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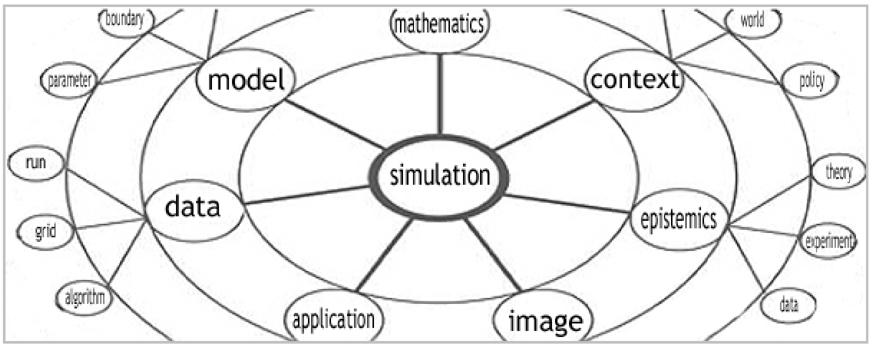

Gabriele Gramelsberger

The Societal and Cultural Influence of Computer Based Simulation – Towards a Philosophy of Computational Sciences

Blankensee-Colloquium 2007

at the Berlin-Brandenburg Academy of Science and Humanities

20. to 22. September 2007

Blankensee-Colloquium 2007, from 20. to 22. September 2007
BBAW Berlin-Brandenburg Academy of Science and Humanities
Dr. Gabriele Gramelsberger, FU Freie Universität Berlin, Institute of Philosophy

Programme Blankensee-Colloquium 2007, 20.-22.09.200, BBAW Berlin

Thursday, 20th of September 2007, 5:00 to 8:00 pm

5:00 pm

Opening

Prof. Dr. Kurt Kutzler, President of the Technische Hochschule Berlin

Prof. Dr. Sybille Krämer, Institute of Philosophy, FU Berlin / Permanent Fellow, Wissenschaftskolleg - Institute for Advanced Study, Berlin

5:30 pm

Key Note Lecture: Digital Labscapes: How Simulation Produces Knowledge

Prof. Dr. Martina Merz, Institute of Sociology, University of Lucerne

7.00 pm

Evening Lecture: When Computers Were Human

Prof. Dr. David Alan Grier, Center for International Science and Technology Policy, George Washington University

Welcome Buffet, 8 pm

Friday, 21st of September 2007, 10:00 am to 7:00 pm

10:00 am – 12:30 am

Panel 1: Philosophical Remarks on the Rationality of Quantification

Roots and media of computational power. Some remarks on the genesis and genius of quantification in early European Modernity, Prof. Dr. Sybille Krämer, Institute of Philosophy, FU Berlin / Permanent Fellow, Wissenschaftskolleg - Institute for Advanced Study, Berlin

Terminus Medius – On the Ambivalence of Simulation, Dr. Nils Röller, HGKZ School of Art and Design, Zurich

Steps and Missteps in the Process of Quantifying Nature, Prof. Dr. David Alan Grier, Center for International Science and Technology Policy, George Washington University

1:15 – 7:00 pm (coffee break 4:00 - 4:30 pm)

Panel 2: The Infrastructure of a Culture of Calculation

The Impact of Petacomputing on Theories and Models, Prof. Dr. Dr. Thomas Lippert, Director of the Central Institute for Applied Mathematics at the German Research Centre Juelich / Member of the Board of Directors of NIC John von Neumann Institute for Computing

Supercomputing: A new era of opportunity and challenges, Dr. Alan Gara, IBM Chief Architect Blue Gene, J. Watson Research Center, Yorktown NY, USA

Predicting versus Shaping Reality by Mathematical Simulation and Optimization, Prof. Dr. Ulrich Trottenberg, Director of the Fraunhofer Institute for Algorithms and Scientific Computing, St. Augustin

Panel 3: Shaping Reality with Algorithms: Earth System, Cells and the Human Brain

Shaping Reality with Algorithms: The Climate System, Dr. Johann Feichter, Head of the Research Group "Aerosols, Chemistry and Climate" at the Max Planck Institute for Meteorology, Hamburg

The Blue Brain Report, Prof. Dr. Henry Markram, Project Director of the Blue Brain Project / Director of the Center for Neuroscience & Technology, EPFL Lausanne

Simulations of the Circadian Clock, Prof. Dr. Hanspeter Herzel, Institute for Theoretical Biology, Humboldt University

Saturday, 22nd of September 2007, 10:00 am to 6:30 pm

10:00 am – 12:30 am

Panel 4: The Artificial Nature of a Technoscientific World

Syntheses of artifacts to simulate the natural, Prof. Dr. Sergio Sismondo, Department of Philosophy, Queen's University, Kingston

Predicting and Explaining with Simulations: Perspectives from Public Health Research and Policy-Making, Dr. Erika Mattila, Economic History Department, London School of Economics and Political Sciences

Artificial, False, and Performing Well, Dr. Johannes Lenhard, ZiF/University of Bielefeld

1:15 – 6:30 pm pm (coffee break 4:00 – 4:30 pm)

Panel 5: Loops between Methods: Simulation, Experimentation, and Measurement

Loops between Simulation and Experimentation, Dr. Gabriele Gramelsberger, Institute of Philosophy, FU Berlin

Mountains in the Lab: Models, Experiments, and the Problem of Scale, Dr. Thomas Brandstetter, Institute of Philosophy, University of Vienna

Constructivist Computing for Empirical Modelling, Prof. Dr. Steve Russ, Department of Computer Science, Warwick University (statement)

Panel 6: Rational Prognosis, the Management of Uncertainty and Future II

Research technology, the computer and scientific advance, Prof. Dr. Renate Mayntz, Max-Planck-Institute for the Study of Society, Cologne (statement)

Particle Histories. Herman Kahn and the 'Conceiving of the Unthinkable', Prof. Dr. Claus Pias, Institute of Philosophy, University of Vienna

Preemptive Culture: its computational significance, historical origins and strategic epistemology, Martin Carlé, Institute for Media Science, Humboldt University Berlin (statement)

Uncertainty in Grammar. Predictions and the Future in the Past, Dr. Peter Bexte, Institute for Media Sciences, University for Applied Sciences, Potsdam

Discussion: The Societal and Cultural Influence of Calculation: The Mathematisised View of Science – Towards a Philosophy of Computational Sciences

Moderation: Prof. Dr. Ulrich Wengenroth, Director of the Munich Center for the History of Science and Technology, c/o Deutsches Museum/ TU Munich

Date: Thursday, 20. September 2007 – Saturday, 22. September 2007

Location: Einstein Hall at the BBAW Berlin-Brandenburg Academy of Science and Humanities, Jaegerstraße 22/23, 10117 Berlin-Centre

Language: Englisch

Organised by: Gabriele Gramelsberger, FU Berlin

Funded by: Kooperationsfond / Institute for Advanced Study Berlin

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Reader

The Societal and Cultural Influence of Computer Based Simulation (Simulation als Kulturtechnik) – Towards a Philosophy of Computational Sciences

Blankensee-Colloquium 2007, 20.-22.09.2007, BBAW Berlin

Introduction to the colloquium

„*Computational Science is synonymous with the exploration of complex systems; its instrument is the super computer, its method is simulation. … it looks at the big unsolved scientific problems. Its importance and impact on managing the future challenges the scientific disciplines as well as the society. The identification of such problems has led in the US to the classification as `Grand Challenges to Computational Science´ to which today's questions in the area of atmospheric chemistry (e.g. environmental sciences), astrophysic, material sciences, molecular biology, high energy physics and aero dynamics can be counted*." [1]

The epoch-making influence of the numerical simulation for science becomes clear from a philosophical perspective if one is willing to follow the idea of Martin Heidegger that the "*fundamental event of modernity is the conquest of the world as picture. From now on the word "picture" means: the collective image of representing production* (*das Gebilde des vorstellenden Herstellens)* … [Therefore] *humanity sets in motion, with respect to everything, the unlimited process of calculation, planning, and breeding. Science as research is the indispensable form taken by this self-establishment in world; it is one of the pathways along which, with a speed unrecognized by those who are involved, modernity races towards the fulfillment of its essence*."[2] Within this perspective the essence of simulation based science can be characterised as "the collective image of representing production" (modelling), using the "unlimited process of calculation" (calculation) and producing " world pictures" (visualisiation). In 1938 when Heidegger wrote "The Age of the World Picture" neither the computer or the method of simulation was widely discussed - Alan Turing had just published his paper "On Computable Numbers" and early computer pioneers had begun to develop ideas of electronic computing devices[3] - nevertheless, the priorisation of the mathematical-modelling approach, describable with differential equations, was already fully introduced into science by Isaac Newton's "Philosophiae Naturalis Principa Mathematica" as "the collective image of representing production" in Early Modern Science.

