Tuscany” (Balliol College, University of Oxford): explores the range of meanings of the term “luxury” as a major tool of intervention in economic, political, and social debates, defining political economy as an emergent science (see p. 44).

Dr. Scott Walter (Postdoctoral Research Fellow, CNRS; REHPSCI (CNRS UMR 7596), Paris, France, January 1, 1998 – January 31, 1999)

Dr. Andrew Warwick (Postdoctoral Research Fellow, Imperial College of Science, Technology and Medicine, London, UK, January 31 – February 7, 1999)

Prof. Dr. George Weisz (Visiting Scholar, McGill University, Montreal, Canada, November 8 – November 28, 1999) pursued research on and presented a paper on the history of medical specialization in Germany, as part of a comparative history of medical specialization in four countries. He also began research for and presented a paper on a new project on the science of mineral waters in nineteenth and 20th-century Europe.

Janina Wellmann (Predoctoral Research Fellow, Humboldt-Universität zu Berlin, July 1, 1999 – June 30, 2001). Project description see p. 78.

Gerhard Wiesenfeldt (Postdoctoral Research Fellow, Universität Hamburg, June 1, 1999 – May 31, 2001)

Prof. Dr. M. Norton Wise (Visiting Scholar, Department of History, Princeton University, USA, June 15 – July 15, 1998; December 7 – 15, 1998 and August 1 – 31, 1999): Project on “Muscles and Engines: Hermann Helmholtz and the Berlin Physical Society in the Industrializing Military State”: shows how Helmholtz’s muscle physiology and energy physics were tied together by the concept and practical measurement of “work”, as realized in the indicator diagrams employed by engineers to measure the work done by steam engines. Situated educationally, economically, militarily, and aesthetically in the culture of 1840s Berlin, Helmholtz’s researches in diverse fields take on a new, unified meaning.

Prof. Dr. Andrea Woody (Visiting Scholar, University of Washington, Seattle, USA, November 20 – December 18, 1999) participated in the conference “Types of Paper Tools and Traditions of Representation in the History of Chemistry” (Dec. 2–4, 1999), and contributed to project 1 of the independent research group of *U. Klein*.

Falk Wunderlich (Predoctoral Research Fellow, January 1, 1999 – December 31, 2000)

Dr. Maria Yamalidou (Postdoctoral Research Fellow, September 1, 1999 – August 31, 2000).

Project description see p. 77.

Rakefet Zalashik (Predoctoral Research Fellow, Tel Aviv University, Israel, September 13 – October 15, 1999) worked on her master’s thesis on the psychiatry of Johann Christian Reill.

Prof. Dr. Baichun Zhang (Visiting Scholar, Institute for History of Natural Sciences, Chinese Academy of Sciences, Beijing, China, November 1, 1999 – April 30, 2000)

Relations with German and Foreign Research Institutions

Memberships

The Institute is member of the *Verbund Wissenschaftsgeschichte*, the *Agricola-Gesellschaft*, the *Gesellschaft für Wissenschaftsgeschichte* and the *Deutsche Gesellschaft für Geschichte der Medizin, Naturwissenschaft und Technik*.

Professorships

Lorraine Daston is honorary professor at the *Humboldt Universität zu Berlin*, *Matthias Dörries* is visiting professor at the *Université Louis Pasteur Strasbourg I*, *Wolfgang Lefèvre* is *außerplanmäßiger Professor* at the *Freie Universität Berlin*, *Jürgen Renn* is adjunct professor at Boston University and honorary professor at the *Humboldt Universität zu Berlin*, *Hans-Jörg Rheinberger* is honorary professor at the *Technische Universität Berlin*.

Cooperation Partners

Bibliotheca Hertziana – Max Planck Institute, Rome (Department I, Development, Project Epistemic History of Architecture)

Institute for the History of National Science, Chinese Academy of Sciences (Department I, Project 1, see p. 20)

Max Planck Institute for Human Development and Education, Max Planck Institute for Psychological Research, Max Planck Institute of Research into Economic Systems, and Max-Planck-Project Group “Common Goods: Law, Politics, and Economics” (Department II, Project Grenzen der Rationalität)

Max Planck Institute for European Legal History (Department II, Project on Natural Law, see p. 34)

Observatoire de la Côte d’Azur: PICS (Department I, Project 1, see pp. 22, 30)

Opera di S. Maria del Fiore (Department I, Development, see p. 30)

Tufts University, Medford (Department I, Archimedes Project, see p. 30)

Istituto e Museo di Storia della Scienza and Biblioteca Nazionale Centrale, Florence (Department I, Development, see p. 29)

Department of Near Eastern Languages and Cultures, University of California at Los Angeles, Vorderasiatisches Museum Berlin, Institut für Vorderasiatische Altertumskunde of the Freie Universität Berlin, Hermitage Museum St. Petersburg (Department I, Development, CDLI, see p. 31)

Prof. Dr. Raphael Falk, Department of Genetics, Hebrew University of Jerusalem (book project on gene concept, see p. 24)

Prof. Dr. Menso Folkerts, Ludwig-Maximilians-Universität München (Department I, Development, ICCMSM, see p. 29)

Prof. Dr. Frederic L. Holmes, Section of the History of Medicine, School of Medicine, Yale University, New Haven (Department I and III, book project “Reworking the Bench”, see p. 81)

Prof. Dr. Timothy Lenoir, Program in History and Philosophy of Science, Stanford University (Department III, Virtual Laboratory, see p. 63)

Prof. Dr. Helmut Müller-Sievers, German Department, Northwestern University, Evanston USA (Department III, Book Project Ecce Cortex, see p. 66)

Editorships

Peter Damerow is Co-Editor of the series *Materialien zu den frühen Schriftzeugnissen des Vorderen Orients (MSVO)*.

Lorraine Daston is Advisory Editor to the *Ideas in Context* series of Cambridge University Press.

