Man Ray, L'Enigme d'Isidore Ducasse

Department III

Experimental Systems and Spaces of Knowledge

Director: *Hans-Jörg Rheinberger*

The core of the research activities of Department III is devoted to the practical, conceptual, and cultural conditions of scientific innovation. Since the early modern period, scientific activity has been associated with the exploration of novel, uncharted ground. Today, the sciences have become the most important factor of social innovation and have penetrated all domains of modern everyday life. But if the essence of science resides in the production of new knowledge, a question of fundamental importance arises for the historian of science: How do scientists manage to produce knowledge that counts as reliable, although they are essentially dealing with objects that still lie in the realm of the unknown, and although, in exploring this realm, they constantly have to be willing to discard knowledge that was believed to be certain?

In one way or another, all projects of Department III are exploring the dynamics of scientific change. Many of the case studies are located in the broad field of the life sciences: from the beginnings of the exploration of heredity in eighteenth century agriculture and medicine, to the most recent developments in molecular genetics; from classical and romantic natural history to experimental physiology and psychology; from an anatomy based on dissection around 1800 to an instrument-mediated medicine and *in vitro* biology in the twentieth century. Particularly within the last 150 years, the realm of the life sciences has experienced a tremendous expansion. Particular areas of expertise, of model organisms, instruments, and experimental arrangements have developed into disciplines with remarkable stability, physiology being a good example of this. But disciplines have also dissolved again, such as phrenology, and given way to new and different fields of research. Experimental objects, instruments, methods, concepts, and specialists have changed places and have been reconfigured in ever changing constellations, resulting in unprecedented developments.

In order to explore these dynamics in depth, the research projects of the Department are organized around topical domains from a long-term perspective and embedded in a multidisciplinary horizon. The individual projects of the research scholars and post-doctoral fellows usually take two to five years. New projects are selected in such a way that there is a certain amount of overlap with existing and ongoing research activities in one of the domains. This allows enough scope for the development of

individual research agendas, and at the same time encourages the emergence of new collaborative projects extending over disciplinary and epochal boundaries. A considerable number of projects of the Department are joined together in such larger collaborations developed over the past years (see below), whereas others are pursued individually. The workshops of the Department are related to its project activities. All members of the Department meet regularly for a biweekly colloquium, where they present their ongoing work to the whole group. The Department also works on the establishment of a "Virtual Laboratory." The Virtual Laboratory is a web-based platform devoted not only to collecting and making accessible a broad range of textual and pictorial sources from the history of the life sciences, but also to constructing an electronic research and publication environment. Since its establishment in 1997, three topical domains have been instrumental in shaping the work of the Department. They shall be described briefly, before reporting on the work in the period between 2004 and 2005.

History and Epistemology of Experimentation

→ "Historia experimentalis" p. 136
→ "Experimental History of Science" p. 143

Philosophers and historians of science agree that since the early modern period, experiments have been at the center of the process of knowledge creation. Detailed investigations on the varieties of experimentation, however, are of relatively recent origin. Indeed, upon closer inspection, it transpires that there is no such thing as "the" experimental method. In contrast, different forms and styles of experimentation must be distinguished. They relate to particular phases of scientific work, and characterize particular experimental cultures of certain time periods or disciplines. In addition, experiments often gain a life of their own that leads researchers away from their original goals and convictions. In this respect, we can talk about a history of experimental systems. Often enough, phenomena that initially were seen as artifacts or disturbances move into the center of attention, and methods that were seen as unproblematic data collection devices move into the focus of epistemic interest. The historical dynamics of the sciences can only be understood properly if all possible forms of experimentation are taken into account in their own right, without elevating one of them to an ahistorical model of "the" good experiment.

History of Objects and Spaces of Knowledge

A decisive aspect of scientific innovation lies in selecting, adapting, and at times also turning away from particular objects. Unicellular organisms, sense organs or populations, for instance, are not scientific objects by themselves; they become scientifically meaningful only inasmuch as they come to embody general phenomena such as organic reproduction, the boundaries of perception, or supra-individual biological processes. Model organisms are a particularly interesting category of objects for the history of the life sciences in this context. As a rule, these objects are embedded in real and symbolic spaces within which they are manipulated, and indeed which they also shape. Natural cabinets, laboratories, the "field" of the zoologist or the anthro-

pologist, but also "virtual" environments such as the paper spaces of the laboratory protocol or computer simulations are instances of such spaces that require new forms of attention, and whose emergences and configurations we investigate in historical detail.

→ "History of Scientific Observation" p. 49

Formation of Concepts and Uses of Theory

Processes of scientific innovation also express themselves in the formation of new concepts and theories. We are less interested in a traditional history of ideas and concepts than in the concrete roles that concepts and theories play in scientific practice. We are interested in the organizing function of concepts in devising and performing experiments; in their role with respect to the creation of research domains and scientific disciplines; in the relations between verbal and pictorial argumentation in the historical development of the life sciences; and in the movement of metaphors between scientific and extra-scientific texts.

→ "Practical Experience and Conceptual Structures" p. 21

Together, the research projects of Department III contribute to a perception of the dynamics of scientific research that is characterized, above all, by historical contingency. Within the history of the sciences, whole disciplines derive their origin from accidental constellations of technical artifacts; their further development depends on achievements that may stem from other disciplines, result in the dissemination and solidification of technologies, and in this form, impinge on neighboring disciplines. There appears to be no universally and permanently valid "logic" of research that would allow scientific progress toward an anticipated goal. An idea that counts as revolutionary for today's science may reveal itself as an obstacle tomorrow; a technology that has beneficial applications at present may deploy destructive effects in the future. Science, as a thoroughly human undertaking, has to be analyzed in all its historical ambivalence.

Project

The Experimentalization of Life. Configurations Between Science, Art, and Technology

RESEARCH SCHOLARS *Sven Dierig, Julia Kursell, Henning Schmidgen*
PREDOCTORAL FELLOWS *Björn Brüsch, Philipp Felsch, Katrin Solhdju*
VISITING SCHOLARS *Klaus Staubermann, Rand Evans, Elfrieda and Erwin Hiebert*
COLLABORATIONS Helmholtz-Zentrum für Kulturtechnik at the Humboldt University Berlin, Media Department at the Bauhaus University of Weimar, Program in History of Science of Stanford University, Zentrum für Literaturforschung Berlin
FUNDING VolkswagenStiftung, MPIWG

This project started in the fall of 2000 and was supported by the VolkswagenStiftung for five years until the fall of 2005. Now it has been established as one of the long-term projects of the Department.

Experimentation is not restricted to science. It has often been noted that the 19th century was a century of laboratory science. Less attention, however, has been paid to the fact that in the same period literary writers, artists, and engineers also claimed to perform experiments. Thus, Emile Zola set out to write experimental novels,

Physiological Laboratory,
in: Ter Herinnering van de veertig jarige Amtsvervulling van D. B. Kagenaar Sr., 1860 1--Mei--1900 [photographic album]. Utrecht (University Museum Utrecht, Archive-Box 1151)

Giacomo Balla called his studio a "laboratory," and the Russian avant-garde strove to perform experiments with life in the Soviet Union. One of the main goals of this project is to take such claims seriously and to write a trans-disciplinary comparative history of experimentation.

The main focus is on the history of the experimental life sciences, mainly 19th century physiology. This research field had an important impact on other, until then non-experimental domains. Psychology, aesthetics, and linguistics, for example, were all adopting the model of physiology when turning experimental in the 1870s.
More specifically, the project investigates a variety of configurations betweens science, art and technology. For example, it covers the interactions between frogs and machines as they were produced in physiological laboratories around 1840; the dialogue between music and experimental acoustics as it started in the 1860s; time experiments from Helmholtz to Proust, and the transfer of graphical instruments from the laboratory to the Italian Alps around 1890. It also covers drug experiments in medicine and literature, and the invasion of gardening practices by experiment.

In the context of this project, the term "experimentalization" addresses the peculiarities of scientific developments as well as broader cultural trends. There are obvious parallels, but also important differences between the emergence and extension of the laboratory-based life sciences on the one hand and more general processes such as the industrialization and rationalization of society or the mechanization of culture on the other. In many ways, the histories of laboratories and experiments resemble the histories of factories and machines.

One of the main results of this project has been that experimentalization, with its peculiarities, cannot be understood as a one-dimensional process. In other words, the laboratory revolution did not take place in the way earlier studies have taught us. With respect to experimental set-ups and instruments, there are striking continuities between 1840 and 1890. What did change were *styles* of experimentation, i. e. the way in which instruments and organisms were connected, the spatial arrangement of experimental components, the time regimes that were implied—in short: the significance or values attached to performing experiments in the lab. As a consequence, experimentalization is not to be seen as a homogeneous process, but rather as a sort of patchwork of local activities, loosely connected yet highly productive.