In this tradition the numerical simulation proves to be a decisive trajectory of Modern Times whose dynamic has been accelerating since the 1940s. John von Neumann, a key figure of this acceleration, wrote in May 1946: "*Our present analytical methods seem unsuitable for the solution of the important problems arising in connection with non-linear partial differential equations and, in fact, with virtually all types of non-linear problems in pure mathematics. The truth of this statement is particularly striking in the field of fluid dynamics. Only the most elementary problems have been solved analytically in this field. … In pure mathematics we need only look at the theories of partial differential and integral equations, while in applied mathematics we may refer to acoustics, electro-dynamics, and quantum-mechanics.*

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[1] Hoßfeld, F.: „Grand Challenges" - wie weit tragen die Antworten des Supercomputing?, KFA-ZAM-IB-9117, German Research Center Juelich, 1991: 1

[2] Heidegger, Martin: The Age of the World Picture (1938), in: The Beaten Track (edited and translated by Julian Young and Kenneth Haynes) Cambridge University Press, 2002, 57-85: 71

[3] Turing, Alan M.: On Computable Numbers, with an Application to the Entscheidungsproblem, Proc. of the London Mat. Society, Series 2, 42/1936–37: 230–265; Zuse, K.: Der Computer – Mein Lebenswerk, Berlin, 1993

The advance of analysis is, at the moment, stagnant along the entire front of non-linear problems."[4]

It was this stagnation in science due to the limitations of analysis which gave rise to the urgent need for numerical methods, calculation, and the automatisation of computation. John von Neumann described his motivation for his concern with computation and simulation by observing a „peculiar" kind of experimentation used to counterbalance the lack of computation power. These experiments didn't aim *"… to verify a proposed theory but to replace a computation from an unquestioned theory by direct measurement. Thus wind tunnels are, for example, used at present, at least in large parts, as computing devices of the so-called analogy type … to integrate the non-linear partial differential equations of fluid dynamics. … It is an analogy (i.e. measurement) method, to be sure. It seems clear, however, that digital wind (in the Wiener – Caldwell terminology: counting) devices have more flexibility and more accuracy, and could be made much faster under present conditions. We believe, therefore, that it is now time to concentrate on effecting transition to such devices, and that this will increase the power of the approach in question to an unprecedented extent."*[5]

The „digital wind tunnel" in particular, the method of numerical simulation in general, are methods of applied mathematics which were utilised by John von Neumann for digital computing in the 1940s to resolve stagnation in science and to make the mathematical-modelling approach applicable for science and engineering. To simulate means to create mathematical models based on scientific theories, to discretise and to equip them with parameterisation and boundary conditions, and, last but not least, to initialise their recursive computation by measurement values. The simulation's target is to execute experimental runs on the mathematical model achieving "in silico" data. Thereto the differential quotients of the differential equations are replaced by difference quotients and solved for a finite grid of computing points under abidance of stability conditions. The results initialise the next run through the model and in so doing the simulation moves forward into time – unfolding its future scenarios, optimisation and extrapolation. From the beginning one of the key aspects was the "unlimited force of computing" as von Neumann pointed out frequently in his work. The sheer quantity of numerical operations, already heralded at the end of the 1940s, is the basis of the simulated "collective image of representing production", its forecasts and technological implementations. Recent super computers perform more than 240.000 trillion operations per second. For what today would take a super computer a number of days, the first automatic computation machines would have required millions of years.

This development led to the establishment of numerical simulation in science as an independent method of research aside from theory, experiment and measurement. Simulation as a new method is revolutionising science as "computational science" – and in the future as "converging technologies" – and raises the importance of computing power more than ever. [6] Actually, the reconstructing of science implicates the establishment of new departments (Departments of Computational Physics, Computational Chemistry, Computational Biology, etc.), of new infrastructures (grid computing), of new forms of data (in-silico data) and of the computnic race for the brute force of calculation *(Panel 2: The Infrastructure of a Culture of Calculation)*.

[4] Goldstine/Neumann, 1963: 2

[5] Goldstine, Herman H./Neumann, John von: On the Principles of Large Scale Computing Machines (May 1946), in: Taub, A.H. (ed.): John von Neumann: Collected Works, Vol. V: Design of Computers, Theory of Automata and Numerical Analysis, Oxford et al. 1963, 1-32: 4

[6] More than 61% of the worldwide top 500 computing power is situated in the United States of America, only 17% is located in Europe. http://www.top500.org

Towards a „Philosophy of Computational Sciences“

Framing the topic of simulation based science within a broader context the following questions are posed:

1) What role does numerical mathematics play in today's science and technology?
2) Which societal and cultural influences are deployed by calculation based science and technology?
3) How is it possible that mathematics can shape reality? Or, in other words: What are the consequences of the concept of „calculability“ and a culture of calculation?

There is a long ongoing tradition in philosophical discussion on mathematical issues such as logical structures of argumentation, axiomatic and algorithms but these discussions mostly address concepts and problems of pure mathematics raising hopes, as Henri Poincaré pointed out, of getting insights into the "essence of human thinking".[7] Theory of Science explores the structure of scientific theory and mathematical modelling but pays little attention to numerical applications. Science and Technology Studies have developed the term of "qualculation" during the last few years but up until now appropriate investigations on this topic are hard to find.[8] A „Philosophy of Computational Sciences“ addresses exactly these by now often neglected themes of numerical applications and their applicability and implementation into society and Lebenswelt. The core of such a philosophy is to study the possibilities and limitations of today's numerical mathematics but also its potential of shaping reality with numbers, in particular against the background of the vast increase in computing power and software applications.

- Investigations on conceptual shifts introduced by mathematics (philosophy)

Rereading philosophy reveals that few philosophers have written about the relevance of calculation and computing. This isn't surprising because until the 1950s the limitation of automatic calculation had made it a laborious work and scientists and engineers preferred analytical methods and measuring instead of calculation.[9] Beside the afore quoted statement of Martin Heidegger, who declared technology and mathematical research into nature as the fulfillment of the essence of Modern Times, interesting ideas for a research programme of a „Philosophy of Computational Sciences“ can be found in the work of Edmund Husserl. Husserl explores in "The Crisis of European Sciences and Transcendental Phenomenology" the conceptual shifts introduced by mathematics into science. He investigates the consequences of these shifts for today's science and its style of causality which is programmed as an "a priori" into our thinking and our "Lebenswelt". *(Panel 1: Philosophical Remarks on the Rationality of Quantification)*. These "a prioris" are for instance the concept of objectivity and accuracy of the world created by mathematical idealisation of objects which are constructible "ex datis", the possibility of the "indirect mathematisation" of the richness of perception, and the mathematical use of "objects of infinity" (Limesobjekte) and thereby introducing concepts of infinity and approximation into science and constituting the idea of research as an infinite

[7] Poincaré, H.: Science and Method, 1914 (Original 1908)
[8] "But what seems certain is that the sheer amount of calculation going on in the world has undergone a major shift of late, as a result of the widespread application of computing power through the medium of software, to the extent that many quite mundane human activities are now shadowed by numerous, often quite complex, calculations. Calculation, in other words, is becoming a ubiquitous element of human life. … forms of calculation are changing. Increasingly, analytic solutions are being replaced by brute computing force engendered by mass recursivity with the result that what is regarded as mathematics is spreading far beyond its original kernel of knowledge." Thrift, N.: Movement-space: the changing domain of thinking resulting from the development of new kinds of spatial awareness, in: Economy and Society, vol. 33, n. 4, 582-604: 586-287
[9] Cf. Grier, D. A.: When Computers were Human, Princeton/Oxford 2005

progress. 'The result of introducing this style of causality into science, Husserl states, is no less than “expanding foresight into infinity” by calculation'. He argues 'that thanks to mathematics and the practise of measurement science can create for any extensional aspect of this world of (mathematically idealised) objects a new kind of inductive foresight which is calculated in inevitable necessity based on given and measured data'.[10]