Michael Hagner is Member of the Editorial Board of the *Revue d'Histoire des Sciences Humaines*.

Dieter Hoffmann is Member of the Editorial Board of *Physics in Perspective*.

Wolfgang Küttler is Member of the Editorial Boards of the *Sitzungsberichte der Leibniz-Sozietät Berlin*, of the journal *Comparativ* (Leipzig) and of the *Historisch-Kritisches Wörterbuch des Marxismus*.

Andrew Mendelsohn is Advisory Editor to *Isis*.

Peter Ramberg is Member of the Editorial Board of the *Bulletin for the History of Chemistry*.

Jürgen Renn is Member of the Editorial Boards of the *Boston Studies in the Philosophy of Science* and of *Science in Context*.

Hans-Jörg Rheinberger is Member of the Editorial Boards of the *Journal of the History of Biology*, of the *Sociology of the Sciences Yearbook*, and of *History and Philosophy of the Life Sciences*, furthermore he is Consulting Editor to the *Studies in History and Philosophy of the Biological and Biomedical Sciences*, and the *Jahrbuch für Geschichte und Theorie der Biologie*.

Teaching Activities

Winter 1997/98

Peter Damerow, Peter McLaughlin: Weltmodelle der frühen Neuzeit (Seminar, Universität Konstanz)

Christoph Hoffmann: Reizbarkeit - Die Entdeckung der Nerven in der Moderne 1870 – 1920 (Proseminar, Europa-Universität Viadrina Frankfurt/Oder)

Dieter Hoffmann: Max Planck – ein Gelehrter im wissenschafts- und zeithistorischen Spiegel (Seminar, Humboldt Universität zu Berlin)

Thomas Potthast: Naturschutzethik: naturwissenschaftliche und moralphilosophische Begründungen des Naturschutzes (Hauptseminar, Universität Tübingen)

Thomas Potthast: Naturschutz und Ethik (Blockseminar, Universität Freiburg)

Jürgen Renn: Galileis Discorsi (Hauptseminar, Humboldt Universität zu Berlin)

H. Otto Sibum: Changing Experimental Cultures in 18th and 19th Physical Sciences (3 Lectures during the Lent Term, University of Cambridge, UK)

Emma Spary et al.: Natural History from Linnaeus to Cuvier (final year undergraduate course, University of Cambridge, UK)

Annette Vogt: Geschichte des Frauenstudiums I (Übung, Humboldt Universität zu Berlin)

Summer 1998

Peter Damerow, Peter McLaughlin, Paul Weinig: Die Entwicklung der vorklassischen Mechanik im 16. Jahrhundert (Seminar, Universität Konstanz)

Michael Hagner: Einführung in die Geschichte der Lebenswissenschaften (Vorlesung, Universität Salzburg)

Michael Hagner: Ausgewählte Kapitel aus der Geschichte der Lebenswissenschaften (Seminar, Universität Salzburg)

Jens Lachmund: Sozialität des Raumes - Räumlichkeit des Sozialen (Seminar, Technische Universität Berlin)

Wolfgang Lefèvre: Philosophie – Gesellschaft – Wissenschaft: Bild und Text – zur Rolle nicht-sprachlicher Repräsentation in Philosophie und Wissenschaft I (Forschungskolloquium, Freie Universität Berlin)

Andrew Mendelsohn: The Health of Nations: Epidemiology, Sociology, Population (Seminar, Tel Aviv University)

Annette Vogt: Geschichte des Frauenstudiums II (Übung, Humboldt Universität zu Berlin)

Paul Weinig: Grammatik für den Bereich Deutsch als Fremdsprache (Seminar, Freie Universität Berlin)

Winter 1998/99

Cornelius Borck: Studientag Wissenschaftsgeschichte (Blockseminar, Verbund Wissenschaftsgeschichte)

Peter Damerow, Peter McLaughlin, Paul Weinig: Die Tradierung und Weiterentwicklung der antiken Mechanik im arabischen Mittelalter (Seminar, Universität Konstanz)

Michael Hagner et al.: Geschichte und Ethik in der Medizin (Vorlesung, Georg-August Universität Göttingen)

Lorraine Daston: The Moral Authority of Nature (Seminars and Lecture, University of Chicago)

Christoph Hoffmann: Episteme des Abfalls (Proseminar, Europa-Universität Viadrina Frankfurt/Oder)

Jens Lachmund: Zur Soziologie der Natur: Das Beispiel Stadtnatur (Seminar, Technische Universität Berlin)

Wolfgang Lefèvre: Philosophie – Gesellschaft – Wissenschaft: Bild und Text – zur Rolle nicht-sprachlicher Repräsentation in Philosophie und Wissenschaft II (Forschungskolloquium, Freie Universität Berlin)

Jürgen Renn: Alternativen in der Wissenschaftsgeschichte am Beispiel der Mechanik (Hauptseminar, Humboldt Universität zu Berlin)

Hans-Jörg Rheinberger: Modelle und Modellorganismen in der Geschichte der Biologie (Vorlesung, Technische Universität Berlin)

Henning Schmidgen: Psychologie und Technologie (Proseminar, Freie Universität Berlin)

H. Otto Sibum: Science and the Knowing Body since the Enlightenment (3 Lectures during the Lent Term, University of Cambridge, UK)

Annette Vogt: Wissenschaftlerinnen in Berlin – an der Akademie der Wissenschaften, an der Universität und in der Kaiser-Wilhelm-Gesellschaft (Übung, Humboldt Universität zu Berlin)

Summer 1999

Cornelius Borck: Studientag Wissenschaftsgeschichte (Blockseminar, Verbund Wissenschaftsgeschichte)

Peter Damerow, Peter McLaughlin: Wissenschaftsgeschichte und Kognitionswissenschaft (Seminar, Universität Konstanz)

Lorraine Daston: The Ideals and Practices of Scientific Objectivity (Isaiah Berlin Lectures, University of Oxford, UK)