Experimentalization of Life

The Laboratory in the City: Urbanization, Industrialization, and the Place of Experiment in 19th Century Physiology

Sven Dierig (Research Scholar)

Sven Dierig

Laboratories, along with the researchers, organisms, instruments, and experiments associated with these places of investigation, are not isolated from the world beyond their physical and institutional boundaries. Like universities, museums, hospitals, botanical gardens, and other institutions of scientific research and education, laboratories are typically located in cities—and both are subject to change. Taking the example of Berlin and the institutionalization of experimental physiology by Emil du Bois-Reymond, the project has been dedicated to connecting aspects of modernity that usually have been researched separately:

1. The laboratory as a material and cultural workplace where experimental phenomena and scientific knowledge are generated, and
2. the dynamic and far-reaching transformation of the urban space during the nineteenth-century industrial revolution. In the light of an "urban history of physiology" which analyzes the laboratory revolution in physiology in the context of the urban revolution, the fundamental aim of the project is to understand how cities and laboratories "cooperate" in the production of scientific novelty.

Membership card of the Physikalische Gesellschaft zu Berlin

The study followed three major themes that illustrate 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 in the Berlin laboratories for physiology.

1 Organisms: In the nineteenth century, physiologists carried out experiments on objects such as frogs, cats, rabbits or dogs. Research fields, experimental set-ups, and instruments within physiology crystallized around such "model organisms."
2 Instruments: This focus of the project is on the role of technology in the making of scientific novelty during the time when Berlin became a technological metropolis.
3 Laboratories: The late 19th century physiology laboratory is highlighted as a specific place of work designated for the factory-like production of new experimental phenomena. This project is now completed.

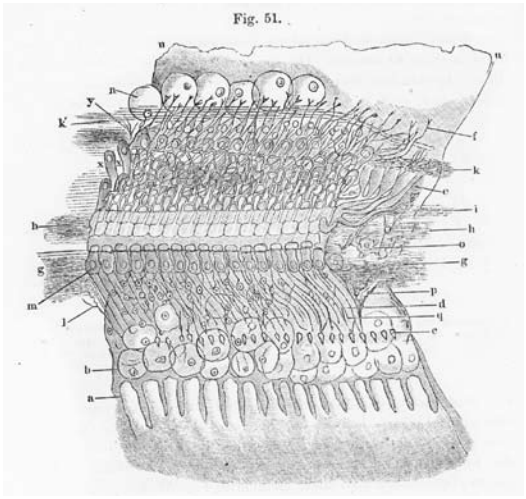
Experimentalization of Life

Ear and Instrument—Hermann v. Helmholtz's *On the Sensations of Tone as a Physiological Basis for the Theory of Music*

Julia Kursell (Research Scholar)

Julia Kursell

The project investigates the relation of psycho-physiological research and musicological theory. It considers music as an experimental set-up in its own right, and it traces the changes in the aesthetics of music brought forth by physiological research. The starting point is Hermann von Helmholtz's *On the Sensations of Tone as a Physiological Basis for the Theory of Music*, first published in 1863. In this work, Helmholtz develops a theory of hearing, according to which the ear functions as a measuring instrument, analyzing complex waveforms and resolving them into their sinusoidal components. Instrument makers, just like musicians and composers, are guided in their work by this activity of the ear, and therefore a tacit, empirical knowledge is enclosed in their products. Ear and instrument are connected by more than just a metaphor: Helmholtz perceives the piano to be a reconstruction of the ear, and likewise, the function of the ear is modeled on the piano. Furthermore, Helmholtz reproduces the rules of music theory and the history of music by means of experimentation, just as the teaching of orchestration involves extensive self-description of music as an experiment. Step by step, the European tradition of music has, as it were, explored its own physiological conditions, and so the distinctions between major and minor, or consonance and dissonance, corroborate the physiological theory of hearing.



The Organ of Corti as shown in: On the sensations of Tone as a Physiolgical Basis for the Theory of Music by Hermann v. Helmholtz.

Yet this circularity of technology, physiology and aesthetics, of musical instruments, experimental set-ups, and the theory of music had far-reaching effects. The experimental set-ups used by Helmholtz produced new sounds, i. e. sounds not present in 19th century music, and the very aesthetics of music that was to prove the physiological theory of hearing eventually collapsed under its scientific explanation. If Helmholtz left it to aesthetics to draw the line between sound and music, the music of the 20th century, in the wake of Helmholtz, is known to have abandoned this distinction: Thus the book *On the Sensations of Tone* points toward aesthetic experiments, the outcome of which is left open.

Experimentalization of Life

Chronos and Psyche: The History of Physiological and Psychological Time Experiments

Henning Schmidgen (Research Scholar)

Henning Schmidgen

This project deals with the emergence and development of the physiological and psychological short-time experiments. These experiments, it is argued, have key importance for the history of the neurosciences, brain research, psychology and the cognitive sciences. Since the 1860s, physiologists and psychologists have conducted short-time measurements in order to determine the temporal relations given in the human brain and nervous system. The measurements generated a wide range of hypotheses on the anatomical structures and physiological functions involved in reaction processes and provoked far-reaching arguments about the nature of human consciousness, thought, and voluntary action.

The project approaches the historical material by way of a generalized notion of "machines" In this perspective, experiments are conceived of as complex, distributed machines that integrate within local settings a multiplicity of heterogeneous components, i. e. scientists, model organisms, instruments, concepts etc. In addition, experiments are seen as embedded in larger socio-technological assemblages (e. g. laboratories, clinics, factories) that have an impact on their application and distribution. At the same time, they can be reduced to core elements that function together despite their fundamental heterogeneity, e. g. frog muscles and telegraphy keys, tuning forks and organic membranes. This approach not only allows one to contextualize experiments with respect to space, but also with regard to time and, more generally, with respect to their intrinsic dynamics. It is argued that reaction time experiments relied on combinations of interrupted flows: flows of organic and inorganic movements, flows of energy, of writing, speech etc. As a result, the history of physiological and psychological time experiments turns into a history of material continuities between, and variations of, machines producing precise measurements and provoking new theories and concepts within different institutional settings.

Experimentalization of Life

Experimentalization of Gardening in 19th Century Germany: Peter Joseph Lenné and the "Gärtner-Lehranstalt" at Wildpark/Potsdam

Björn Brüsch (Predoctoral Fellow)

Björn Brüsch

Much of the promotion of Prussian "Landeskultur" in the early 19th century was closely connected to the use of land as gardens—both on a rhetorical and a practical level. This movement led to the establishment of an institution specifically aimed at providing gardeners with a comprehensive education. Gardeners were no longer meant to be humble land-workers but rather experts of cultivation of all the resources that nature provided. The new school was molded on the example of the Parisian Jardin des Plantes with its head gardener and professor for plant cultivation, André Thouin. Like the botanical garden in Paris that was a center of expert knowledge for the Republic, the Gardeners' Institute in Berlin was to function as a prominent center of Prussian "Landeskultur."

Peter Joseph Lenné became the first director of the Royal Gardeners Institute founded in August 1823. Teachers were recruited from the Society for the Advancement of Horticulture in the Royal Prussian States and the Botanical Garden in Schöneberg / Berlin. Besides practical matters, the garden artists were acquainted with basic knowledge in botany, physics, chemistry, and physiology. Using archival material, the project follows in detail how Lenné composed a draft of the organization of the school and how he set up his program of scientific gardening. In sum, the institute provided a space in which the garden became a "laboratory of plant sciences," as Alexander Braun put it in 1852. The project aims to situate this development in the broader context of 19th century efforts to render agriculture scientific.

Ch. W. P. Beuth flying on a Pegasus (1837)—"Ich schwebe über einer von mir gegründeten Fabrikstadt auf dem Pegasus und mache Seifenblasen. (Bemerkung Beuths)". Karl Friedrich Schinkel, Fig. in Karl Friedrich Schinkel 1781–1841 (1980), p. 314, quotation from Wolzogen (1862): Aus Schinkels Nachlaß. Reisetagebücher, Briefe und Aphorismen. Zweiter Band. Berlin: Kgl. Geh. Oberhofdruckerei, p. 337, picture lost since 1945

Experimentalization of Life

Laboratory Landscapes: The Alps as a Medium of Physiology Circa 1900

Philipp Felsch (Predoctoral Fellow)

The project focuses on Alpine physiology around 1900. The main argument is that mountains were an "intensive place" of modernity. Experimental physiologists left the closed space of their laboratories and developed a thermodynamic, almost Nietzschean image of man, ironically under the eyes of an increasing vacationing middle-class. Like a magnifying glass, the history of Alpine physiology exposes two essential modes of speechlessness in the 19th century: the deep "subjectivity" of landscape experience on the one hand, and the austere "objectivity" of scientific experimentation on the other.

The aesthetic discovery of the Alps in the eighteenth century had physiological traits from the very beginning. When Johann Joachim Winckelmann, the German father of classicism, crossed the St. Gotthard Pass in 1760, he shut the windows of his coach to avoid the ugly sight of rocks and snow. 50 years later, Percy Bysshe Shelley wrote his famous poem about Mont Blanc with his eyes on the mountain. Shelley still considered mountains terrible, and would under no circumstances have climbed them. It was Horace Bénédict de Saussure, the Genevan professor of natural history, who transcended the romantic mountain genre. When his dream of climbing the Mont Blanc was finally realized, he could not help but stamp around the top of the mountain in anger: Far above the tree line, the sublime shudder had turned into a physical calamity.