Investigations of a „Philosophy of Computational Sciences“ would concentrate on these conceptual shifts introduced by mathematics and the socio-cultural influences of these shifts. Numerical simulation is the modern prototype “object of infinity” producing “infinite foresight” and therefore enabling today’s science to create a more or less reliable “rational prognosis”. Not only does tomorrows climate change seem to be calculable today but also genetic and molecular coordinates of future creatures, new molecules and new materials. *(Panel 3: Shaping Reality with Algorithms: Earth System, Cells and the Human Brain)*. Rational prognosis, since the 1950s increasingly established by computer based simulation, has caused another conceptual shift by introducing the complex and hybrid symbolic form of “future II” into research. Future II, a rarely used grammatical tense, expresses in a dazzling way the anticipation of retrospection from a future position projected on presence. Peter Bexte calls it a gesture of “a playful tryout in retrospective of future events.” [11]

Implementing future II into science and research challenges basic scientific concepts such as reversibility and repeatability because the preterit of the handed down theory, the present of the model code, the recursivity of the numerical simulation, the future of the prognosis and, last but not least, the virtuality of the approximation of discrete simulation cerate the complex meshwork of the scientific version of future II. The outcome of such a computational practise is a vague and uncertain picture of the world. The intricate temporal coexistence becomes apparent when climate research predicts global warming afflicted with an unpleasant range of uncertainty and thus forcing society into action. The contingency of the, into infinity expanded, foresight by calculation connects these vague and uncertain pictures of the world with their social and political reception and asks for the development of new operative behaviour patterns in anticipation of turning away possible but unintended futures. This is one of the conceptual shifts introduced by numerical mathematics into research but it is at the same time a shift of the scientific view of the world which is shining through the discussions on climate change, genetic manipulation and the inaccuracy of scientific expertise *(Panel 6: Rational Prognosis, the Management of Uncertainty and Future II)*.

- Socio-cultural influence of numerical mathematics (case studies)

A critical view on of the computational sciences can also be derived from Husserls work when he highlights the crisis of the European sciences at the beginning of the 20th century as the loss of mathematics as an instrument for rationality and knowledge. From his point of view the concepts of formalisation and technisation “understand method as true being” and therefore reduce scientific thinking by increasingly falling into the oblivion of the “Lebens-welt” as the fundament of perception and meaning. While Husserl interprets this reduction of mathematics and science – due to increasing abstraction – as a crisis, Bachelard calls it “surrational-

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[10] „Vermöge der reinen Mathematik und praktischen Meßkunst kann man für alles dergleichen Extensionale an der Körperwelt eine völlig neuartige induktive Voraussicht schaffen, nämlich man kann von jeweils gegebenen und gemessenen Gestaltvorkommnissen aus unbekannte und direkter Messung nie zugängliche in zwingender Notwendigkeit »berechnen«“. Husserl, E.: Die Krisis der europäischen Wissenschaften und die transzendentale Philosophie (1954), Hamburg 1996: 33; cf. Husserl, E.: The Crisis of European Sciences and Transcendental Phenomenology: An Introduction to Phenomenological Philosophy, Northwestern University Press, Evanston, 1970

[11] Bexte, Peter: Das Futur II als symbolische Form, in: Gey, Thomas (Hg.), Berlin, 1992: 703

ism". 'Surrationalism', as he says, 'refers to an expanded concept of knowledge and to areas where the scientific mind can follow its anagogic dreams. These anagogic dreams are shaped by mathematics with the pursuit of more and increasingly complex mathematical functions'.[12] What were dreams in 1940 are now becoming visible, experimental applicable and technologically feasible entities by using simulation. *(Panel 4: The Artificial Nature of a Technoscientific World; Panel 5: Loops between Methods: Simulation, Experimentation, Measurement)*[13]. This is the creative aspect of numerical mathematics, generating objects by methods and using them to expand and transform reality.[14] *(Panel 3: Shaping Reality with Algorithms)*.[15] How is it possible that mathematics can shape reality? In which way is human existence and the environment reformulated? These research questions hit the core of a „Philosophy of Computational Sciences" and reveal the enigma that, as Charles S. Peirce would say, an independent world of objects – not perceivable as thing-in-itself – can be changed by our activity in future. In other words: What is the concrete relationship between numerical mathematics and technology and how do numbers shape reality (case studies).

Gabriele Gramelsberger

[12] Bachelard, G.: La philosophie du non, 1940

[13] „This is our aim: a loop between simulation and experiment. We learn from the experimenter: What is the problem? What do we know? ... Then we start simulating and we ask "stupid" questions: What are the important aspects of the process? And the experimenter usually says that he never had thought about it. These are the typical questions of theorists doing simulations. These questions are usually not addressed by experimentation but when we think about these questions together with the experimenter it turns out that they are very fruitful and we start to design new experiments and new simulations." Interview with a biologist, in: Gramelsberger, G.: Computersimulationen - Neue Instrumente der Wissensproduktion. Explorationsstudie, BBAW Berlin 2004: 18/19

[14] E.g. Ambient Intelligence will increasingly confront us with „reconstructed phenomenon" beside „natural phenomenon". This ontological gap is a further conceptual shift introduced by applied mathematics.

[15] "Mathematics is an organ for knowledge, man's mental eye that allows him to venture into areas of knowledge extraordinarily remote from his everyday world of experience." Eberhard Zeidler, MPI für Mathematik in den Naturwissenschaften, Leipzig: http://www.mis.mpg.de/mpi/zeidler-en/

20.9.2007

▪ *Key Note Lecture: Digital Labscapes: How Simulation Produces Knowledge*

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Computer simulation has become an enormously powerful and versatile means of knowledge production throughout the sciences. Notions such as "virtual laboratory" or "digital laboratory," frequently associated with computer simulation, suggest that simulation applications constitute research environments in their own right. This raises important questions about the relation of simulation and "real" experimentation. Is simulation a legitimate surrogate that enables scientists to replace traditional laboratory experiments by way of computer experiments? But also, what are other epistemic benefits of simulation?

The presentation takes up these questions with the aim to sketch a more fine-grained account. Inspired by Robert E. Kohler's (2002) notion of "labscapes" (employed to address the boundaries of field and laboratory in biology), it proposes to explore "digital labscapes" with their complex topography of practices. The underlying assumption is that simulation is not an isolated practice of knowledge production. The presentation will address the dynamic interplay of simulation with other research activity with the purpose to unravel the multilayered structure that accounts for simulation's power and versatility.

- Merz, M. (2007): Locating the Dry Lab on the Lab Map. In: J. Lenhard, G. Küppers, T. Shinn (eds.), Simulation: Pragmatic Construction of Reality – Sociology of the Sciences, vol. 25 (Dordrecht: Springer), 155-172

- T. Knuuttila, M. Merz, E. Mattila (eds.) (2006): Computer Models and Simulations in Scientific Practice (Special Issue), Science Studies: An Interdisciplinary Journal for Science and Technology Studies 19

- Merz, M. (2002): Kontrolle – Widerstand – Ermächtigung: Wie Simulationssoftware Physik konfiguriert, in: Rammert, W./Schulz-Schaeffer, I. (Hg.): Können Maschinen handeln? Soziologische Beiträge zum Verhältnis von Mensch und Technik, Frankfurt 2002: 267-290

- Merz, M. (1999): Multiplex and Unfolding: Computer Simulation in Particle Physics, in: Science in Context 12, 2, 1999: 293ff

20.9.2007

▪ *Evening Lecture: When Computers Were Human*

Prof. Dr. David Alan Grier
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Editor-in-Chief: IEEE Annals of the History of Computing, http://www.computer.org/annals/

"Before Palm Pilots and iPods, PCs and laptops, the term "computer" referred to the people who did scientific calculations by hand. These workers were neither calculating geniuses nor idiot savants but knowledgeable people who, in other circumstances, might have become scientists in their own right. When Computers Were Human represents the first in-depth account of this little-known, 200-year epoch in the history of science and technology.