Michael Hagner: The Cultural History of the Brain (Seminar, Tel Aviv University)

Christoph Hoffmann: "Was ist ein Dichter" (Pro-/ Hauptseminar, Europa-Universität Viadrina Frankfurt/Oder)

Dieter Hoffmann: Elektrizität und Magnetismus – zur Etablierung eines Wissenszweiges im 18. und 19. Jahrhundert (Seminar, Humboldt Universität zu Berlin)

David Hyder: Philosophie der Informatik (Seminar, Humboldt Universität zu Berlin)

Jens Lachmund: Karten, Pläne, Daten: Zur visuellen Repräsentation von Städten und Landschaften (Seminar, Technische Universität Berlin)

Wolfgang Lefèvre: Philosophie – Gesellschaft – Wissenschaft: Bild und Text – zur Rolle nicht-sprachlicher Repräsentation in Philosophie und Wissenschaft III (Forschungskolloquium, Freie Universität Berlin)

Andrew Mendelsohn: Organismus und Gesellschaft im 19. Jahrhundert (Seminar, Humboldt Universität zu Berlin)

Thomas Potthast: Ökologie, Naturschutz und Ethik: interdisziplinäre Verknüpfungsversuche in historischer und aktueller Perspektive (Seminar, Freie Universität Berlin)

Henning Schmidgen: Kritik und Klinik, 1920–1970 (Hauptseminar, Freie Universität Berlin)

Annette Vogt: Casablanca – Exil und Remigration von Wissenschaftler(innen) (Proseminar, Humboldt Universität zu Berlin)

Winter 1999/00

Cornelius Borck: Studientag Wissenschaftsgeschichte (Blockseminar, Verbund Wissenschaftsgeschichte)

Cornelius Borck: Medizinische Terminologie (Kurs, Freie Universität Berlin)

Cornelius Borck: Psychosomatik als Ausweg? Medizintheoretische Neuansätze nach dem 2. Weltkrieg (Seminar, Freie Universität Berlin)

Peter Damerow, Peter McLaughlin: Die Entwicklung der Kosmologie Descartes' (Seminar, Universität Konstanz)

Lorraine Daston: Geschichte der wissenschaftlichen Objektivität (Vorlesung und Seminar, Humboldt-Universität zu Berlin)

Matthias Dörries: Histoire sociale des sciences (Lecture, Université Louis Pasteur, Strasbourg I)

Matthias Dörries: Science, éthique et droit (Lecture, Université Louis Pasteur, Strasbourg I)

Christoph Hoffmann: Text und Experiment (Pro-/ Hauptseminar, Europa-Universität Viadrina Frankfurt/Oder)

Dieter Hoffmann: Wissenschaftler in Sozialismus- Karrieren von Naturwissenschaftlern und Technikern in der DDR (Seminar, Humboldt Universität zu Berlin)

Wolfgang Lefèvre: Philosophie – Gesellschaft – Wissenschaft: Bild und Text – zur Rolle nicht-sprachlicher Repräsentation in Philosophie und Wissenschaft IV (Forschungskolloquium, Freie Universität Berlin)

Jens Lachmund: Soziologische Theorien der Globalisierung und ihre Relevanz für die Stadtsoziologie (Seminar, Technische Universität Berlin)

Thomas Potthast: Naturschutz und Ethik (Blockseminar, Universität Freiburg)

Jürgen Renn: Einsteins Autobiographie – Die Entstehung von Relativitäts- und Quantentheorie in der rückblickenden Reflexion von Albert Einstein (Hauptseminar, Humboldt Universität zu Berlin)

Hans-Jörg Rheinberger: Ausgewählte Kapitel zur Geschichte der Biologie (Seminar, Technische Universität Berlin)

Henning Schmidgen: Medien des Imaginären (Hauptseminar, Bauhaus Universität Weimar)

Volkmar Schüller: Einführung in Newtons Principia (Vorlesung und Seminar, Humboldt Universität zu Berlin)

H. Otto Sibum: Instruments, Models and Working Experiments (4 Lectures during the Lent Term, University of Cambridge, UK)

Annette Vogt: Mäzenatentum in Wissenschaft und Kunst. Bedeutende Stifter(innen) in Berlin (Proseminar, Humboldt Universität zu Berlin)

Hosted Scholars

1998/1999 the Institute hosted 25 scholars funded externally by the following institutions:

- Alexander von Humboldt Stiftung
- Centre National de la Recherche Scientifique
- Consejo Superior de Investigaciones Científicas
- Darwin Trust of Edinburgh

- Deutscher Akademischer Auslandsdienst
- Deutsche Forschungsgemeinschaft
- Heinrich-Böll-Stiftung
- Icelandic Research Council
- Liechtenstein Fonds for the History of Science
- Research Council of Canada
- Schweizerischer Nationalfonds
- Studienstiftung des Deutschen Volkes
- The Wellcome Trust

Symposia, Conferences, Colloquia

International Summer Schools

Berlin Summer Academy 1999, "Science, Technology, and the Law",
August 23–27, 1999

Science, technology, and the law are among the most important institutions of the modern period. They have not only penetrated deeply into the fabric of political and social life; they also display a rich history of mutual interaction, including routine cooperation as well as conflict. On the one hand, law has become an arbiter of technological and scientific matters, for example, in patent disputes or, more recently, in litigation or legislation concerning biotechnological and other politically contested technological innovations. On the other hand, beginning with the routine use of expert witnesses in the courtroom, scientific and technological expertise has become widely used as a resource for legal decision-making. The recent extension of legal regulation to new fields of technological and scientific activities has dramatically expanded the quest for of scientific and technical advice in legal procedures. It was the aim of the ninth Berlin summer academy to shed light on the relationship between science, technology and the legal system. It explored the interaction of these fields at different times and at different places, following their epistemical and social practices through various transformations from the early modern period to the near present.