Experimental Set-Up. Photograph taken in Angelo Mosso's Laboratory (from the Angelo Mosso Papers)

In 1861, Auguste Rosalie Bisson and his 25 porters managed to expose collodion plates on the summit of Mont Blanc. Both the public and the critics were enthused about the feat. Throughout the second half of the nineteenth century, mountain photography was surrounded by a discourse on the heroic conditions of its production. Better than any words could, the new mechanical images captured what it physically meant to climb up the high Alps. But rather than symbolizing sublimity, they indicated fatigue. By using the graphic method, Jean Chauveau could render the moun-

taineers' troubles observable: For the first time, he translated mal de montagne, vertigo, and fatigue into mechanical tracings. In Italy, Angelo Mosso extended Alpine physiology and even managed to invest it with national prestige. The project analyzes how the stammering language of poetry was replaced by the silent language of curves, and how the romantic theatre was turned into a laboratory landscape for experiments on modern fatigue. This project has now been completed.

Experimentalization of Life

Self-Experimentation: Crossing the Borders Between Science, Art and Philosophy 1840–1920

Katrin Solhdju (Predoctoral Fellow)

Katrin Solhdju

The aim of this project is to investigate how different practices and techniques of approaching the self changed and shaped concepts of subjectivity and selfhood and vice versa. It focuses on a specific kind of experimentation on vital processes in which the experimenter poses as the subject and the object at the same time.

Self-experimentation as a practice has always existed in various contexts, but only at the end of the 18th century was it sanctioned as a necessary step in the process of developing drugs in pharmaceutics. Mainly due to ethical reasons, the researcher himself was to "go first" thereby taking primary risk. In the context of her dissertation project, Katrin Solhdju is investigating the role self-experimentation played in various scientific and non-scientific contexts between the late 18th and the early 20th centuries. Her claim is that around the end of the 18th century, the self-experiment gained an epistemological status that transcended the realm of risk management and ethical concerns. The assumption is that self-experimentation was epistemologically always tied to experimenting *with* the self, and methodologically to introspection. Therefore, the reconstruction of self-experimental contexts not only raises theoretical questions concerning the operating modes and the status of experiments, but is also aimed at contributing to a history of subjectivity. The case studies include the French psychiatrist Moreau de Tours, the British statistician Francis Galton, the American amateur philosopher Benjamin Paul Blood and psychologist William James.

Experimentalization of Life

The Virtual Laboratory

[http://vlp.mpiwg-berlin.mpg.de]

The Virtual Laboratory is a digitalization project devoted to the history of the experimentalization of life with a focus on the interaction between life sciences, arts and technology. The project is developed in close cooperation with the IT Group and the Digitalization Group of the Institute.

Online since 2002, the Virtual Laboratory has become a unique research tool for the history of 19th century physiology, understood in a broad sense. Currently, it has some 9,000 individual page accesses per week. The Virtual Laboratory offers more than 25,000 bibliographical references, partly covering journal articles and also consisting of complete bibliographies established for some twenty eminent physiologists and psychologists: Du Bois-Reymond, Helmholtz, Bernard, Marey, Donders, etc. The Virtual Laboratory also includes all 19th century references from Karl Rothschuh's comprehensive bibliography concerning the history of physiology, in a completed and updated form. As a special feature, the laboratory offers access to all book titles available in two private 19th century libraries: Those of Johannes Müller and Wilhelm Wundt, in total some 5,000 items. This collection will soon be supplemented by Franciscus Donders's library. The Virtual Laboratory displays a total of some 3,000 scanned items consisting of approximately 2,000 journal articles, 250 book chapters, 120 monographs and textbooks, and some 180 trade catalogues, all to be downloaded and printed out easily. In total, there are some 120,000 pages available.

The Virtual Laboratory is not just a digital library, however. It is also a powerful research tool. Besides the bibliographical references, there are more than 20,000 referenced images that are searchable by caption, author and image type. To date, this image database has focused primarily on instruments. Search results show image captions and direct the user to the book, article or catalogue from which the image is taken. In addition, the Virtual Laboratory contains a so-called "trend-scout," a tool allowing statistical analyses of bibliographical references. Another user tool will be implemented in the near future. The Virtual Laboratory will allow users to create their own workbenches where subscribers can build, manage and share subsets of annotated sets of objects, such as literary sources, library searches, biographies, sites, etc.

Finally, the Virtual Laboratory offers ample space for scholarly publications. The project publishes short articles on the history of 19th and early 20th century experimental physiology and psychology. These articles are linked to the holdings in the digital library and to the various other sections of the Virtual Laboratory: short biographies, laboratory descriptions, instruments, etc. Scholars from outside the institute working on related topics and sources have also started to publish here.

Experimentalization of Life

Projects of the Visiting Scholars

- *Rand Evans* (East Carolina University, Greenville, U.S.A.): "Brass Instruments—A History of Scientific Instruments in Experimental Psychology, 1830–1930"
- *Elfrieda and Erwin Hiebert* (Boston): "Pianos, Pianists and Composers in the Changing Landscape of Late 19th Century Acoustics"
- *Klaus Staubermann* (Universiteitsmuseum Utrecht, The Netherlands): "Appropriating Experimentation in Museum Databases"

Experimentalization of Life

Activities Related to the Project

- Workshops and Exhibitions:
  "Zwischenräume: Seriality; Vitalism/Mortalism; Figures of Isolation; Infection and Immunity." Four Workshops organized together with the Helmholtz-Zentrum für Kulturtechnik and the Zentrum für Literaturforschung, Berlin, February 6 and June 25, 2004, January 28 and July 15, 2005.
  "Kultur im Experiment." Presentation of a book comprising the papers of the Opening Conference of the project, in conjunction with Kadmos Verlag, Berlin, June 9, 2004.
  "Labor und Seminar. Berliner Kulturräume der Wissenschaften im 19. Jahrhundert." Workshop organized together with the Institute for the History of Medicine (Charité), Berlin, March 10–12, 2005.
  "The Shape of Experiment." International Conference, Berlin, June 2–5, 2005.
  "Apoll im Labor." Exhibition organized by Sven Dierig in cooperation with the Museum for the History of Medicine at the Charité, Berlin, May to October 2005.
- Completed Dissertations:
  Julia Voss: "Darwins Bilder. Ansichten der Evolutionstheorie 1837–1874" (2005).
  Margarete Vöhringer: "Avantgarde und Psychotechnik. Wissenschaft, Kunst und Technik der Wahrnehmungsexperimente im postrevolutionären Russland" (2005).
- Books:
  Henning Schmidgen, Peter Geimer, and Sven Dierig, eds. *Kultur im Experiment*. Berlin: Kulturverlag Kadmos, 2004.

Henning Schmidgen, ed. *Lebendige Zeit*. Berlin: Kulturverlag Kadmos, Berlin 2005.
Sven Dierig. *Wissenschaft in der Maschinenstadt. Emil Du Bois-Reymond und seine Laboratorien in Berlin.* Göttingen: Wallstein Verlag, 2006.
Peter Geimer, ed. *UnTot.* Verhältnisse von Leben und Leblosigkeit. Berlin: Kulturverlag Kadmos, (in press).

Project

A Cultural History of Heredity

RESEARCH SCHOLARS *Staffan Müller-Wille, Hans-Jörg Rheinberger, Christina Brandt*
POSTDOCTORAL FELLOWS *Jennifer Marie, Bernd Gausemeier*
VISITING SCHOLARS *Soraya de Chadarevian, Edna Suárez-Díaz*
SHORT TERM QUEST RESEARCHERS *Jonathan Harwood, Manfred Laubichler*
COLLABORATIONS MPIWG, Dept. I *(Wolfgang Lefèvre and Peter McLaughlin)*, School of Life Sciences at Arizona State University in Tempe, ESRC Centre for Genomics in Society at the University of Exeter
FUNDING DFG, Government of Liechtenstein, British Council, German Academic Exchange Service (DAAD), British Academy, and MPIWG

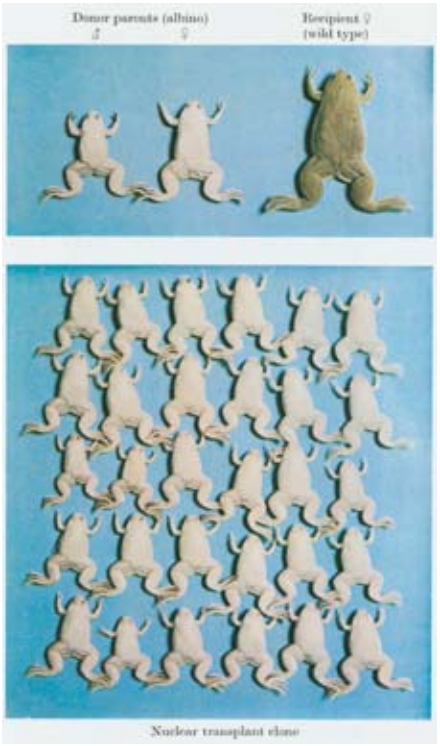
This project centers on the history of the scientific and technological practices in which the knowledge of biological "heredity" became materially entrenched and the cultural contexts in which it unfolded its effects. Knowledge of "heredity" is taken here as encompassing much more than the scientific discipline of "genetics," namely a knowledge regime in which a naturalistic conception of inheritance has slowly been formed that came to influence all areas of modern society, including medical, jurisdictional and political discourses. The aim of the project is to explore the changing practices, standards, and architectures of this regime as well as their particular historical conjunctions from a "longue durée" perspective.