Beginning with the story of his own grandmother, who was trained as a human computer, David Alan Grier provides a poignant introduction to the wider world of women and men who did the hard computational labor of science. His grandmother's casual remark, "I wish I'd used my calculus," hinted at a career deferred and an education forgotten, a secret life unappreciated; like many highly educated women of her generation, she studied to become a human computer because nothing else would offer her a place in the scientific world.

The book begins with the return of Halley's comet in 1758 and the effort of three French astronomers to compute its orbit. It ends four cycles later, with a UNIVAC electronic computer projecting the 1986 orbit. In between, Grier tells us about the surveyors of the French Revolution, describes the calculating machines of Charles Babbage, and guides the reader through the Great Depression to marvel at the giant computing room of the Works Progress Administration.

When Computers Were Human is the sad but lyrical story of workers who gladly did the hard labor of research calculation in the hope that they might be part of the scientific community. In the end, they were rewarded by a new electronic machine that took the place and the name of those who were, once, the computers." http://press.princeton.edu/titles/7999.html

- Grier, D. A. (2005): When Computers Were Human, Princeton University Press
- Grier, D.A. (2006): Biographies and Writings by Charles Babbage (1791-1870), in: Communications Book Notes Quarterly, vol 37:1 Winter 2006, p 7-13.
- Grier, D.A. (2006): In Our Time: George Stibitz’s Virtues and Seymour Cray’s Cat, in: Computer, vol 39 no 1, January 2006, p 11-13.

21.9.2007

▪ *Panel 1: Philosophical Remarks on the Rationality of Quantification*

Roots and media of computational power. Some remarks on the genesis and genius of quantification in early European Modernity.

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Long before we invented the computer, we developed computational power shaped as the cultural technique of quantification. What does 'quantification' mean? We use to judge quantification as a mathematical process of abstraction and reduction. But if we look at the emergence of quantification in the early European Modernity (1500 – 1700), we can recognize, that 'quantification' is connected with visualizing the invisible and materialising the immaterial by means of perceptible and palpable symbol systems. To understand this, we have to investigate the function of the 'calculus', not only in every day reckoning (decimal position system and its algorithms) but even in higher mathematics (symbolic algebra, analytical geometry). The use of the 'zero' not only as a gap-sign, but as a numeral is a significant feature. But the cultural technique of quantification by visualization exceeds the use of the calculus. This can be demonstrated by investigating other media relevant for the rise of modernity as money and maps.

- Grube, G., Kogge, K., Krämer, S. (2007): Spur. Spurenlesen als Orientierungstechnik und Wissenskunst, Frankfurt am Main: Suhrkamp

- Krämer, S. (2006): The Cultural Techniques of Time Axis Manipulation: On Friedrich Kittler's Conception of Media, in: Theory, Culture & Society, 2006 vol 28, n. 7-8, S. 93-109

- Krämer, S. (2006): Zur Sichtbarkeit der Schrift oder: Die Visualisierung des Unsichtbaren in der operativen Schrift. Zehn Thesen, in: Susanne Strätling, Georg Witte (Hg)., Die Sichtbarkeit der Schrift, München: Fink 2006: 75-84

- Krämer, S. (1991): Berechenbare Vernunft. Kalkül und Rationalismus im 17. Jahrhundert, Berlin, New York: de Gruyter

- Krämer, S. (1988): Symbolische Maschinen. Die Idee der Formalisierung in geschichtlichem Abriß, Darmstadt: Wissenschaftliche Buchgesellschaft

21.9.2007

▪ *Panel 1: Philosophical Remarks on the Rationality of Quantification*

Terminus Medius – On the Ambivalence of Simulation

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In personal comments on the history of simulation Herbert A. Simon distinguished between a traditional pejorative meaning and a contemporary meaning of the term simulation. The contemporary meaning refers to computer science. Here simulation is an epistemic technique. It is used in order to foresee and determine properties of a system by computational means. Simon guesses that only critics of Artificial Intelligence were aware of the traditional sense of the term as fraud. Exactly this sense was reactivated by French theoretician Jean Baudrillard. In his critique on consumer society he labels processes of simulation as "pseudo". Doing so Baudrillard reactivates a "continental" distrust towards computing and natural sciences. This distrust was sharpened by Martin Heidegger already in the late 1920s. In this tradition of reflection on mathematics the idea is virulent that mathematics and natural science contribute to a closed and finite picture of the world. Heidegger sharpens this idea after the Davos Debate with Ernst Cassirer. Cassirer conceived mathematical symbols as a possibility to overcome human finiteness. Out of this background the ambivalence of the term simulation can be understood as one effect of a principal controversy on the finiteness or closeness of man. Current discussions on simulation may counterbalance the pejorative sense of the term simulation by exploring metaphors that focus on time, process and rhythm and not on pictures.

Jean Baudrillard: La société de consummation. Paris 1988 (EA Paris 1970)

Herbert A. Simon: Die Wissenschaften vom Künstlichen. Berlin 1990 (EA Cambridge/Mass. 1981)

Michael Friedman, A Parting of the Ways: Carnap, Cassirer, and Heidegger, Chicago: Open Court, 2000

- Röller, N. (2006): Marshall McLuhan und Vilém Flusser zur Tragödie des Hörens, in: Schwarz, Hans-Peter(Hg.): Aufträge - Zweites Zürcher Jahrbuch der Künste 2005. Zürich: HGKZ
- Röller, N. (2005): Revolution of the ear? The Typewriter as a Listening Aid, in: Zielinski, Siegfried und Wagnermaier, Silvia (eds): Variantology 1. Köln: Verlag der Buchhandlung Walther König
- Röller, N. (2005):Ahabs Steuer – Navigationen zwischen Kunst und Naturwissenschaft. Berlin: Merve
- Röller, N. (2003): Hierarchies of Communication, in: Diebner, Hans and Ramsay, Lehan (eds.): Hierarchies of Communication. Karlsruhe: ZKM
- Röller, N. (2002): Medientheorie im epistemischen Übergang — Hermann Weyls Philosophie der Mathematik und Naturwissenschaft und Ernst Cassirers Philosophie der symbolischen Formen im Wechselverhältnis. Weimar: Verlag und Datenbank für Geisteswissenschaft
- Röller, N. (1996): Simulation.in: Historisches Wörterbuch der Philosophie, Bd. 9. Basel: Schwabe

21.9.2007

▪ *Panel 1: Philosophical Remarks on the Rationality of Quantification*

Steps and Missteps in the Process of Quantifying Nature

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We are so familiar with the common mathematical models of natural and social phenomena that we have tended to forget the process by which we arrived those models and the missteps along the way. These missteps become intriguing when we remember than they generally required large scale calculations by hand and that the developers of mathematical models felt committed to certain ideas because they had invested so much in the process of calculation. This presentation will consider a scientific version of Gresham's Law. Do we throw good work after bad? Do we stick to ideas simply because we are invested in them?

- Grier, D. A. (2005): When Computers Were Human, Princeton University Press
- Grier, D.A. (2006): Biographies and Writings by Charles Babbage (1791-1870), in: Communications Book Notes Quarterly, vol 37:1 Winter 2006, p 7-13.
- Grier, D.A. (2006): In Our Time: George Stibitz's Virtues and Seymour Cray's Cat, in: Computer, vol 39 no 1, January 2006, p 11-13.

21.9.2007

▪ *Panel 2: The Infrastructure of a Culture of Calculation*

The Impact of Petacomputing on Theories and Models

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Mich würde interessieren, über die Rückwirkung von Rechnern der Nach-Petaflop-Klasse auf Theorien und Modelle selbst zu sprechen. Wir sind nämlich in Jülich der Meinung, dass in der Zukunft eine vom Superrechner abgekoppelte Theorie- und Modellbildung immer weniger erfolgreich sein wird. Was nützt eine Theorie, wenn man sie nicht berechnen kann, so dass sie Vorhersagekraft gewinnt, bzw., wenn man sie nicht einmal simulieren kann?