As in previous years the summer academy was a transdisciplinary enterprise bringing together scholars and advanced doctoral students from the history of science, social studies of science, philosophy, legal studies, and other fields of social and cultural history. Following the format of previous summer academies, it began with an intensive preparatory seminar for junior participants, led this year by *Robert Proctor* (Pennsylvania State University) and *Michael Hagner* (Max Planck Institute for the History of Science), assisted by *Hans Pols* and *Jens Lachmund* (both Max Planck Institute for the History of Science). Over the course of one week participants discussed key literature on the theme of the summer academy and prepared commentaries on the papers presented during the second week by senior scholars.

The second week focused on five main topics: (1) The Scientist as Expert Witness; (2) Thinking in Cases; (3) Who Owns Science? (4) Law and the Life Sciences; (5) Priority and Property, Discovery and Invention: What do Patents Patent and Where? In all of these fields, close relationships have evolved between scientific or technological expertise and legal forms of regulation. As most of the papers have shown, however, science and technology have not been simple tools which were applied to pre-given/*prescribed* judicial problems. Epistemically, these constellations often involved unease about matters of truth, proof, evidence, and trust. This implied conflicts between scientific and legal modes of reasoning as well as the migration of concepts and categories from one sphere to the other. In fact, the very boundary that sets apart science, technology, and the legal system proved to be rather permeable and historically negotiated. On a more institutional level, the interaction between science, technology and law has also created new social roles, forms of interaction, and (often fragile) power balances between different groups of experts as well as between experts and other participants of/*in* the legal system. In a time of widespread concern about the consequences of the mutual engagement of science, technology and the law, a historical perspective on these problems might be of direct importance for the understanding of contemporary public debate .

List of speakers:

Ken Alder (Northwestern University, Evanston): Reading Characters: French Handwriting Experts from the Counter-Reformation to the Dreyfus Affair

John Forrester (University of Cambridge, UK): Reasoning in Cases in Law and the Sciences.

Tal Golan (Dibner Institute): The History of Scientific Expert Testimony in the English Courtroom.

Sheila Jasanoff (Harvard University): Cases and Controversies: Epidemiology, Mass Torts, and the Expansion of Judicial Power

Dan Kevles (California Institute of Technology): Patenting Human Genes: The Advent of Ethics in the Political Economy of Patent Law

Marianne de Laet (Columbia University): Using Patents: Another Intellectual Property Mode.

Jens Lachmund (Max Planck Institute for the History of Science): Science, Law, and the Rise of Urban Nature Conservation. The Berlin Species Protection Survey, 1979–1984

Paul Lucier (Rensselaer Polytechnic Institute): The Kerosene Controversy: Chemistry, Industry, and the Law

Elizabeth Lunbeck (Princeton University): Narrating Nymphomania Between Science and the Law

Everett Mendelsohn (Harvard University): The Controversial Career of DNA in the Courtroom: Creating Identity.

Donald MacKenzie (University of Edinburgh): Physics and Finance: S-Terms and Modern Finance as a Topic for Science Studies.

Hans Pols (Max Planck Institute for the History of Science): Legal Anthropology and Colonial Administration in the Former Dutch East Indies.

Anthony Travis (Hebrew University Jerusalem): Patents for Synthetic Dyestuffs: The Interaction Between Science, Technology, and the Law

Martha A. Woodmansee (Case Western Reserve, Cleveland): Beyond Authorship: Imagining Rights in Traditional Culture and Bioknowledge

Second Meeting of the International Laboratory for the History of Science on "Material Calculation", June 19–26, 1999

The International Laboratory for the History of Science is a joint project of the Dibner Institute for the History of Science and Technology, Cambridge (USA), the Max Planck Institute for the History of Science, Berlin, the Cohn Center, Tel-Aviv University, the Istituto e Museo di Storia della Scienza, Florence, and the Center for the History of Science, University of Athens. It brings together junior and senior scholars for seven to ten days each year to confront a focused and novel research topic through hands-on contact with instruments and techniques, as well as the study of texts. Approximately a dozen fellows meet with five or six senior scholars, experts in the topic to be dealt with in the particular year, for an intensive seminar under the sponsorship of one of the five participating institutions. The unity of the International Laboratory is one of approach rather than of theme: a workbench-like emphasis on the concrete sources of past scientific experience, whether embedded in objects, mediated by techniques, or displayed in words and images.

The goals of the International Laboratory for the History of Science are: (1) to expand the preparation of younger scholars in the history of science and related fields by exposure to sources and methods not ordinarily included in graduate training; (2) to introduce techniques and perspectives from other disciplines (e.g. archaeology, cognitive science, art history) as they intersect with problems in the history of science; (3) to promote interactions of junior and senior scholars around a focused topic across national boundaries; and (4) to stimulate research on new areas in the history of science by concentrating scholarly attention on them by means of the seminars.

The second meeting of the International Laboratory examined the historical development of ethnomathematics and of abstract arithmetic from proto-arithmetical practices in rural communities to sophisticated arithmetical techniques used by ancient, medieval and early modern administrators and merchants. For each level of historical achievements the work was focused on the relation between material tools and operations by means of which calculations were actually performed, on the one hand, and the cognitive preconditions and outcomes of their application in the institutional contexts of economy and public administration, on the other hand.

The study of arithmetical techniques during the meeting was focused on the following themes:

- overview: calculation in different cultures,
- roots of calculation techniques in indigenous cultures,
- calculation techniques in Pre-Columbian cultures,
- calculation techniques in East, South and Middle Asia,
- calculation in Mesopotamia before and after the invention of the sexagesimal positional system,
- the material culture of calculation after the exchange with the European colonizers,
- outlook: historio-geography of calculation techniques and their interaction with the development of number concepts.