The project is collaborative and interdisciplinary in its nature, as it aims to draw together expertise, besides history of science, from other historical disciplines such as the history of medicine, law, economics, and art as well as political history and anthropology. The backbone of the project is a series of five workshops, each concentrating on a specific "epoch" in the cultural history of heredity.

These epochs cut across the received turning points in the history of biology "around 1800" and "around 1900." We concentrate on periods characterized by certain developments in the field itself. The following phases are distinguished: the first, extending from the late seventeenth century to the 1780s, in which "heredity" came into exis-

tence in several separate but confined fields, such as horticulture or pathology; the second, lasting to the middle of the nineteenth century, in which "heredity" became central to the life sciences; the third, covering the period from 1870 to the 1930s, in which heredity became experimental and mathematical; the fourth, from the 1930s to the 1970s in which heredity went "molecular;" and, finally, from the 1970s to the present, the fifth, characterized by the technological application and commodification of molecular hereditary knowledge.

The first workshop, focusing on the seventeenth and eighteenth centuries, took place in May 2001. A second workshop on the late eighteenth and early nineteenth century was held in January 2003. The third workshop on the second part of the nineteenth century took place in January 2005. The fourth workshop is in the planning stage and will be held in December 2006 at the University of Exeter. The results of the workshops will be published in two essay collections. A first volume is currently being published by MIT Press.



Cloned frogs, in: John Gurdon: The Cronian Lecture, 1976. Egg cytoplasm and gene control in development, in: Proceedings of the Royal Society of London, Series B, Vol. 198 (1977), p. 211–247, 218

Cultural History of Heredity

Landscapes of Experimentation: Research on Heredity in Early Twentieth Century Germany

Hans-Jörg Rheinberger (MPIWG, Director)

Hans-Jörg Rheinberger's current research focuses on a number of case studies designed to map the development of experimental genetics in Germany from the end of the 19th to the middle of the 20th century. The general aim of the project is to 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 heredity research in the early 20th century. These experimental systems and strategies of experimentation were rooted in, and therefore carried the stamp of, a number of different disciplinary backgrounds.

The project is aimed at characterizing what may be called a "landscape of experimentation." Landscapes of experimentation are to be mapped out both in terms of the coherence of a domain of research, and in terms of the plurality of approaches they leave for investigation. It is the balance between these two features that determines the productivity of a particular domain of research at a given time.

One cluster of studies deals with the work of Carl Correns, from the restatement of Mendel's laws around 1900 to experimental sex determination. Another case study investigates the convergence of transmission genetics and developmental physiology. It is aims to provide a reconstruction of how Alfred Kühn and his collaborators, in particular Ernst Caspari, came to conceptualize gene-action chains involved in pigment formation in the flour moth Ephestia between 1925 and 1945. Another case study is devoted to the establishment of tobacco mosaic virus research in Germany, with Georg Melchers, Gerhard Schramm, Gernot Bergold and Rolf Danneel as its major protagonists. The most recent study in this context is concerned with the history of protozoology. It deals with Max Hartmann's fertilization, reproduction, and sexuality studies and their relation to genetics.

Cultural History of Heredity

The Structural Turn in 20th Century Biology and Anthropology

Staffan Müller-Wille (Research Scholar, MPIWG/Senior Researcher, University of Exeter, U.K.)

Staffan Müller-Wille

The project deals with one of the most contentious notions of 20th century biology, "race," and its changing relationship to genetics. Initially, genetics went against well-established notions in biology. In particular, it went against evolution and adaptation, and against orientation towards larger wholes such as races and species. In this respect, one can speak of a "structural revolution" which biology and anthropology underwent during the 20th century. Yet thinking in terms of race did not simply give way to a purely genetic understanding of life. The changing relationship of race and genetics over the latter part of the 20th century ranges from the outright rejection of race as a scientifically viable category by natural scientists in the UNESCO Statement of Race in 1951, to the recent upsurge of racial studies in the context of genomics.

The results of the case studies carried out by Müller-Wille point to a pattern familiar from the philosophy of science: the development of a field of enquiry from a qualitative, taxonomic approach to quantitative methods allowing for calculation. The important and remarkable point, however, is that such transitions are not smooth, but are characterized by resistance and ruptures. Moreover, they are not to be described as progress towards a more objective, value-free understanding of the subject of enquiry, in this case human diversity. On the contrary, the genetic understanding of human populations has provided even more powerful bio-political tools than racial biology could ever aspire to.

Cultural History of Heredity

On the History of Cloning. A Comparative Analysis of the Life Sciences in Germany Since 1950

Christina Brandt (Senior Research Scientist)

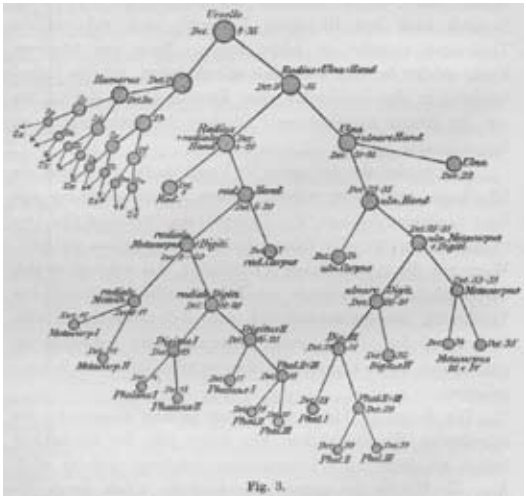
Christina Brandt

The project is aimed at uncovering the different scientific and cultural layers in the history of cloning. At the turn of the 20th century, the term "clone" was newly coined to designate plants that propagated in a vegetative manner from a common ancestor. During the 20th century, the concept passed through very different research areas, such as plant breeding, botany, cytology, tissue culture, cell lineage research, immunology, genetic engineering and developmental biology as well as reproductive medicine. The epistemic status of the clone also changed over time: The concept was first developed in the context of horticultural breeding, but the clone soon became something that could be called a technical object in different experimental systems throughout the 20th century. So far, the following areas have been investigated:

1. Protozoology in early 20th century, in particular the work of Herbert Spencer Jennings and Victor Jollos;
2. the history of nuclear transfer, in particular the work of Joachim Hämmerling, Robert Briggs and Thomas King, and of John Gurdon;
3. science fiction literature on cloning between 1960 and 1980.

The debate on cloning in the 1970s. Bild der Wissenschaft, Heft 7, cover, July 1979

Exploring the circulation of the term through different research areas, Christina Brandt's study addresses the relationship between material practices and concept formation within biological research. Furthermore, it deals with the images and phantasms that have been associated with the scientific practices of cloning since the early 1960s. The main subject matter of this part of the research consists of novels and science fiction. The history of cloning in (West-) Germany is compared to the situation in the U.S.A. and the U.K. Such a comparative perspective also raises the question of whether national research styles persisted in an increasingly internationally organized scientific landscape during the second half of the 20th century. One of the principal objectives of this project is to specify at which level national peculiarities may still be of relevance.



Weismann's theory of the "Keimplasma": differentiation of the "Idioplasma". August Weismann: Das Keimplasma. Eine Theorie der Vererbung, Jena, p. 136, 1892

Christina Brandt was appointed as Senior Research Scientist in the context of the Max Planck Society program for outstanding woman scholars by February 2006.

Cultural History of Heredity

Gardening, Fancying and Heredity

Jennifer Marie (Karl Schädler Postdoctoral Fellow, University College London, U.K.)

Jenny Marie

Jenny Marie investigated the relationship between breeders and geneticists in Britain between 1900 and 1940. The main focus of the project was on the links that existed between fanciers, economic breeders and geneticists that bred poultry and rabbits. Animal fanciers bred animals for exhibition, the aim being to gain prizes and prestige. The project looks at the differing social ideals that were embedded in the practices of breeding rabbits and poultry for display, and how this changed throughout the nineteenth and early twentieth centuries. Economic breeders bred animals for money —either by selling their animals for meat or for their by-products, such as fur, wool and eggs. The trade in breeding animals developed throughout the 19th and early 20th centuries. The project traces this development and analyzes how it was affected by world economic changes and wars.

In the project, these developments in breeding for fancy and economic gain are related to the rise of genetics as a scientific discipline. Many geneticists were also fanciers and some sold their excess animals to fund their research programs. Equally, economic breeders and fanciers needed some knowledge about heredity to breed exhibition winning animals and animals that would gain the highest price at market. This raises the question of what the boundaries were between these three groups of breeding practitioners. All three groups met up at international conferences, such as the World Poultry Congresses, and national events, such as the Harper Adams Poultry Conferences. At these events, they shared breeding knowledge, techniques and material. The project investigates how open each of the three groups' boundaries were to the other groups and how they controlled their boundaries.