Warum wird dies gerade jetzt zum Problem? Der Grund ist das Ende der exponentiellen Frequenzsteigerung von Prozessoren. Die Miniaturisierung wird sehr bald zu Multi-Core-Systemen führen, die selbst schon auf Node-Ebene parallel programmiert werden müssen. Weiterhin kann eine Leistungssteigerung schneller als Moore's Law nur durch weitere Parallelisierung mit vielen solcher Nodes erfolgen. Bei Rechnern, die bald mit 10^6 Prozessoren aufwarten werden - in Jülich bekommen wir am 24.9. einen Blue Gene /P mit 64.000 Prozessoren, Ende 2009 wollen wir auf ein Petaflop/s mit 256.000 Prozessoren -, wird es nicht mehr genügen, wie bisher Theorien oder Modelle zu formulieren, die gewonnenen Formeln dem Angewandten Mathematiker weiterzureichen und um einen passenden Algorithmus zu bitten: Die Parallelisierung und rechnergerechte Aufarbeitung muss immer weiter vorne ansetzen.

Da Wissenschaft evolutionären Prozessen unterliegt, erwarte ich, dass mit der Steigerung der Computerleistungen in der Zukunft genau solche Theorien und Modelle die erfolgreichsten sein werden, die "simulierbar" sind. Das bedeutet, höchste Skalierbarkeit eines theoretischen Ansatzes wird unumgänglich werden. Es gibt Beispiele solcher hochskalierbarer Theorien, die ich gerne andiskutieren möchte, wie z.B. ab-initio-Methoden der Material Sciences oder Quantenfeldtheorien, aber es gibt auch Bereiche, die hier noch weit im Hintertreffen sind, vor allem auf dem Gebiet der klassischen Ingenieurwissenschaften.

- Lippert, Th., Schilling, K. (2003): Physics with High-End Computers-Advanced Lab Courses, Springer: Heidelberg

- Raedt, K. De; Michielsen, K.; Raedt, H. De; Trieu, B.; Arnold, G.; Richter, M.; Lippert, Th.; Watanabe, H.; Ito, N. (2007): Massively parallel quantum computer simulator, in: Computer Physics Communications, 176 (2007), 127 - 136

- Arnold, Guido; Richter, Marcus; Lippert, Thomas (2006): High Performance Simulation of Ideal Quantum Computers, in: NIC Symposium 2006; Proceedings, March 1-2, 2006, Jülich, Germany,G. Münster, D. Wolf, M. Kremer (eds.), pp. 349-356,John von Neumann Institute for Computing, NIC series Vol. 32

- Seyfried, Armin; Steffen, Bernhard; Lippert, Thomas (2006): Basics of Modelling the Pedestrian Flow, in: Physica A, 368 (2006), 1, 232 - 238

- Lippert, T.; Kunze, M.; Streit, A. (2006): Rahmenkonzept für die Einrichtung eines Helmholtz-Grid: Bericht des Helmholtz-Programms Wissenschaftliches Rechnen an den Präsidenten der Helmholtz-Gemeinschaft Jülich, Forschungszentrum Jülich, Zentralinstitut für Angewandte Mathematik

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▪ *Panel 2: The Infrastructure of a Culture of Calculation*

Supercomputing: A new era of opportunity and challenges

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Due to ever improving economies, supercomputing is playing an important role in virtual all fields of science. Areas of science with long term expertise are continuing to push for faster supercomputers. New entries to the supercomputer arena are exploiting the ever improving cost efficiency of supercomputing. Examples of applications on BlueGene/L, (currently the world's fastest machine) will be discussed.

Fundamental technology challenges are upon us forcing the supercomputing community to rethink the approach towards achieving ever improving cost performance. These challenges will result in supercomputing communities, the mature and the new, to adopt different practices to exploit this tremendous opportunity which supercomputing will continue to offer.

- Vranas, P.; Bhanot, G.; Blumrich, M.A.; Chen, D.; Gara, A.; Heidelberger,Ph.; Salapura, V.; Sexton, J. (2006): Gordon Bell finalists II - The BlueGene/L supercomputer and quantum ChromoDynamics. SC 2006: 50

- Salapura, V.; Walkup,R., Gara, A. (2006): Exploiting Workload Parallelism for Performance and Power Optimization in Blue Gene. IEEE Micro 26(5): 67-81

- Gara,A., et al. (2005): Overview of the Blue Gene/L system architecture. IBM Journal of Research and Development 49(2-3): 195-212

21.9.2007

▪ *Panel 2: The Infrastructure of a Culture of Calculation*

Predicting versus Shaping Reality by Mathematical Simulation and Optimization

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In this talk we will discuss the possibilities and the limitations of mathematical simulation and optimization. We will see that mathematical models offer great possibilities of prediction by simulation, but that there are also “chaotic limitations” on certain scales. Only the change of scales may allow to move these boundaries.

On the other hand, mathematical modelling and optimization allow to shape and control reality. In that respect, shaping may be less limited than predicting reality by mathematics. We will exemplify our considerations by applications: weather, climate, crash, automotive design etc.

- Trottenberg, U.; Oosterlee, C. W.; Schüller, A. (2001): Multigrid, Academic Press, London, San Diego

- Trottenberg, U.; Linden, J.; Thole, C.-A. (2002): Simulation und virtuelles Engineering, in: T. Sommerlatte (ed.): Angewandte Systemforschung, Gabler: Wiesbaden, 285-296

- Trottenberg, U., Linden, J. (2003): Simulation und Optimierung - Innovation durch Mathematik, in: Warnecke, Hans-Jürgen; Bullinger Hans-Jörg (ed.): Kunststück Innovation: Praxisbeispiele aus der Fraunhofer-Gesellschaft, Springer Verlag: Berlin, 55-60

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▪ *Panel 3: Shaping Reality with Algorithms: Earth System, Cells and the Human Brain*

Shaping Reality with Algorithms: The Climate System

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To understand the system “Earth" and the impact of man-made change on our living conditions is one of the grand challenges for science. The global environment, and in particular the climate, are extremely complex systems, whose dynamics and future development can only be understood through extensive investigations and complicated model computations. Climate models provide a virtual laboratory to test our understanding of the fundamental physical processes controlling climate and to investigate possible changes that will occur. The presentation will give a short introduction into how such models are developed, used, and what limitations they might have.

Because climate researchers are increasingly involved in making statements about physical phenomena that influence, and are influenced by, human activities, and because their statements might have some influence on political and economical decisions, scientists have to communicate performance and limitations of their model simulations. In the framework of the IPCC assessment a globally organized system of evaluation and model comparison has been established. We will outline the evaluation strategy and present some examples of model’s performance. In this context, we will also address the question what do we know from observations about the climate system.

Finally, we will address the question whether climate is predictable.

- Feichter J., M. Schultz, and T. Diehl (2002): Modeling chemical constituents of the atmosphere, Computing in Science & Engineering 4, 56-63.

- Feichter J., E. Roeckner, U. Lohmann, B. Liepert B (2004): Nonlinear aspects of the climate response to greenhouse gas and aerosol forcing, Journal of Climate; 17, No 12, 2384-2398.

- Lohmann U., Feichter J. (2005): Global indirect aerosol effects: A Review, Atmospheric Chemistry and Physics; 5 (2005), 715-737

- Stier P., Feichter J., Kinne S., Kloster S., Vignati E., Wilson J., Ganzeveld L., Tegen I., Werner M. , Schulz M., Balkanski Y., Boucher O., Minikin A., Petzold A. (2005): The Aerosol-Climate Model ECHAM5-HAM, Atmospheric Chemistry and Physics; 5 (2005), 1125-1156.

- Kloster S., J. Feichter, E. Maier-Reimer, E. Roeckner, P. Wetzel, K.D. Six, P. Stier, and M. Esch: Response of dimethylsulfide (DMS) in the ocean and atmosphere to global warming, submitted to J. Geophys. Res., 112, G03005, doi:10.1029/2006JG000224.

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▪ *Panel 3: Shaping Reality with Algorithms: Earth System, Cells and the Human Brain*

The Blue Brain Report

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The cerebral cortex, the convoluted "grey matter" that makes up 80% of the human brain, is responsible for our ability to remember, think, reflect, empathize, communicate, adapt to new situations and plan for the future. The cortex first appeared in mammals, and it has a fundamentally simple repetitive structure that is the same across all mammalian species.

The brain is populated with billions of neurons, each connected to thousands of its neighbors by dendrites and axons, a kind of biological "wiring". The brain processes information by sending electrical signals from neuron to neuron along these wires. In the cortex, neurons are organized into basic functional units, cylindrical volumes 0.5 mm wide by 2 mm high, each containing about 10,000 neurons that are connected in an intricate but consistent way. These units operate much like microcircuits in a computer. This microcircuit, known as the neocortical column (NCC), is repeated millions of times across the cortex. The difference between the brain of a mouse and the brain of a human is basically just volume - humans have many more neocortical columns and thus neurons than mice.