In some cases, the theoretical consequences of these technologies were far-reaching. Nevertheless, the manipulations and tricks of the trade which were once second nature to the communities of calculators have been largely submerged in the history of exact sciences. The very fact that such techniques were second nature to the experts who wielded them renders them effectively invisible, especially to historians who have grown up with different techniques for solving the same class of problems. There is a need for a hands-on excavation of these arithmetical techniques in close conjunction with careful examination of primary texts that document their former practice as well as of devices and techniques still used today by indigenous people in various cultures. At this meeting of the International Laboratory for the History of Science, the preconditions and implications of arithmetical techniques to be studied were explored by actually practicing them and comparing the outcomes.

List of senior scholars

Ubiratan D'Ambrosio (University of Campinas), *Michael Closs* (University of Ottawa), *Peter Damerow* (Max Planck Institute for the History of Science), *Robert K. Englund* (University of California at Los Angeles), *Menso Folkerts* (University of München), *Jöran Friberg* (University of Göteborg), *Geoffrey Saxe* (University of California at Berkeley). A special presentation of non-exhibited quipus of the Inca culture and other artifacts kept in the Museum für Völkerkunde was provided by *Manuela Fischer*, Curator of the American collections, and *Carmen Loza*, Max Planck Institute for the History of Science, who also provided an overview of types, production techniques, and functions of quipus in the Inca culture.

Other Conferences and Workshops

14 – 18 January 1998: Workshop of Archimedes Project (see p. 30)

3 – 5 February 1998: Greek Mathematics: Workshop organized by Sabetai Unguru in context of Project 1 of Department I

28 – 30 May 1998: QED: Demonstration in Historical and Cross-Cultural Context (see p. 36)

5 – 6 June 1998: Space-Time, Quantum Entanglement and Critical Epistemology (Department I, Project 2, see p. 24)

25 – 28 June 1998: Demonstration-Test-Proof (see p. 36)

8 – 11 July 1998: Postgenomics? Historical, Techno-Epistemic, and Cultural Aspects of Genome Projects (see p. 78)

24 – 28 August 1998, Berlin and 27 February – 9 March 1999, Konstanz: Die Tradierung und Weiterentwicklung der antiken Mechanik im arabischen Mittelalter (see p. 20)

30 August – 1 September 1998: Gehirn und Kultur (see p. 66)

2 – 6 September 1998, Berlin and 12 June, 1999, Paris: Instruments, Travel and Science: Itineraries of Precision in the Natural Sciences, 18th – 20th Century (see p. 95)

13 – 15 October, 1998: Invisible Architectures: On Small-Scale Entities in the Life Sciences (see p. 73)

11 – 14 November 1998: Reworking the Bench: Research Notebooks in the History of Science (see p. 81)

- 14 – 16 January 1999: The Organization of Visibility: Photography in Science, Technology and Art (see p. 81)
- 15 – 18 March 1999, Florence and 26 November 1999, Berlin: Structures of Planning and Organisation of Knowledge in the Construction of the Florentine Cupola, together with Opera del Duomo, Florence (see p. 30)
- 4 – 6 June 1999: Scientific Personae (see p. 43)
- 3 – 4 July 1999: Physiological and Psychological Practices in the 19th Century: their Relationships to Literature, Art, and Technology (see p. 67)
- 14 – 16 July 1999: Philosophy and Science between Leibniz, Newton and Kant (workshop in context of Project 2 of Department I)
- 20 – 23 October 1999: Natur-Gesetz-Naturgesetz (see p. 48)
- 25 – 27 November 1999: The Brain and its Sciences in the Twentieth Century (see p. 82)
- 2 – 4 December 1999: Types of Paper Tools and Traditions of Representation in the History of Chemistry (see p. 84)

Planned Conferences

- 22 – 23 June 2000: Reflection and Intervention (Department I)
- 13 – 15 July 2000: Pure Science and its Impurities (Department III, organized by *Christoph Hoffmann*)
- Fall 2000: Workshop on the Canon of Mechanical Treatises in the Early Modern Period (in the framework of PICS, (see p. 30)
- 16 – 18 November 2000: Science between Money and Mind (see p. 131)
- 1 – 12 December 2000: Science and the City (see p. 67)
- 14 – 16 December 2000: The Foundations of Quantum Physics before 1935 (Department I together with German Physical Society, IUHPS-DHS and European Physical Society)
- 18 – 19 December 2000: What's in a Line: Drawing as Intelligence and Intelligibility (see p. 54)
- Spring 2001: Workshop on spatial thinking (see p. 18)
- 1 – 4 March 2001: The Mapping Cultures of 20th Century Genetics (organized by *Hans-Jörg Rheinberger* and *Jean-Paul Gaudillière*, CERNES, Paris)
- 11 – 12 May 2001: Historical Perspectives on Anthropomorphism in the Sciences (see p. 49)
- 24 – 27 May 2001: A Cultural History of Heredity - 17th and 18th Centuries (organized by *Hans-Jörg Rheinberger* and *Peter McLaughlin*)
- 1 – 2 June 2001: Moralizing Nature, 1600–1750 (see p. 49)
- 1 –10 June 2001: Fourth International Laboratory for the History of Science: *Art, Science, and Techniques of Drafting in the Renaissance* (held by the Istituto e Museo di Storia della Scienza, organized by an international consortium, see p. 121) in Florence and Vinci
- 13 – 24 August 2001: Berlin Summer Academy 2001: Human Origins
- Summer 2001: Workshop on the Epistemic History of Architecture (Department I)
- October 2001: Bioethics and History (Department III, organized by *Thomas Potthast*)

The Institute's Colloquia

- 11 February 1998** *Bernadette Bensaude-Vincent*: Atomism and Positivism in the 19th Century France
- 25 February 1998** *Nicholas Jardine*: The Production of Meanings
- 18 March 1998** *Silvan S. Schweber*: The Moral Responsibility of the Scientist: Bethe and Oppenheimer
- 8 April 1998** *Rudolf Stichweh*: Globalisierung des Wissenschaftssystems: Historische und Systematische Aspekte