The geneticist, Michael Pease, holding one of Lord Greenway's fancy Marans hens. From The Feathered World (30 October 1936): 447

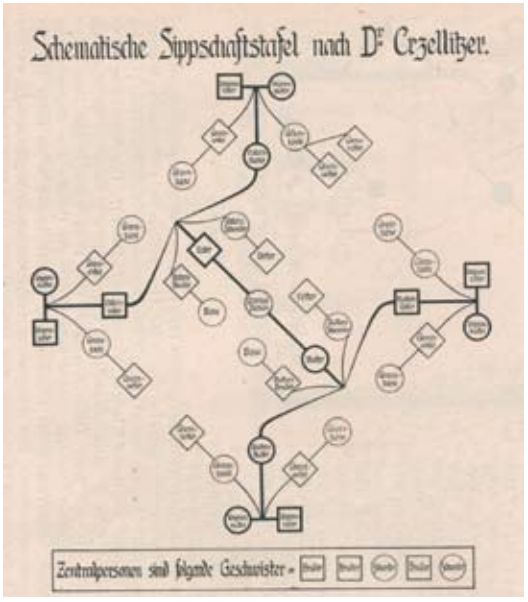
Cultural History of Heredity

Genealogy and Human Heredity in Germany, Late 19th and Early 20th Century

Bernd Gausemeier (Postdoctoral Fellow)

Bernd Gausemeier

All knowledge about human heredity is based on genealogy, but only in the 19th century did genealogy become a key method for the study of heredity. Animal breeders, plant breeders, physicians and psychiatrists all used genealogical systems to record or reconstruct information about hereditary transmission. Genealogy, thus, was the material basis for constructing knowledge about heredity in various scientific fields. Yet, genealogy is not only relevant as a scientific method. Its use also reflects prevailing ideas about familial and social order. Looking at genealogical practices can therefore tell us much about the political and social changes that were associated with the emergence of a science of heredity.



Genealogical record used for family research in medicine. Max von Gruber, Ernst Rüdin (eds.) Fortpflanzung, Vererbung, Rassenhygiene. Illustrierter Führer durch die Gruppe Rassenhygiene wder Internationalen Hygiene-Ausstellung 1911 in Dresden, München, 1911

Psychiatry is a particularly interesting field in this respect, since psychiatric asylums were the first institutions to record alleged hereditary phenomena on a regular basis. It was at the end of the 19th century, however, that genealogy was defined as an auxiliary science of biology and medicine. The central part of the project is concerned with the redefinition of genealogy in Germany around 1900. In his influential handbook on *Scientific Genealogy* (1898), historian Ottokar Lorenz defined genealogy as the bridge between historical and scientific research. Genealogical associations, by then mainly occupied with the mere collection of family records, began to join forces with psychiatrists and other medical scientists interested in the study of human heredity.

In the years before and after World War I, plans for genealogical collections filing family histories and medical data flourished. Genealogical surveys were regarded as the starting point both for a scientific study of human heredity and as a means of eugenic control. The interest in "biologized" genealogy culminated under the Nazi regime, when numerous eugenic databases were created and the right to live became virtually dependent on one's family chart.

Cultural History of Heredity

History of Radiation Biology and Genetics after 1945

Soraya de Chadarevian (Visiting Scholar, Department of History and Philosophy of Science, Cambridge University, U.K.)

Soraya de Chadarevian

During her research stay in Berlin, Soraya de Chadarevian pursued her research on the history of radiation biology and genetics after 1945. The research is part of a broader project aimed at studying the transformations of postwar biology. Studies on the effects of radiation on organisms and the environment and on the ways to protect against them, as well as the plethora of new tools derived from nuclear energy research whose peacetime uses in biology and medicine were actively promoted after the war, had a much broader impact on postwar biology than generally acknowledged. This research also provides a new perspective from which to view the relations of biology and physics and the role of biology in the nuclear age.

A particular line of research concerns the debate on the mutational effects of radiation that prompted various government reports and dominated much of the genetic research agenda after the war. Investigations aimed at tracing the mutational effect of radiation, and elucidating their mechanism included large-scale irradiation experiments with mice and other laboratory animals as well as perfecting methods for the study of human chromosomes. In the late 1950s, human chromosome analysis promised broad applications in clinical diagnostics. Following these lines of research offers a broader view on postwar genetics than is generally provided by the exclusive focus on DNA research and molecular biology. The debate on radioactive fallout from atmospheric bomb testing that fuelled concerns about the long-term genetic effects on the population also raised concerns on the contamination of the environment with radioactive isotopes and their accumulation in the human body. Research on these topics helps to unravel the intricate relationships between scientific, medical and political concerns in the postwar era.

Cultural History of Heredity

Representation and the Construction of Knowledge in Molecular Evolution

Edna Suárez-Díaz (Visiting Scholar, Universidad Nacional Autonoma de Mexico)

Edna Suárez-Díaz

The aim of the project is to develop an analysis of the production and representation of knowledge in the field of molecular evolution, since its beginnings in the early 1960s, to the rise of bioinformatics and comparative genomics in the 1990s. The analysis takes place at three different levels:

At the micro-level, molecular evolution offers a place to investigate the role of experiments and techniques in different scientific traditions and the ways in which they are connected with specific practices of representation. The goal is to extend a previous study in experimental traditions on nucleic acid hybridization, to cover the role of electrophoresis in theoretical population genetics, and the effects of protein and DNA sequencing on the construction of phylogenies and comparative genomics.

On the disciplinary level, the project aims to offer an account of how the idea of informational molecules came to provide a powerful rhetoric for a new style of evolutionary studies. It simultaneously opened and constrained the ways by which the evolution of organisms began to be studied and represented. By developing a new vocabulary, scientists such as Emile Zuckerkandl, Walter Fitch, Roy Britten and others helped to create not only a linguistic convention, but a technical, social and political frontier between the new molecular evolutionists and the "old" organismal evolutionists.

At a transdisciplinary level, molecular evolution has been constitutive in the development of the bioinformatics revolution. The elaboration of the first computer programs for the construction of trees based on molecular data on similarities by Walter Fitch, and the first databases on proteins by Margaret Dayhoff, as early as 1966, illustrate this point. The project emphasizes the symbiosis between computer technology, bioinformatics and genomics as a result of the Human Genome Project.

Cultural History of Heredity

Projects of the Short Term Guest Researchers

- *Jonathan Harwood* (University of Manchester): "Europe's Green Revolution: The Rise and Fall of Peasant-Oriented Plant-Breeding in Central Europe, 1890–1945"
- *Manfred Laubichler* (State University of Arizona, Tempe): "Heredity and Development as Related Problems—August Weismann and the Origin of Theoretical Biology"

Cultural History of Heredity

Activities Related to the Project

- Workshops:
  "A Cultural History of Heredity III: Nineteenth and Early Twentieth Centuries." Third International Conference of the project, Berlin, January 13–16, 2005.
  "History and Epistemology of Molecular Biology. Problems and Perspectives." International Conference organized in conjunction with the Institut Pasteur, Paris and the Société d'Histoire et d'Epistémologie des Sciences de la Vie, Berlin, October 13–15, 2005.
  "The Century of the Gene." One-Day-Workshop, Exeter, December 2, 2005.
- Books:
  Hans-Jörg Rheinberger and Jean-Paul Gaudillière, eds. *Classical Genetic Research and its Legacy*. London: Routledge, 2004.
  Jean-Paul Gaudillière and Hans-Jörg Rheinberger, eds. *From Molecular Genetics to Genomics.* London: Routledge, 2004.
  Hans-Jörg Rheinberger, Epistemologie des Konkreten. Studien zur Geschichte der modernen Biologie. Frankfurt am Main: Suhrkamp, 2006.
  Staffan Müller-Wille and Hans-Jörg Rheinberger, eds. Heredity Produced: At the Crossroads of Biology, Politics, and Culture. Cambridge: MIT Press, 2006 (in press).

Project

Generating Experimental Knowledge: Experimental Systems, Concept Formation and the Pivotal Role of Error

RESEARCH SCHOLARS *Uljana Feest, Hans-Jörg Rheinberger*
POSTDOCTORAL FELLOWS *Igal Dotan, Gábor Zemplén*
PREDOCTORAL FELLOW *Lambert Williams*

SHORT TERM QUEST RESEARCHERS *Thomas Dohmen, Giora Hon, Jutta Schickore*
COLLABORATIONS Philosophy Department, University of Haifa *(Giora Hon)*, Historisches Seminar, Universität Wuppertal *(Friedrich Steinle)*, Department of History and Philosophy of Science, Indiana University Bloomington *(Jutta Schickore)*
FUNDING German-Israeli Foundation, MPIWG

The project consists of two working groups. One of them is based at the University of Haifa (Giora Hon as principal investigator, Galina Granek as postdoctoral fellow, Thomas Dohmen as doctoral student), the other at the MPIWG in Berlin. It is supported by the German-Israeli Foundation. In order to facilitate and implement the exchange and cooperation among all group members, there are regular meetings bringing together the local groups at Haifa and Berlin, and in which the progress of individual projects and relevant literature are discussed. Moreover, in order to integrate the two groups, three workshops were planned in which individual works in progress are presented. The first took place in Haifa in May 2005, the second in Berlin in June 2006.

Experimentation, a core procedure of modern science, has received new attention in history and philosophy of science in the last two decades. While a wealth of new perspectives have opened up, one essential feature has remained largely unanalyzed—the very role of experiment as a *knowledge-generating* procedure. Here is where the project starts off. It is aimed to develop a broader philosophical and historical understanding of how knowledge is gained, shifted and revised in experimental research. The links and dynamics between three focal issues are being explored: experimental systems, concept formation, and the pivotal role of error.