This structure lends itself to a systematic modeling approach. And indeed, the first step of the Blue Brain project is to re-create this fundamental microcircuit, down to the level of biologically accurate individual neurons. The microcircuit can then be used in simulations.

The Blue Brain Project is an attempt to reverse engineer the brain, to explore how it functions and to serve as a tool for neuroscientists and medical researchers. It is not an attempt to create a brain. It is not an artificial intelligence project. Although we may one day acheive insights into the basic nature of intelligence and consciousness using this tool, the Blue Brain itself is simply a representation of a biological system and thus would never be considered conscious itself.

- Markram, H. (2006):The Blue Brain Project, in: Nature Reviews Neuroscience 7, 153-160

- Maass, W.; Markram, H. (2001): Dynamic Synapses as Memory Buffers. Neural Networks, in press

- Gupta, A., Toledo, M., Wang Y., Markram, H. (2001): Organizing principles of the neocortical microcircuit. Cellular and Molecular Life Sciences, in press

- Gupta, A., Wang, Y & Markram, H. (2000): Organizing principles for a diversity of GABAergic interneurons and synapses in the neocortex, in: Science, 287(5451):273-8.

- Tsodyks, M.; Uziel A.; Markram H. (2000): Synchrony generation in recurrent networks with frequency-dependent synapses, in: Journal of Neuroscience, 2000 Jan 1;20(1):50.

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▪ *Panel 3: Shaping Reality with Algorithms: Earth System, Cells and the Human Brain*

Simulations of the Circadian Clock

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Circadian rhythms, characterized by a period close to 24 h, are observed in nearly all living organisms, from cyanobacteria to plants, insects and mammals. In mammals, the central circadian clock is located in the suprachiasmatic nucleus (SCN) of the hypothalamus, where it receives light signal from the retina. In turn, the SCN controls circadian rhythms in peripheral tissues and behavioral activity. The SCN is composed of about 20,000 neurons forming a heterogenous network. Within each individual neuron, clock genes and proteins compose interlocked regulatory feedback loops that generate circadian oscillations on the molecular level.

Simulations of the gene regulatory network within single cells are presented. It is shown that a delayed negative feedback constitutes the core of the clock. Mathematical modeling reveals how phosphorylation events can lead to either short or long periods explaining the human familial sleep phase syndrom and doubletime mutants in the fly. Furthermore, the robust synchronization of 20,000 SCN neurons via neurotransmitters is simulated. Finally, extensive parameter optimization is applied to scan different hypothetical mechanisms of the circadian clock in cyanobacteria.

Simulations of the circadian clock illustrate general problems arising due to the enormous complexity of biological systems: How to isolate subsystems suitable for mathematical modeling? How to overcome the permanent lack of kinetic parameters? How to extract evolutionary design principles of biological systems?

- Clodong, S.; Duhring, U.; Kronk, L.; Wilde, A.; Axmann, I.; Herzel, H.; Kollmann, M. (2007): Functioning and robustness of a bacterial circadian clock, in: Mol Syst Biol. 2007;3:90

- Vanselow, K.; Vanselow, JT.; Westermark, PO.; Reischl, S.; Maier, B.; Korte, T.; Herrmann, A.; Herzel, H.; Schlosser, A.; Kramer, A. (2006): Differential effects of PER2 phosphorylation: molecular basis for the human familial advanced sleep phase syndrome (FASPS), in: Genes Dev. 2006 Oct 1;20(19): 2660-72

- Gonze, D.; Bernard, S.; Waltermann, C.; Kramer, A.; Herzel, H. (2005): Spontaneous synchronization of coupled circadian oscillators, in: Biophys J. 2005 Jul;89(1):120-9

22.9.2007

▪ *Panel 4: The Artificial Nature of a Technoscientific World*

Syntheses of artifacts to simulate the natural

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In this presentation I draw attention to two broad families of styles of scientific representation, which I label "Platonic" and "empirical." Platonic representations aim to describe idealized structures isolated from each other and from the impurities and imperfections of the natural world, whereas empirical ones aim to describe nature as it is found, as any skilled observer would find it. Some simulations are found in each family, and perhaps some are members of both.

My focus is on the more empirical ones; it can be difficult to appreciate how these simulations serve as scientific representations at all. I look at the ways in which modelers use multiple artifacts in order to attend to the twists and turns of the natural world, and as such attempt to represent nature in an ordinary and old-fashioned manner.

- Sismondo, S. (2005): Boundary Work and the Science Wars, in: Episteme 1 (2005): 235-248

- Sismondo, S. (2004): Maps and Mapping Practices: A Deflationary Approach, in: Rheinberger, H.-J.; Gaudilliere, J.-P. (eds.): From Molecular Genetics to Genomics: Mapping Cultures of Twentieth Century Genetics. London: Routledge: 203-209

- Sismondo, S. (2004): An Introduction to Science and Technology Studies, Blackwell

- Castel, B.; Sismondo, S. (2003): The Art of Science, Broadview Press

- Sismondo, S.; Gissis, S. (eds.) (1999): Practices of Modeling and Simulation, Science in Context 12/Summer 1999

- Sismondo, S. (1999): Models, Simulations, and their Objects, in: Science in Context 12 (1999): 247-60

- Sismondo, S. (1997): Modelling Strategies: Creating Autonomy for Biology's Theory of Games, in: History and Philosophy of the Life Sciences 19 (1997): 147-61

- Sismondo, S. (1996): Science without Myth: On Constructions, Reality and Social Knowledge, Albany, NY: SUNY Press

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▪ *Panel 4: The Artificial Nature of a Technoscientific World*

Predicting and Explaining with Simulations: Perspectives from Public Health Research and Policy-Making

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Simulation models used in infectious-disease studies provide an increasingly important means to produce evidence for public health decision-making. More precisely, the interest to control epidemic outbreaks or to plan cost-effective vaccination schemes is frequently grounded on model-based evidence. However, little attention has been paid to the ways in which simulation models are used in order to produce reliable explanations and predictions of the phenomena of interest. In order to increase transparency of model-based evidence, we need to analyse the initial explanatory and predictive questions that a simulation model was built to address. In other words, focusing on a "what if" -type of question enables us to see how the capability of a simulation to project possible future conditions of a phenomenon also requires explanatory answers to why, what and how questions. This means tracing back the set of sub-models that are built to address these questions and that simultaneously result in accumulation of knowledge beneficial for the efforts of answering the "what if"-question.

My argument is that "what if"-questions, when studied in simulation models, are not only explaining the phenomena, but also integrating the aspiration of predicting future behaviour of the phenomena. A simulation in this case is an agent-based model used to examine the transmission of an infectious disease in a population via individual contacts (considering also the age-structure of contact sites and including the information of the administered vaccination programmes). The model incorporates mechanisms of disease transmission (e.g. SIS-pattern) or herd immunity. Following Bechtel and Abrahamsen (2005), explaining a phenomenon involves describing the mechanism responsible for it, and furthermore, resulting in building a model to specify the key parts and operations of the phenomenon. Mechanisms, hence, are sought in order to explain how a phenomenon comes about or how a significant process works (Machamer, Darden and Craver 2000). In the model under scrutiny, the mechanisms are detected to explain, for example, why certain timing of booster vaccinations increases herd immunity to protective level. Furthermore, we are able to detect a set of questions addressing the how, what and why of the phenomena and resulting as a set of explanations of the specificities of its behavioural patterns. These questions can also be classified as manipulative questions, which is in line with Woodward's (2003) argument that explanatory relations in principle support interventions. These interventions are used in order to understand possible developments in the behavioural patterns of the phenomena. The explanations are incorporated in the simulation by answering a broader, predictive "what if"-question. Hence, the simulation model is not only explaining the phenomena, but predicting how it would behave when the initial conditions are changed (e.g. herd immunity levels decrease, the population is exposed to external, cross-reactive bacteria, or vaccination schedules are changed). Therefore, we may conclude that analysis of explanatory and predictive functions of simulation models by defining the initial questions facilitate uncovering the hidden model assumptions and hence increase understanding of the nature of evidence produced by the models.