- 22 April 1998** *Jürgen Mittelstraß*: Das Udenkbare denken. Über den Umgang mit dem Udenkbaren und Unvorstellbaren in der Wissenschaft
- 29 April 1998** *Neel Smith*: Reading Ptolemy's Geography with a GIS: Observations on his Data Sources and Methods
- 20 May 1998** *Alan Gabbey*: The Mind and its Place in Newtonian Nature
- 3 June 1998** *Evelyn Fox Keller*: Form and Formalism: The Place of Mathematics in Studies of Biological Form: 1917 – 1997
- 17 June 1998** *Theodore Porter*: Positivist Science and the Enlightenment Tradition
- 8 July 1998** *Robert Brain, M. Norton Wise*: Muscles and Engines – Hermann von Helmholtz in the Industrializing Military State
- 9 September 1998** *Abdelhamid I. Sabra*: Problems in the Transmission of Greek Science to Islam
- 7 October 1998** *Salvo D'Agostino*: The Bild-Conception of Physics from Helmholtz to Schrödinger
- 21 October 1998** *John Pickstone*: Foucault, Kuhn, Gillispie and the Age of Analysis: towards a synoptic History of Science Technology and Medicine, 1780–1850
- 4 November 1998** *Nils Roll-Hansen*: Eugenics in Scandinavia after 1945: Change of Values and Growth in Knowledge
- 11 November 1998** *Joella Yoder*: The manuscripts of Christiaan Huygens: Their history as exemplified by the condition of de motu and de vi centrifuga
- 16 December 1998** *Margit Szöllösi-Janze*: Lebens-Geschichte – Wissenschafts-Geschichte. Vom Nutzen biographischer Forschung für Geschichtswissenschaft und Wissenschaftsgeschichte
- 3 February 1999** *Andrew Warwick*: Making sense of Maxwell in Victorian Cambridge
- 10 February 1999** *Raphael Falk*: Can the Norm of Reaction Save the Gene Concept?
- 24 March 1999** *Daniel Garber*: On the Frontlines of the Scientific Revolution: How Mersenne Learned to Love Galileo
- 7 April 1999** *Paul U. Unschuld*: Social Dynamics in Ancient China as Reflected in Ancient Chinese Medical Thought – Findings in the Mawangdui Manuscripts and the Huang Di Neijing Suwen of the 2nd Century B.C. to the 3rd Century A.D.
- 21 April 1999** *Michel Blay*: Force, Continuity, and the Mathematization of Motion at the End of the XVIIth Century (Newton, Leibniz, Varignon)
- 5 May 1999** *Alan Rocke*: Gießen on the Seine: French Academic Chemical Laboratories, 1830–1870
- 30 June 1999** *David Gugerli*: Sociotechnical Evidence. The “pictorial turn” as a challenge for historiography
- 15 July 1999** *Howard Gruber*: The Idea of Point of View
- 11 August 1999** *M. Norton Wise*: Drawing with Precision
- 20 October 1999** *Manfred Laubichler*: Allgemeine Biologie: Between Conceptual Unification and Popularization of the Life Sciences
- 17 November 1999** *George Weisz*: Rethinking Medical Specialization in Comparative Perspective
- 15 December 1999** *Robert Proctor*: A Historian of Science in Court: Three Trials to Compensate Forcible Sterilization, Radiation Experimentation, and Tobacco Industry Malfeasance

Academic Achievements, Scientific Awards and Memberships

Habilitation thesis

Ursula Klein completed her Habilitation thesis on “Experimente, Modelle, Paper-Tools – Kulturen der organischen Chemie im 19. Jahrhundert” and received the *venia legendi* in philosophy with a focus on the history of science by the University of Konstanz in January 2000.

PhD theses

Francesca Bordogna completed her thesis on “The Scientific Contexts of William James’s Pragmatist Epistemology” and was awarded her PhD by the University of Chicago in December 1998.

Nani Clow completed her thesis on “The Laboratory of Victorian Culture: Experimental Physics, Industry, and Pedagogy in the Liverpool Laboratory of Oliver Lodge, 1881–1900” and was awarded her PhD by Harvard University in August 1999.

Sarah Jansen completed her thesis on “‘Schädlinge’: Zur Selbstkonstruktion der angewandten Entomologie in Deutschland, 1840–1920” and was awarded her PhD by the Technical University of Braunschweig in July 1997.

Cheryce Kramer completed her thesis on “A Fool’s Paradise: The Psychiatry of Gemueth in a Biedermeier Asylum” and was awarded her PhD by the University of Chicago in June 1998.

Mark Schiefsky completed his thesis “Techne and Method in the Hippocratic Treatise ‘On Ancient Medicine’” and was awarded his PhD by Harvard University in June 1999.

Appointments

Christophe Bonneuil (Predoctoral/Postdoctoral Research Fellow August 1996 – February 1998) was appointed as Chercheur at Centre Koyré d’Histoire des Sciences et des Technique, Paris, France.

Francesca Bordogna (Predoctoral Research Fellow April – December 1996, Postdoctoral Research Fellow October 1998 – June 1999) was appointed as Assistant Professor at the University of Notre Dame, USA.

Jordi Cat (Postdoctoral Research Fellow October 1997 – September 1998) was appointed as Lecturer at the University of Chicago, USA.

Cristina Chimisso (Postdoctoral Research Fellow October 1997 – October 1998) was appointed as Lecturer at the University of Aberdeen, UK.

William Clark (Research Scholar October 1997 – September 1998) was appointed as Visiting Lecturer at Cambridge University, UK.

Berna Kılıç Eden (Predoctoral Research Fellow September 1995 – December 1996, Postdoctoral Research Fellow September 1997 – September 1998) was appointed as Assistant Professor at the Bogazici University, Istanbul, Turkey.