Challenging the clear-cut rationalist picture of experiment, Ludwik Fleck and others early on drew attention to the manufacture of scientific facts, arguing that modern scientists, as a rule, do not deal with single experiments in the context of a properly delineated theory. Experimental scientists deal with clusters of experiments that are usually not well defined and do not provide definitive answers. In a permanently

changing and varying pattern, experimental systems combine elements which historians and philosophers of science have long sought to separate: Research objects, theories, technical arrangements, instruments as well as disciplinary, institutional, social, and cultural dispositifs. In addition to looking at such assemblages, an analysis of how different experimental systems interact will provide insight into the developmental dynamics of broader fields of science.

Focusing on the details of experimental practice, recent studies have made clear that, in order to account for the epistemic variety, one needs to differentiate several levels of conceptualization. Experiment is only possible by relying on certain instruments, procedures, and concepts that are taken as unproblematic. At the same time, scientific activities and conceptualizations are in constant attunement to each other as the experimental process unfolds. Focusing on these processes, a specific type of experimentation becomes delineated: the exploratory experiment. It follows distinct guidelines and epistemic principles. In many cases, moreover, it leads to the revision of existing concepts and the formation of new concepts that creates a stable and general expression of the experimental results. The study of concept formation in experimental contexts promises new insights into the epistemic dynamics of experimental research.

A claim to knowledge within a certain system of research may be found in time—by various means—to be erroneous. But the variety of what "error" or, more generally, "going wrong" may mean is huge and has so far only insufficiently been studied under an epistemological perspective. At the same time, we might gain significant insight into the epistemic dynamics of experiment by asking what constitutes an error within an experiment. There is a close connection between epistemological framework and methodological approach on the one hand, and the detection and characterization of error on the other. Furthermore, what counts as an error is as much dependent on the individual experiment as on the wider system in which it has been designed and conducted. Again one is directed away from the individual experiment to a broader system. To explain the underlying phenomenon of error, the very structure of the system has to be taken into account. Studies of error can therefore demonstrate how the system functions.

Generating Experimental Knowledge

Exploring Implicit Memory: On the Interrelation Between Operationalizations, Concept Formation, and Experimental Artifacts

Uljana Feest (Research Scholar)

Uljana Feest

Uljana Feest's research is divided into three—partially overlapping—projects. The first is on the relationship between the emergence of Gestalt psychology and the philosophical movement that later became known as "logical positivism" or "logical empiricism" during the time of the Weimar Republic. The second project looks at the historical context of the emergence of the dichotomy between *Erklären* and *Verstehen* in philosophical and scientific debates about the role and approach of the human sciences. Finally, Uljana Feest looks at epistemological issues in the history and philosophy of 20th century psychology and neuroscience.

The issue of the relationship between methodological and conceptual decisions lies at the heart of all three projects. Within the project on Generating Experimental Knowledge, Feest has been working on a book project, entitled Operationism, Experimentation, Concept Formation. In it, she focuses on the methodological concept of operationism within psychology. The concept itself has a history that she traces back to early 20th century American psychology. However, apart from history, Feest is also interested in the ways in which the concept might be used to address systematic questions that have been raised within epistemology of experimentation. The thesis underlying the work is that all experiments require an operationalization, and that operationalizations require some presuppositions about the subject matter under investigation. While scientists frequently refer to such presuppositions as "definitions," Feest shows in her work that such definitions have a pragmatic and temporary status. They can alter as the research proceeds. The thesis is developed and illustrated by means of a case study that looks at research on the purported phenomenon of implicit memory within cognitive psychology and neuropsychology from the early 1980s to the mid 1990s.

Generating Experimental Knowledge

Science in Crisis and Progress

Igal Dotan (Postdoctoral Fellow, University of Haifa, Israel)

Igal Dotan

The project is a philosophical and historical case study of the experimental exploration of the evolutionary theory of aging. This research program was initiated in the late 1970s by Michael Rose and Brian Charlesworth, a prominent evolutionary biologist from the University of Sussex. They were stirred by a bold yet poorly studied theory of organismal aging put forward by Peter Medawar and George Williams. According to the theory, aging is the consequence of the declining force of natural selection with age. Late life deleterious mutations escape selection, accumulate and cause the protracted overall decline of bio-performance.

The system designed by Rose was based on experiments in which populations of fruit flies are subjected to various kinds of selection regimes. However, as is often the case with new experimental systems devised to explore a yet unstudied phenomenon, it soon became clear that in spite of carefully crafted conditions the new system yielded contradictory data and was riddled with artifacts. After more than two decades of selection experiments with *Drosophila*, participants agree that a great deal was learned, and that at the same time much remained highly questionable.

The picture revealed by the historical study seems to be at odds with the widely accepted empiricist view of scientific research that equates scientific knowledge with empirically justified information. The philosophical analysis of the episode follows Karl Popper's basic idea according to which explanation and confirmation, *qua* scientific aims, are in methodological conflict. In order to initiate and to maintain a research program researchers are often willing to sacrifice empirical adequacy for explanatory depth. Two eminent critics of Popper have characterized and studied this "bootstrapping" dynamics: Joseph Agassi and later Mario Bunge. In his case study, Dotan employs the bootstrap operation view to show how programmatic thinking and action interact in experimental work to produce scientific knowledge that is controversial *and* progressive.

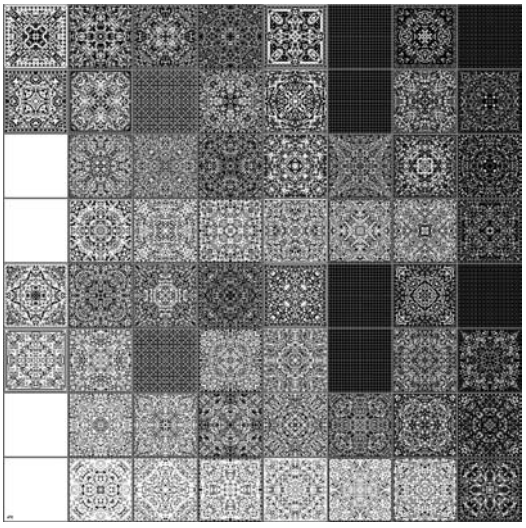
Generating Experimental Knowledge

Complexity, Computation, and Virtual Experiment, 1960–2000

Lambert Williams (Predoctoral Fellow, Harvard University, U.S.A.)

Lambert Williams

Thinking that the world is governed by natural laws written in mathematical language has a long, venerable and complicated history. But what sort of laws? For Galileo at least, it was obvious that God had not only written the universe in mathematical language, but that conceivably this language would be *simple*. Down to today, this idea that the universe might be fundamentally simple, whether at the level of grand cosmology or of minute quanta, has persisted. And yet alongside this, another vision has emerged which the project of Lambert Williams aims to disentangle. This is a vision which considers that certain systems—and examples run a heterogeneous gamut from ant foraging, to brains, to cities, to financial markets—have in some way an irreducible dimension of *complexity*. This all-important yet slippery word, taken from everyday language and not lending itself to any obvious formal definition, has given rise to a range of responses. Some have verged on mysterianism: Physicist Eugene Wigner, writing in 1960, asserted that 'the world around us is of *baffling complexity* and the most obvious fact … is that we cannot predict the future.' Yet whereas some have read an impediment, others sensed an opportunity. There is by now a community—counting among its members such people as Doyne Farmer, John Holland, and Stuart Kauffman—who are interested precisely by the lack of any tight definition, and are drawn in by the deep potential for bafflement; such depth is deemed worthy of a new science. Approaching the big question of complexity by reference to further notions such as emergence, feedback and organization, and often relying heavily on the computer, they and other researchers at such institutions as the Santa Fe Institute have attempted to launch a concrete science of complexity. Framing the emergence and dispersion of complexity science from 1960 to 2000 as a 'quasi-discipline,' Williams's project insists from the outset that attention be paid to connections between this new archipelago of ideas and what arguably are the indispensable aspects of both computational practice and virtual experiment. At root, this dissertation studies mathematical modeling techniques as inextricably tied to the tools available.



64 elementary bi-dimensional binary cellular automata with 1 white central starting point. (Copyright granted by Jean-François Colonna, CMAP (Centre de Mathematiques Appliquées)

Generating Experimental Knowledge

Experimentation and Experimental Error in Scientific Debates and in the Area of Generative Linguistic

Gábor Zemplén (Postdoctoral Fellow, Budapest University of Technology and Economics, Hungary)

Gábor Zemplén

In connection with the research group "Generating Experimental Knowledge," Gábor Zemplén has been exploring the epistemological relevance of experimentation and experimental error in disciplines where the historical development of the field has not prepared the researchers for tackling the difficulties arising from the process of experimentation. He has written and co-authored articles on the assessment and interpretation of experimentation and experimental error in the area of generative linguistics (or biolinguistics).

Concerning his main research topic at the MPI, he has been studying the use of experimental descriptions as arguments in scientific debates, especially the 17th century debate around modificationist theories of color and Newton's theory of light and colors.

Generating Experimental Knowledge

Projects of Short Term Guest Researchers

- *Thomas Dohmen* (University of Haifa, Israel): "Context and Error in the Epistemology of Scientific Experiment"
- *Giora Hon* (University of Haifa, Israel): "History of the Concept of Symmetry"
- *Jutta Schickore* (University of Indiana, Bloomington, U.S.A.): "Revisiting Discovery and Justification: The Context Distinction in Historical and Philosophical Perspective" (Book project with Giora Hon and Friedrich Steinle)

Activities Related to the Project

- Workshops:
  First Group Meeting, Berlin, July 12–13, 2004.
  Second Group Meeting, Berlin, December 6–7, 2004.
  "Error in Experimental Science" Workshop, Haifa, May 8–10, 2005.
  Third Group Meeting, Berlin, November 25–26, 2005.
- Book:
  Giora Hon, Jutta Schickore, and Friedrich Steinle (eds.), *Going Amiss*. Cambridge: MIT Press, in press.