- Mattila, E. (2007): Struggle between specificity and generality: How do infectious disease models become a simulation platform?, in: Küppers, G.; Lenhard, J.; Shinn, T.: Simulation: Pragmatic Constructions of Reality. Sociology of the Sciences Yearbook vol 25, Springer: 125-138

- Mattila, E. (2006): Questions to Artificial Nature: a Philosophical Study of Interdisciplinary Models and their Functions in Scientific Practice, Phil. Studies from the Univ. of Helsinki, no 14. Dark oy: Helsinki

- Mattila, E. (2006): Interdisciplinarity 'In the Making': Modelling Infectious Diseases, in: Perspectives on Science 13:4; 531-553

- Knuuttila, T.; Merz, M.; Mattila, E. (2006): Productive and Contested: Computer Models and Simulations in Scientific Practice, in: Science Studies, 19:1

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▪ *Panel 4: The Artificial Nature of a Technoscientific World*

Artificial, False, and Performing Well

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My talk will examine the question of how computer simulation challenges basic assumptions of mathematical modeling. Te main claim is that instrumental modeling steps play an essential role in a variety of simulation modeling techniques. I will illustrate this claim by a brief discussion of cellular automata and finite differences as applied in astronomy and climate science. In both cases, deliberatively false or artificial assumptions and parameterizations provide the clue to appropriate model performance. Consequently, I will argue, how well simulations perform cannot be derived from how accurately they approximate some underlying mathematically formulated laws. Therefore, simulation calls for a new conception of mathematical modeling.

- Küppers, G.; Lenhard, J. (2007): Simulation and a Revolution in Modelling Style: From Hierarchical to Network-like Integration, in: J. Lenhard, G. Küppers und T. Shinn (Hrsg.): /Simulation: Pragmatic Construction of Reality/, Sociology of the Sciences Yearbook 25, Dordrecht: Springer (2007): 89-106

- Lenhard, J. (2006): Surprised by a Nanowire: Simulation, Control, and Understanding,in: Philosophy of Science (PSA 2004) /73/5 (2006), 605-616

- Lenhard, J. (2006): Expert Knowledge, Mode-2 and Scientific Disciplines: Two Contrasting Views (gem. mit H. Lücking und H. Schwechheimer), Science and Public Policy, 33/5: 341-350

- Lenhard, J.; Lücking, H.; Schwechheimer, H. (2006): Expert Knowledge, Mode-2 and Scientific Disciplines: Two Contrasting Views, Science and Public Policy, 33/5: 341-350

22.9.2007

▪ *Panel 5: Loops between Methods: Simulation, Experimentation, and Measurement*

Loops between Simulation and Experimentation

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Conducting a science research study on the practise and epistemic of simulation in science reveals different styles of conceiving and operating simulations according to the varying pragmatic factors of the different disciplines. One of the most interesting aspects is the interlinking between different methods, in particular simulation and experimentation (biology). In contrast to climate research which has limited possibilities to evaluate simulation results by experimentation, cell biology has established a strong interlinking between simulation and experimentation.

The loop between methods transfers specific strategies from one method to the other, e.g. the time resolution of discrete simulation to cell culture experiments. As a result of these observations a "taxonomy" of disciplinary simulation settings in relation to theory, measurement and experimentation can be developed. Such a taxonomy could help to specify coupling problems, e.g. between climate and economic modelling in earth systems but it could also be the basis of an inductive definition of simulation.

- Gramelsberger, G. (in print, 2007): 'Die präzise elektronische Phantasie der Automatenhirne' Eine Analyse der Logik und Epistemik simulierter Weltbilder, in: Martina Hessler, Dieter Mersch: Die Logik der Bilder, Berlin: Transcript

- Gramelsberger, G. (in print, 2007): Simulation - Analyse der organisationellen Etablierungs-bestrebungen der (neuen) epistemischen Kultur des Simulierens am Beispiel der Klimamodellierung, in: Jost Halfmann: Organisation(en) der Forschung, Wiesbaden: VS Verlag für Sozialwissenschaften

- Gramelsberger, G. (2006): Story Telling with Code - Archaeology of Climate Modelling, in: TeamEthno-online, Issue 2, University of Lancaster, June 2006, 77-84

- Gramelsberger, G. (2005): Vom Verschwinden der Orte in den Daten, in: Gegenworte - Hefte für den Disput über Wissen, BBAW Berlin-Brandenburgische Akademie der Wissenschaft, 16/2005: 31-35

- Gramelsberger, G. (2005): Simulation als Kreativitätstechnik, in: Günter Abel (Hg.): Kreativität, XX. Deutscher Kongress für Philosophie, Sektionsband 1, Berlin: TU Berlin, 435-445

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▪ *Panel 5: Loops between Methods: Simulation, Experimentation, and Measurement*

Mountains in the Lab: Models, Experiments, and the Problem of Scale

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When John von Neumann first pointed towards to possibility of using computers to conduct experiments, he referred to wind tunnels, which he understood to be "computing devices of the so-called analogy type". Following this lead, I want to examine the prehistory of computer simulations by drawing attention to the practice of model experiments around 1900. Such "mimetic experiments" (Peter Galison) could be found in different fields of inquiry, like engineering science, geology, meteorology, physiology and even biology, and they brought up important epistemological problems which are still persistent today.

Geology is an especially interesting case, because it was, first of all, defined as an outdoor science. However, at the end of the 19th century, geologists began to make experiments on mountain building and tectonics using small-scale models. Which knowledge did they hope to acquire, and what questions did this move into the laboratory raise? As geological processes happen on a grand spatial and temporal scale, one of the main problems was scale. Which procedures were invoked to guarantee the representativeness of model experiments, and what was the status of the knowledge gained?

By addressing these questions, I hope to complement the present debate on computer simulations with an historical epistemology of the practice of modelling.

- Brandstetter, Th. (forthcoming 2007): Sentimental Hydraulics. Utopia and Technology in 18th Century France, in: Zittel, C./Nanni, R./Engel, G./Karafyllis, N. (eds.): Philosophies of Technology. Francis Bacon and His Contemporaries, Leiden: Brill

- Brandstetter, Th. (2007):Herzpumpen. Wasserhebemaschinen um 1700 als Metaphern, Bilder und Strukturmodelle, in: Wiener Zeitschrift zur Geschichte der Neuzeit 7, Heft 1, 22-38

- Brandstetter, Th. (2005): Der Staub und das Leben. Szenarien des nuklearen Winters, in: Archiv für Mediengeschichte 5, 149-156

22.9.2007

▪ *Panel 6: Rational Prognosis, the Management of Uncertainty and Future II*

Particle Histories. Herman Kahn and the 'Conceiving of the Unthinkable'

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Like no other civil defense consultant Herman Kahn was a figure of public interest in 60's and 70's who focused the »Angst« of a whole generation in his works on nuclear deterrence. Being an pokerfaced advocate for nuclear armament, the *Scientific American* once called him »Ghengis-Kahn«. His frequent writing on first- and second-strike capabilities, unaffectedly taking the loss of millions of US-citizens, scandalized people. On a playing field somewhere between science and fiction Kahn fought all the possible wars that where not going to happen in reality. Although he considered himself as an author using an experimental methodology, he was not well reputed in the circles of Futurology and earned harsh critique by authors like Stanislaw Lem.

In my presentation I would like to show that his method of »scenario-building« (and thus exploring »alternative world futures«) was deeply coined by his early works as a Los Alamos programmer of computer simulation models in particle physics.