Fa-ti Fan (Postdoctoral Research Fellow September 1999 – August 2001) was appointed as Assistant Professor at the State University of New York at Binghamton, USA.

Patricia Fara (Postdoctoral Research Fellow October 1998 – September 1999) was appointed as Lecturer at Cambridge University, UK.

Antonio García Belmar (Postdoctoral Research Fellow September 1997 – August 1998) was appointed as investigador contratado at Consejo Superior de Investigaciones Científicas, Universitat de València, Spain.

Peter Geimer (Postdoctoral Research Fellow June 1997 – January 1999) was appointed as wissenschaftlicher Mitarbeiter at the Sonderforschungsbereich Anthropologie und Literatur at Universität Konstanz, Germany.

Gerd Graßhoff (Research Scholar April 1995 – March 1999) was appointed as Professor at the University of Berne, Switzerland.

Kilian Heck (Postdoctoral Research Fellow October 1997 – December 1999 and June 1999 – September 1999) was appointed as wissenschaftlicher Assistent at Universität Heidelberg, Germany.

Alain Herreman (Postdoctoral Research Fellow October 1997 – September 1998) was appointed as Chercheur Associé at CNRS, REHSEIS, Paris, France.

David Hyder (Postdoctoral Research Fellow September 1998 – August 2000) was appointed as wissenschaftlicher Assistent at Universität Konstanz, Germany.

Michel Janssen (Postdoctoral Research Fellow Summer 1998 and 1999) was appointed as Assistant Professor at Boston University, USA.

Doris Kaufmann (Research Scholar October 1995 – March 1998, Research Director of the project History of the Kaiser-Wilhelm-Gesellschaft during the National Socialist period April 1998 – February 2000) was appointed as Professor at Universität Bremen, Germany.

Alexei Kojevnikov (Postdoctoral Research Fellow October – December 1995, April – September 1996, Visiting Scholar June 1998 – July 1998) was appointed as Assistant Professor at the University of Georgia, Athens, USA.

Morgane Labbé (Postdoctoral Research Fellow October 1996 – September 1998) was appointed as Consultant at Centre de Civilisation Francaise, University of Warsaw, Poland.

William Lynch (Postdoctoral Research Fellow January 1999 – August 1999) was appointed as Assistant Professor at the Wayne State University, USA.

Michael May (Postdoctoral Research Fellow April 1997 – March 1998) was appointed as Teamleiter at GMD – Forschungszentrum Informationstechnik, Sankt Augustin, Germany.

Andrew Mendelsohn (Postdoctoral Research Fellow/Research Scholar October 1995 – August 2000) was appointed as Lecturer at the Centre for the History of Science, Technology and Medicine, Imperial College, University of London, UK.

Hélène Mialet (Postdoctoral Research Fellow September 1998 – August 1999) was appointed as Assistant Professor at Cornell University, Ithaca, USA.

Javier Moscoso (Postdoctoral Research Fellow June 1998 – September 1998) was appointed as Professor at Universidad de Murcia, Spain.

Staffan Müller-Wille (Predoctoral/Postdoctoral Research Fellow May 1996 – May 1998) was appointed as wissenschaftlicher Mitarbeiter at Deutsches Hygienemuseum, Dresden, Germany.

Marc J. Ratcliff (Postdoctoral Research Fellow October 1997 – August 1998) was appointed as Assistant (FNRS) at the University of Geneva, Switzerland.

Sophie Roux (Postdoctoral Research Fellow/Research Scholar October 1996 – August 1998) was appointed as Professeur agrégé at Centre Alexandre Koyré/École des Hautes Etudes en Sciences Sociales, Paris, France.

Britta Scheideler (Postdoctoral Research Fellow October 1995 – September 1997, Visiting Scholar September 1998 – October 1998) was appointed as wissenschaftliche Mitarbeiterin at Johannes Gutenberg-Universität, Mainz, Germany.

Mark Schiefsky (Postdoctoral Research Fellow January 1999 – December 1999) was appointed as Assistant Professor at Harvard University, Cambridge, USA.

Jérôme Ségal (Postdoctoral Research Fellow March 1999 – November 2000) was appointed as Maître de Conférence at Institut Universitaire de Formation des Maîtres, Paris.

Jonathan Simon (Postdoctoral Research Fellow September 1997 – August 1998) was appointed as Lecturer at the University of Sydney, Australia.

Denis Thieffry (Research Scholar July 1997 – December 1998) was appointed as Professor at Université d'Aix-Marseille II.

Scott Walter (Postdoctoral Research Fellow January 1998 – January 1999) was appointed as Assistant Professor and Director of the Philosophy Department the ACERHP, Université Nancy 2, France.

Michael Wintroub (Research Scholar September 1998 – August 1999) was appointed as Assistant Professor at the University of Michigan, USA.

Awards

The Book “Wonders and the Order of Nature” by *Lorraine Daston* and *Katharine Park* was awarded the Roland H. Bainton Book Prize 1999 and the Pfizer Price of the History of Science Society 1999. The electronic representation of Galileo’s manuscript Ms. Gal. 72 (see p. 29) was awarded the Pirelli INTERNETional Award 1998.

Tara Nummedal’s essay “Alchemical Reproduction and the Strange Career of Anna Maria Zieglerin” was awarded the Partington Prize by the Society for the History of Alchemy and Chemistry.