Individual Projects of the Department

Project

The Senses of the Observer

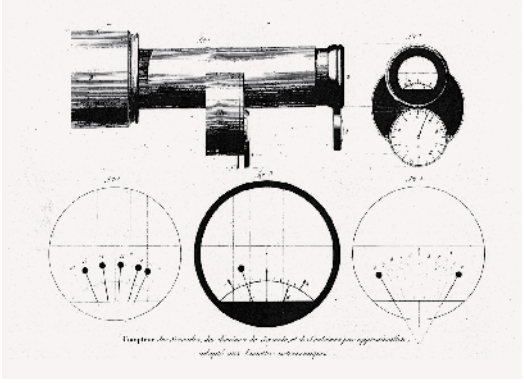
Christoph Hoffmann (Research Scholar)

Christoph Hoffmann

The research project focuses on the conceptualization of the human senses in different practices of observation during the period between 1750 and 1830. The domains analyzed include the measuring procedures in optics (photometry), astronomy (transit observations, determinations of longitude), and physiology (duration of the afterimage; acuity of the sense of touch). The resulting book *Unter Beobachtung* (Göttingen: Wallstein Verlag, 2006, in press) rests on three major arguments.

A fundamental shift in the understanding of the senses took place at the beginning of the 19th century. In the century before that, the use of the senses in observation was primarily conceptualized in terms of training, education, the correct application of appropriate methods, and an awareness of inadequate conclusions from the judgment of the senses. At the beginning of the 19th century, the emphasis was placed on unconscious errors due to the functioning of the sense apparatuses themselves. This shift was closely related to a transformation in the apprehension of scientific instruments.

As a consequence, a new regime of control was established. It was oriented toward the measurement of the errors stemming from both the instruments of observation and the senses of the observer, partly by means of mathematical reckoning, and partly by means of special routines of experimentation and observation. Both the instruments of observation and the senses of the observer were practically handled in the same way in the new regime of observation. The senses were defined as apparatuses whose errors could be calculated in the very same manner as the errors produced by clocks or telescopes.



Compteur des Secondes, des dixièmes de Seconde, et de Centièmes par approximation adapté aux Lunettes astronomique (Abraham-Louis Breguet). Annales de Chimie et de Physique, Vol. 10, 1819

From this point of view, the conceptualization of the human senses with respect to functions of instruments and technologies

such as telegraphy, telephone, or photography, which dominated the research practice in sensory physiology in the second half of the 19th century, appears in a new light. Broadly speaking, the symmetrical approach to the senses and the instruments of observation created the ground for a new type of experimentation, in which instruments and apparatuses became physically comparable to sensory functions and vice versa.

Project

Epistemic History of Children's Drawings, 1880–1930

Barbara Wittmann (Postdoctoral Fellow, Universität Trier, Germany)

Barbara Wittmann

The research project investigates the emergence of the scientific interest in children's drawings and their instrumentalization as diagnostic tools between the late 1880s and the 1920s. Before 1880, children's drawings were not considered to be of any aesthetic or heuristic value. Soon after, they became a major diagnostic device in psychological analysis. Barbara Wittmann tracks the successive interest that psychologists, pedagogues, historians and art historians took in children's drawings as scientific objects and psychological instruments. In three case studies, she focuses on the various kinds of methods, techniques and tests developed to "read" what had theretofore been regarded as "meaningless."

Georg Kerschensteiner: Die Entwickelung der zeichnerischen Begabung, München: Gerber, plate 37, Library B. W., 1905

The first case study deals with the very emergence of children's drawings as *scientific objects*, namely with the earliest publications on and exhibitions of children's drawings, such as the exhibition "Das Kind als Künstler" (Hamburger Kunsthalle in 1898) and the writings of the art historian Corrado Ricci, the psychologists Bernard Pérez and James Sully, and pedagogues such as Ebenezer Cooke and Georg Kerschensteiner. The collection and exhibition of children's drawings were not only the major tools by which their "discovery" was materially accomplished, but also a formative epistemological condition. Through the order and virtual analysis of the *tableau* the "art of little children" underwent a process of purification and preparation which enabled its instrumentalization as an experimental and diagnostic instrument.

The second and third case studies investigate the implementation of the drawing child in psychological experiments and tests. In the laboratories (and nurseries) of James Mark Baldwin, William Stern and Ernst Meumann, the scribbling of infants was used to explore the functional cooperation of eye, hand and mind, the development of the spatial perception or the origin of handwriting. Children's drawings were

considered to act as embodied curve plotters visualizing and recording psycho-physiological functions at the same time. The practical definition of scribbling as *écriture automatique* became a major condition for its use as diagnostic tool in psychometrics and psychoanalysis.
In the 1920s, the "artistic production" of children was finally believed to reveal hidden secrets, to show proof of the child's intelligence and social development, to document its psychoanalytic dispositions and symptoms. This typically modernist paradigm was not only the product of the rapid accumulation of knowledge about drawing children, but also a consequence of an experimental set-up of which scribbling had become part in the laboratories of psycho-physiology around 1900.

Project

Müller's Lab

Laura Otis (Visiting Scholar, Emory University, U.S.A., McArthur Fellow)

Laura Otis

"Müller's Lab" is an interdisciplinary book that combines the research techniques of the history of science with those of literary analysis. In this multi-perspective study of science in Berlin, 1833–58, Laura Otis compares seven renowned scientists' descriptions of their advisor, Johannes Müller. Jakob Henle, Theodor Schwann, Emil du Bois-Reymond, Hermann von Helmholtz, Rudolf Virchow, Robert Remak, and Ernst Haeckel left very different portraits of Müller, and by studying their reasons for representing him as they did, Otis aims to show how scientists' ongoing work and career choices have colored their accounts of the past.

To produce a picture of each scientist's own work as well as his representation of Müller, Otis is using personal letters, published and unpublished, scientific writings, and, when available, statements about Müller in eulogies and popular lectures. Historians Gabriel Finkelstein and Nicholas Jardine have noted how Emil du Bois-Reymond and Rudolf Virchow consciously shaped their narratives of Müller to serve their own academic interests, but until now, no historian has systematically compared multiple accounts of one advisor to demonstrate how scientists' personal interests have created the history of science.

By juxtaposing seven successful scientists' accounts of their advisor, however, "Müller's Lab" offers much more than narrative analysis. A second aim of the project is to show how personal interactions among scientists affect their decisions about which fields to enter and which experiments to undertake.

Project

The Popular Science Book: A New Genre Between Literature and Science in the Late 19th and Early 20th Century

Safia Azzouni (Postdoctoral Fellow)

Safia Azzouni

In Europe, popular science books emerged during the second half of the 19th century. The project explores the role these books played in the transfer—and the production—of knowledge. By studying the different ways of writing popular science around 1900, Azzouni's aim is to trace the interaction of experts, amateurs and laypeople. Popular science books were not only written by scientists who wanted to make their work accessible to a broad public, but also by literary authors. Accordingly, the question arises to which extent the genesis of the popular science book is linked to the literary movements of the time.

Over the course of the 19th century, the interest that writers took in scientific experimentation and innovation constantly increased. The French critic Hippolyte Taine established a positivist literary theory by naming "la race, le milieu et le moment" as determinants of human life and artistic production. His reference to Darwinism is obvious. Emile Zola modeled his theory of the "Roman Expérimental" upon Claude Bernard's "Médecine Expérimentale." The French naturalistic movement in turn influenced German literary circles. Literary naturalism reinforced the claim to truth and objectivity already pronounced by realistic writers like Honoré de Balzac and Theodor Fontane.

Title page of "Vom Bazillus zum Affenmenschen" (1900), one of Wilhelm Bölsche's numerous popular scientific publications. Wilhelm Bölsche: Vom Bazillus zum Affenmenschen. Naturwissenschaftliche Plaudereien. Leipzig: Diederichs, 1900

Along with these movements, various means of popularizing natural science developed in Europe due to political and educational views. Several writers engaged in this enterprise. Azzouni's research project is centered upon exemplary case studies from the continental context of popular science. Through a close reading of popular science writings, she attempts to reveal patterns and techniques of communicating science as well as their preconditions. Among the writers dealt with in this project are the theorist of naturalism Wilhelm Bölsche, the mathematician, physicist and philosopher Kurd Laßwitz, the Belgian symbolist dramatist Maurice Maeterlinck, and the naturalist writer Johannes Schlaf.

Project

The Uses of Theory in Studies of Brain and Mind, 1930–1960

Tara Abraham (Postdoctoral Fellow, University of Toronto, Canada)

Tara Abraham

Tara Abraham's postdoctoral project was concerned with the emergence of theoretical methods in studies of brain and mind in the U.S.A. during the twentieth century. The use of theory in this context was connected to debates about the complexity of biological phenomena, the autonomy of biology from the physical sciences, and arguments about the unity of the sciences. Many physicists, mathematicians and cyberneticians saw the complexity of living processes—particularly those of the central nervous system—as justification for the use of mechanical analogies and theoretical methods to address problems in the life sciences.