- Pias, C. (ed.) (2006): Hrsg.: Herman Kahn – Szenarien, Zürich/Berlin: diaphanes
- Pias, C. (ed.) (2004): Die Zukünfte des Computers, Zürich/Berlin: diaphanes
- Pias, C. (2003): Die Epoche der Kybernetik, Stuttgart: Alcatel SEL
- Pias, C. (ed.) (2003): Cybernetics/Kybernetik. Die Macy-Konferenzen 1946-1953, 2 Bde., Zürich/Berlin: diaphanes
- Pias, C. (2002): ComputerSpielWelten, München: sequenzia

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▪ *Panel 6: Rational Prognosis, the Management of Uncertainty and Future II*

Uncertainty in Grammar. Predictions and the Future in the Past

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Dealing with the future and making predictions includes a grammatical problem. Herman Kahn, founding father of futurology, discussed this question in his famous book »The next 200 years« (1976). According to him, modelling the future implies writing the history of the present. And as we can't wait for historians to do so, we have to do it now – looking back to the present from a future point of view. Doing so we will be formulating sentences in a very special grammatical form: the future perfect. Sentences like »X will have been in the way of Y«, include a hig degree of uncertainty. That is exactly why the future perfect has been a favourite grammatical form in certain periods of literature, philosophy and science (Jean Paul, Friedrich Nietzsche, H.G. Wells, Jacques Lacan, Herman Kahn, W.J.T. Mitchell). One might even speak of a »symbolical form«, as Ernst Cassirer called it. The lecture will have a look at some examples of future perfect, discussed as a symbolical form of/in making predictions.

- Bexte, P. (2007): Zwischen-Räume: Kybernetik und Strukturalismus, in: Topologie. Zur Raumbeschreibung in den Kultur- und Medienwissenschaften, hg. von Stefan Günzel, Bielefeld: transcript, S. 219-233
- Bexte, P. (2006): Aus dem Zeitalter des Weltbildes: Das »World Model« von Jay W. Forrester. Vortrag zum HyperKult 15, Lüneburg 13.7.2006. – Videoaufzeichnung des Vortrags auf der Website der Universität Lüneburg: http://weblab.uni-lueneburg.de/kulturinformatik/hyperkult/archiv/hk_15/bexte.mp4
- Bexte, P. (Hg.) (2005): Denis Diderot – Schriften zur Kunst. Ausgewählt und mit einem Nachwort versehen von Peter Bexte, Berlin: Philo & Philo Fine Arts
- Bexte, P. (1999): Blinde Seher. Wahrnehmung von Wahrnehmung in der Kunst des 17. Jahrhunderts. Mit einem Anhang zur Entdeckung des Blinden Flecks im Jahre 1668, Dresden: Verlag der Kunst
- Bexte, P.; Künzel, W. (1996): Maschinendenken / Denkmaschinen. An den Schaltstellen zweier Kulturen, Frankfurt am Main: Insel
- Bexte, P.; Künzel, W. (1993): Allwissen und Absturz. Der Ursprung des Computers, Frankfurt am Main: Insel
- Bexte, P. (1992): Das Futur II als symbolische Form, in: Gey, Thomas (Hg.), Die deutsche Literatur im 20. Jahrhundert (Germanistentag 1992), Berlin, S. 703-720

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▪ *Statments*

Constructivist Computing for Empirical Modelling (Panel 5)

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For over fifteen years we have been developing an alternative approach to both computing and modelling. Conventional programming assumes sufficient understanding of an application domain to permit a statement of requirement or functionality. The EM approach is focussed at a more fundamental level on the process of gaining such understanding. Therefore sense-making, and the interactive experience of an evolving computer model, are at the centre of its activity. It is philosophically aware, principled and yet practical. It is also essentially informal, still embryonic in some ways, and hard to communicate - especially to the established computing community.

The focus and direction of Empirical Modelling is to develop tools, methods and principles that give greater priority to immediate experience - and particularly to interactive experience of a computer model - than to the forms of language and logic that are conventionally used to capture and communicate that experience. As an example of giving priority to experience - drawn from practice - certain lines of a graphical model originally representing jars of liquid were re-interpreted as the neck and frets of a guitar. Such a drastic re-interpretation is hardly of a kind to be advocated, or even possible, within a conventional program. However, such re-interpretation 'on-the-fly' is not difficult to imagine - or to achieve through the use of our tools. Because of this priority given to experience in EM the use of metaphor, visualization and the modeller'scontinuous interpretative interaction are all prominent in our work.

- Beynon, Russ, McCarty (2006): Human Computing: Modelling with Meaning, online paper, URL: http://www2.warwick.ac.uk/fac/sci/dcs/research/em/publications/papers/082/

- Russ, S. (2004): The Mathematical Works of Bernard Bolzano, Oxford University Press

- Russ, S. (2002): A new paradigm for computer-based decision support, in: Decision Support Systems, Volume 33 , Issue 2 (June 2002): 127 – 142

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▪ *Statments*

Research technology, the computer and scientific advance (Panel 6)

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- Mayntz, R. (ed.) (2006): Die Handlungsfähigkeit des Nationalstaats in Zeiten der Globalisierung, in: Heidbrink, L.; Hirsch, A. (eds): Staat ohne Verantwortung?, Campus, 267-281
- Mayntz, R. (2006): Control of a Terrorist Network: Lessons from the 9/11 Commission Report, in: International Public Management Journal 9 (3), 295-311
-- Mayntz, R. (2006): From government to governance: Political steering in modern societies, in: Dirk Scheer, Frieder Rubik (eds): Governance of Integrated Product Policy. Aizlewood Mill: Greenleaf Publishing, 18-25
- Mayntz, R. (ed.) (2002): Akteure - Mechanismen - Modelle. Zur Theoriefähigkeit makro-sozialer Analysen. Frankfurt: Campus

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▪ *Statments*

Preemptive Culture: its computational significance, historical origins and strategic epistemology (Panel 6)

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Preemption is a privileged mode of action in relation to time. It consolidates the operative core of computer simulations but has equally arisen to a defining attribute of our societal condition. To act preemptively generally means to run ahead of time to forestall or prevent something from happening. Its basic appearance is interruption and replacement. Yet, in stark opposition to a-priory prevention, the crucial anticipatory character of preemptive measures forces actions to be decisive, intelligent and farsighted. Thus, preemption introduces an inevitable strategic epistemology on a time-critical fundament.
Considering the realised paradoxical logics, to undermine 'events' before they may occur, the preemptive establishes a new category of Being amongst the real, the possible and the necessary. The statement shall evince how preemptive reasoning depends on computer simulations and point out the infra-structural underpinnings of our Preemptive Culture.

- Carlé, M. (2007): Signalmusik. MKII - Eine zeitkritische Archäologie des Technosystems QRT, Kadmos Kulturverlag: Berlin

- Carlé, M. (forthcomming 2007): Das Sonische: Vom Klang als Medium zum Ethos des Sound", in: Wicke, P.; Papenburg, J. (eds.): PopScriptum 10: Das Sonische Sounds zwischen Akustik und Ästhetik, Berlin

- Carlé, M. (forthcomming 2007): PARASEMANTICS AND ENHARMONY – coding and decoding the ancient Greek sonosphere, in: Kouche, T. (ed.): Mathematical music theory and computation, Staatliches Institut für Musikforschung PK, Berlin

- Carlé, M. (2006): Zeit des Mediums – Die Genese des Medienbegriffs im griechischen Denken, in: Kittler, F; Ofak, A. (eds.): Medien vor den Medien – Übertragung, Störung, Speicherung bis 1700, Fink

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▪ *Discussion: The Societal and Cultural Influence of Calculation: The Mathematisised View of Science – Towards a Philosophy of Computational Sciences*

Moderation

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- Wengenroth, U. (2007): The German Chemical Industry after World War II, in: Louis Galambos, Takashi Hikino, Vera Zamagni (Eds.), The Global Chemical Industry in the Age of the Petrochemical Revolution, New York: Cambridge University Press, 141-167

- Wengenroth, U.; Hof, H. (2007): Innovationsforschung - Ansätze, Methoden,

Grenzen und Perspektiven, Münster: Lit

- Wengenroth, U. (2006): Intuitiv-heuristische Methoden, in: Gerhard Banse, Armin Grunwald, Wolfgang König und Günter Ropohl (Hrsg.), Erkennen und Gestalten. Eine Theorie der Technikwissenschaften, Berlin: Sigma, 133-144

- Wengenroth, U. (2004): Gute Gründe. Technisierung und Konsumentscheidungen, in: Technikgeschichte Bd. 71, S. 1-18

- Wengenroth, U. (2003): Science, Technology, and Industry, in: David Cahan (Hrsg.), From Natural Philosophy to the Sciences. Writing the History of Nineteenth-Century Science, Chicago: The University of Chicago Press, 221-253

- Wengenroth, U.; Schneider, I.; Trischler, H. (2000), Oszillationen. Naturwissenschaftler und Ingenieure zwischen Forschung und Markt, München: Deutsches Museum