Outreach

Public Evening Lecture Series 1998: The Sciences of the Body

Barbara Duden (Universität Hannover): Entkörperung in der Moderne – Zur Geschichte des erlebten (Frauen-) Körpers zwischen 1950 und 1990

Michael Hagner (Max-Planck-Institut für Wissenschaftsgeschichte): In der Grenzregion von Körper und Seele. Zur Geschichte des Schwindels im 19. Jahrhundert

Emma Spary (University of Warwick): A Taste for Learning: Gastronomy and the Sciences in Post-Revolutionary France

Heinrich von Staden (Yale University): Reading the Agonal Body: The Language of Conflict and Competition in “Hippocrates”



Evening lecture with Emma Spary

Public Lecture 1998

Elfrieda und Erwin Hiebert (Harvard University): Naturwissenschaft und Musik – Das Erbe von Hermann von Helmholtz. Reflexionen über die musikalische Praxis mit Beispielen am Klavier

Public Evening Lecture Series 1999: Media of thinking

Michael S. Mahoney (Princeton University): Rechnen – Denken – rechnendes Denken

Christina von Braun, Institut für Kulturwissenschaft, Humboldt-Universität zu Berlin:
Der Körper des Alphabets

Peter Damerow (Max-Planck-Institut für Wissenschaftsgeschichte): Anatomie der ungeborenen Zahl – Entzifferung der numerischen Notierungen in proto-keilschriftlichen Verwaltungstexten Mesopotamiens (3.200 – 3.000 v. Chr.)

Jan Assmann (Ägyptologisches Institut, Ruprecht-Karls-Universität Heidelberg):
Die Inganghaltung der Welt – Riten als Medien des Denkens im alten Ägypten

Medien des Denkens

Öffentliche Abendvorträge
am Max-Planck-Institut für Wissenschaftsgeschichte

Wilhelmstraße 44 10117 Berlin (Mitte)
Am U-Bahnhof Mohrenstraße
Eingang über Mohrenstraße/Parkplatz

Michael S. Mahoney
Department of History Princeton University
Donnerstag 18. 3. 99 19h
Rechnen - Denken - rechnendes Denken

Christina von Braun
Institut für Kulturwissenschaft Humboldt-Universität zu Berlin
Donnerstag 22. 4. 99 19h
Der Körper des Alphabets

Peter Damerow
Max-Planck-Institut für Wissenschaftsgeschichte
Donnerstag 20. 5. 99 19h
Anatomie der ungeborenen Zahl - Entzifferung der numerischen Notierungen
in proto-keilschriftlichen Verwaltungstexten Mesopotamiens (3200 - 3000 v. Chr.)

Jan Assmann
Ägyptologisches Institut Ruprecht-Karls-Universität Heidelberg
Donnerstag 1. 7. 99 19h
Die Inganghaltung der Welt - Riten als Medien des Denkens im alten Ägypten



Studientag Wissenschaftsgeschichte

Since its inception in January 1999 this history of science workshop has convened around 30 pre- and postdoctoral scientists twice a year to discuss their work in progress. It is jointly organized by *Michael Becker*, Wissenschaftskolleg zu Berlin, and *Cornelius Borck*, Max Planck Institute for the History of Science.

Book Presentation

The Book *Ecce Cortex* (see p. 66) was presented to the public on 23 September, 1999.

Conference Project: Science between Money and Mind (Wissenschaft zwischen Geld und Geist) November 16-18, 2000

Lorraine Daston, Matthias Dörries, Michael Hagner

“First of all it’s about money.... No, first of all, I admit it, it’s about simplicity.... The most important criterion is a simple question with a simple system that nobody else works on, and to which I can give a simple answer, so that my research funding will be renewed.” This sober remark of a rising young biologist at the end of the twentieth century stands in sharp contrast to Max Planck’s propagation in 1946 of “absolute values in the sciences and ethics... to strive for which is the real task of an intellectually active human being.” By these absolute values Planck meant not only the determination of physical constants, as he had done for the quantum of action, but also the scientist’s “truthfulness... with himself.”

Pragmatism and idealism – or, reduced to essences, money and mind – seem irreconcilable; and there is little doubt that the (self-)image of the sciences has oscillated between the two poles. However, to find evidence that science had ever existed without money would be as difficult as to assert that the sciences at the end of the twentieth century could be reduced entirely to economic conditions. Today, on the threshold of the next millennium, discussions about science’s future and financing move between the economic – practical feasibility – and the cultural – intellectual self-understanding. This conference will illuminate science’s Janus faces from a range of perspectives, encompassing both the humanities (*Geisteswissenschaften*) and the natural sciences (*Naturwissenschaften*).

In the twentieth century, human curiosity and the desire for knowledge witnessed increasing coordination, concentration, industrialization and instrumentalization, driven by increasing resources. Does the actual intellectual achievement of this century lie in this organization of intellect? Take, as a consequence of this development, research proposals and their increasing influence on scientific competition. Research proposals are hybrids: on the one hand they emphasize utility and efficiency; on the other, they have little hope of success if they do not incorporate and perpetuate specific cultural and scientific values.

Similar tensions also inform the creation and uses of patents. On the one hand, there is the ideal of intellectual priority and scientific knowledge; on the other, there are solid financial interests, including the acquisition and rapid pace of information and technology turnover, mimicking commodities in the market of scientific production.

A scientific career also manifests tension between pragmatic aims and a “higher calling.” The scientist’s old ideal of individual autonomy is variously realized in the university, a research center or a biotech or computer firm. Nevertheless, despite increasing organization and bureaucratization, scientists still enjoy a degree of freedom to be found in few other professions.

“Wissenschaft zwischen Geld und Geist” will highlight the following themes:

- scientific careers: pragmatic aims and “higher calling”;
- the history of research proposals: competition and intellectual achievement;
- the history of patents: commercialization of knowledge and intellectual priority;

- funding of science: national-cultural values and objective knowledge (taking archaeology as an example);
- values of science: system constraints and autonomy.

The conference aims at both exploring possible margins in the amalgam of money and intellect and providing some initial answers to the questions raised. It aims to contribute to the historical and cultural self-understanding of our scientific world at the turn of the millennium.

Publications and Preprints

Publications

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Abattouy, Mohamed. "'Nutaf min al-hiyal' : an Arabic short version of Pseudo-Aristotle's 'Problemata mechanica'." *Early science and medicine* (in press)

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Daston, Lorraine see also: Carl and Daston

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