The main focus of the project was on the work of cybernetician Warren S. McCulloch. It investigated the transdisciplinary nature of the cybernetics movement and the power and controversy surrounding the cybernetic discourse that emerged during the 1940s and 1950s in the American context. At the heart of this discourse was the concept of negative feedback. Negative feedback served to unify the physical and the biological: cyberneticians saw goal-directed behavior as a shared property of certain types of machines and organisms, and the underlying mechanisms in their purposeful behavior were seen to involve negative feedback. With their characterization of negative feedback as a concept common to physical, biological, and social systems, cyberneticians aimed to transcend disciplinary boundaries, and McCulloch exemplifies this movement.

Project

Electronic Imaging and Cell Biology, 1945–1995

Nancy Anderson (Rathenau Postdoctoral Fellow, Stanford University, U.S.A.)

Nancy Anderson's postdoctoral project was devoted to a study on electronic imaging and cell biology, 1945–1995. The first part of the study covers the 1950s and the introduction of the television-microscope—the precursor to video microscopy—as well as initial uses of the computer for cell sorting and the development of pattern recognition programs. It is introduced by a discussion of the interwar uses of electronics (photomultipliers) in research on cells. The second part covers electronic instrumentation introduced to cell biology in the 1960s, such as the image intensifier and digital computing programs. It focuses on media shifts from photography and cinema to video and the rise of systematic image processing in the laboratory. The study of systems for analyzing living cells is of central interest in the project.

Another part of the study has been devoted to the history of Green Fluorescent Protein (GFP) as the first successful transgenic fluorescent reporter molecule. This study begins with a description of various applications of bioluminescence in experimentation and as biological assays in the interwar period, and then concentrates on the discovery of GFP in a jellyfish in the 1960s and the first experiments introducing the protein's gene into exogenous genomes in the 1990s. It addresses the success of fluorescence light microscopy during the second half of the 20th century, but also emphasizes that the meager light offered by these fluorophores could not have made such crucial contributions to cell biology without the assistance of electronic imaging systems.

Project

Minimum Measures

Dana Simmons (Postdoctoral Fellow, University of Chicago, U.S.A.)

Dana Simmons

Dana Simmons's postdoctoral research project explored the intersections between science and economy in modern France. It focused on a new paradigm for measuring the human economy: the minimum standard of living. In the late 19th and early 20th centuries, a complex of concepts emerged for quantifying and normalizing life functions. Minimum standards fixed quantities of food, air and other consumer goods deemed necessary to sustain life. The project developed the claim that by the twentieth century, a wide field of measurement and intervention focused specifically on the consuming body. Its practitioners shared a common program: to maintain bodily functions at the lowest possible expense of goods and money. Consumption and waste became the object of intensive scientific optimization.

Minimum measures inflected many facets of daily existence: dietary standards and school lunch programs, building codes and migrant housing, need-based welfare and the poverty line. Within this landscape, the project examined the history of four strategic fields: the science of nutrition, wartime rationing, the minimum wage, and domestic architecture. Chemists formulated scientific standards for dietary intake and breathable air. State administrators quickly grasped these measures and applied them to non-productive, institutionalized populations in schools, hospitals and prisons. By the 1950s, minimum wage laws exposed the national working population to state-organized consumption.

Project

Sciences of the Soul and Mind in France, Late 19th and Early 20th Century

Sofie Lachapelle (Postdoctoral Fellow, University of Notre Dame, U.S.A.)

Sofie Lachapelle

During her postdoctoral stay, Sofie Lachapelle worked on a number of case studies in the context of her project. The first was on the nineteenth-century Belgian stigmatic Louise Lateau (1850–1883), her phenomena and interactions with both the Church and the scientific community. More generally, she explored the scientific scrutiny under which such physical manifestations of religiosity were put in the second half of the nineteenth century. The study deals with the authority of physiological and pathological explanations in the face of religion, and tells a story of people caught between faith and science, between miracle and sickness.
The second case study focused on the creation and early years of the Institut Métapsychique International (IMI). In 1919, the IMI held its first meeting in Paris. With their choice of a name, the founders made their intentions clear; by using the term *métapsychique* rather than the more commonly used *sciences psychiques,* they indicated a departure from previous enterprises of such kind in France. The study analyzes the first twelve years of the IMI in its attempts to impose a program of research and to incorporate psychical phenomena into the scientific corpus in specific ways.

The third case study concerned the schools that were developed for idiots in 19th-century France. It deals with the treatment of idiots in the alienist circles from the perspective of the relationships between the educational theories and both the physical places and structural organization from which they emanated and to which they led. If only a few alienists encouraged the education of idiots at the beginning of the nineteenth century, with time, more sophisticated methods of instructing idiots and more specific ideas on the goals that could be attained in such an enterprise were enunciated.

Project

History and Anthropology of Premature Babies Care in Post WWII France

Olivier Thiery (Postdoctoral Fellow, Ecole Nationale Supérieure des Mines, Paris, France)

The research project concerns the contemporary history and the ethnology of the care of premature babies—a part of which is called "neonatology"—in France. The project has a historical and an anthropological part. The main purpose of the historical work is to identify the genealogy of the construction of a medical object: the

premature baby. Already during the first part of the 20th century, obstetricians—in France, Germany, and the United States—took care of very low birth-weight infants. Feeding, thermoregulation in the first incubators, and prevention of infections were the main aspects of their care during this period. However, it is only after the Second World War that the premature baby emerges as an object in itself. With a new definition, by age and not by weight, a new alliance between research in physiology and clinics became possible.

The second part of the project consists in an ethnological fieldwork of four months in a French Neonatal Intensive Care Unit for premature babies, using the methods of micro-sociology (observations, discussions, analysis of documentation). At a first level, this inquiry aims to realize an extensive description of the daily care of premature babies. At a second and more problematic level, by following some cases in detail, the project serves to characterize the care of premature babies as a risky experimentation with life.

Upcoming Project

In the fall of 2006, a new project on "Emerging Knowledge—Drawing and Writing as Research Procedures" will be launched. The project will be directed by Christoph Hoffmann and Barbara Wittmann. Part of the funding will be provided by the Fritz Thyssen Stiftung. The project will investigate the activities of drawing and writing as knowledge-directing procedures characteristic of modern science. It starts from the premise that the highly variable interactions of hand, pencil, and paper do not merely serve to secure what is already there in thought, but also to engender knowledge effects that are closely bound to the procedural practices of drawing and writing. Even in the age of technoscience, simple sketches and notations continue to mediate between perception and reflection, between securing facts and the generation of hypotheses. As means of representation, they delineate the critical domain of preliminary and probing action in which more or less stabilized facts arise from raw data that are more or less opaque. This process in which objects of experience are formed in the very act of writing and drawing shall be analyzed in exemplary case studies spanning from the sciences and the humanities to literature and art (ca. 1750 to 2000).

Short Term Visits of Former Fellows and Their Projects

- *Rodolphe Gasché* (State University of New York at Buffalo, U.S.A.): "Jan Patocka's Care of the Soul and Edmund Husserl's Lebenswelt"
- *Birgit Griesecke* (Universität Bonn, Germany): "The Foreignness of Science"
- *Jens Lachmund* (Universiteit Maastricht, The Netherlands): "The Making of an Urban Ecology. Biology and Wildlife Protection in Post WWII Berlin"
- *Andreas Mayer* (University of Cambridge, U.K.): "The Study of Human and Animal Locomotion Systems: Rise and Fall of Etienne Jules Marey's Physiological Station"
- *Alexandre Métraux* (Universität Mannheim, Germany): "Art Machines"

Other Short-Term Visitors

- *Jenny Beckman* (Uppsala Universitet, Sweden): "Crossing Borders in the Kingdoms of Nature: Amateurs in Science"
- *Rüdiger Campe* (Johns Hopkins University, Baltimore, U.S.A.): "Procedures and Techniques of Writing and Notation in the 17th and 18th Centuries"
- *Markus Christen* (Universität/ETH Zürich, Switzerland): "History of Neural Coding and Neural Computation"
- *Paul Forman* (Smithsonian Institution, Washington, DC, U.S.A.): "Apprehending Postmodern Science"
- *Tania Munz* (Princeton University, U.S.A.): "Of Birds and Bees: Karl von Frisch, Konrad Lorenz and the Science of Animals in Germany"
- *Jahnavi Phalkey* (Georgia Institute of Technology, U.S.A.): "History of Scientific Instruments and Practices in India, ca. 1930–1970"
- *Christina Ratmoko* (Universität Zürich, Switzerland): "The Essence of Femininity and Masculinity: The Industrial Making of Sex Hormones and their Therapeutic Use from 1910 to 1940"
- *Alexander von Schwerin* (Research Program "History of the Kaiser Wilhelm Society in the National Socialist Era"): "Radioactivity and Biological Research in Germany, 1920–1970"
- *Leo Slater* (Johns Hopkins University, U.S.A.): "History of Malaria Chemotherapy in the 20th Century"
- *Heiko Stoff* (Research Program "History of the Kaiser Wilhelm Society in the National Socialist Era"): "Research on Enzymes, Hormones, and Vitamins in Germany, 1920–1970"