EPF LAUSANNE – OBSERVATOIRE SCIENCE, POLITIQUE, SOCIÉTÉ

MARTINA MERZ

DISCIPLINARY DIFFERENTIATION AND SCIENTIFIC PRACTICE: COMPUTER-BASED WORK AT THE INTERFACE OF RESEARCH FIELDS

Introduction

During the last two decades there has been a tremendous upsurge in the use of computer simulation, mathematical modeling and other computer-based procedures for solving scientific and technical problems throughout industry, economy, science and educational practice. These procedures have become widespread instruments for the production and dissemination of knowledge. They are flexible and powerful tools to accomplish a wide range of tasks in diverse contexts of application and assume different functions: They are used for "dry-lab" experimentation, assist in the interpretation of experimental data and promote a better theoretical understanding.

How can this success be explained? The unique problem solving potential of computer-based procedures is partly due to the fact that they sit at interfaces between different domains of research and/or application between which they establish a connection. Examples of such interfaces are those between theory and experiment, between different research domains, different scientific disciplines, and between contexts of research and of practical application.

The new pervasive use of computational procedures has consequences for science, which are explored in the present project. The initial thesis is that these procedures modify scientific practice and affect the internal differentiation between the sciences. The thesis asserts that computational research in boundary areas assists in displacing and redrawing the boundaries. The central aim of the research project is to reach a better understanding of how computer-based procedures reorganise boundary areas and facilitate communication across boundaries.

Research Plan, Methodology

– Comparative approach: two case studies, maximum contrast
  + inner-disciplinary boundary
  + trans-disciplinary boundary
– Methods:
  + "laboratory studies" approach (sociology of science)
  + participant observation, interviews, document analysis

Conceptual Approach

Constructivist sociology of science:
  + emphasis on scientific practice
  + processes of disciplinary differentiation are conceived as contingent constructions, i.e. boundaries are constantly reproduced, redrawn or dissolved

Central aim: to better understand how computer-based work reorganizes boundary areas and facilitates communication across boundaries

computer-based research <–> boundaries / differentiation

+ Computer models, simulation, etc.

+ Differentiation of disciplinary spectrum
+ Boundaries between research communities and between science and the public

scientific practice

Case Study 1
Inner-disciplinary Boundary – Theoretical and Experimental Particle Physics

– Boundary between theoretical and experimental physics within particle physics
– Study conducted at CERN, European Laboratory for Particle Physics, Geneva
– Computer-based work considered: computer simulation
– Computer simulation is an indispensable strategy of knowledge production with a multitude of applications in both theory and experiment

Epistemic Dimension
– Simulation connects theoretical models with experimental data
– Different application modes of simulation exist in parallel and simultaneously ("multiplexity", Merz 1999)

Social Dimension: Internal Differentiation
– Institutionally and historically consolidated distinction between theoretical and experimental physics (with respect to career patterns, organizational structures)
– But: In the perspective of scientific practice, pattern is superposed by more fine-grained and fluid structures according to which responsibilities and expertise are distributed
  + Boundaries are less solid, less permanent, multiple memberships
  + Simulation activities are embedded in and constitutive of some of these more fine-grained patterns
– Connections between different simulation activities as well as between simulation and other activities are socially supported

Boundary Work and Mediation
How does simulation assist in epistemically and socially connecting different contexts? Modes and conditions?
– Social conditions: Despite large degree of diversity, particle physicists share "epistemic culture" (Knorr Cetina), i.e. they share preferences, meanings, practices, problems, etc.
– Modes of mediation:
  + Simulation supports the sharing of mental images
  + it allows to translate between relevance structures
  + it serves as a tool of knowledge integration and coordination
  + it supports new forms of division of labor (by way of a shift in responsibilities and practices)
– Modes of mediation facilitate:
  + Interaction, negotiation, manipulation, discovery in boundary areas

Case Study 2
Trans-disciplinary Boundary – Environmental Science and the Public

– Boundary between (environmental) science and the public, specifically, between model builders and users
– Example of integrated environmental assessment
– Approach: observation of "energy saving" Focus Group
  + Focus groups are moderated group conversations
  + Version of "integrated assessment focus groups" which aim at introducing a participatory element in the assessment process of complex environmental problems
– Computer model: as "discussion support tool" (Schlumpf 1996)
– Computer model represents scientific knowledge vis-à-vis lay persons

Epistemic Dimension and Boundary Construction
– Constitution of core and surface of computer models
  + Core: scientific machinery of the model is turned into a black box, only accessible to experts
  + Surface: user interface, accessible to 'lay persons'
– Model builders turn computer model into an "answering machine" (Rheinberger)
  –> Standardization of application formats, masking alternative modes of application, as witnessed in focus groups

Social Dimension and Boundary Construction
– Boundary as a "sharp cut"
  + Computer model crosses boundary
  + Substantial feedback from users (laypersons) to model builders (experts) is rare
  + No co-production of knowledge across the boundary
  + Space for negotiation and discussion with help of simulation exists, but outside the construction context of the model: among focus group participants alone

Cultural Dimension
– Access to computer-based infrastructure, expertise constrains the user
– Simulation models offer "an exceptionally powerful tool for reestablishing an authoritative space for science" (Jasanoff/Wynne 1998)

General Results

Comparison of the case studies shows a strong context-sensitivity of how computer-based research assists in reorganizing boundary areas. The technology does not determine its use (against technical determinism).

Communication across boundaries is facilitated and cooperation is encouraged only where the interacting communities share expertise and experience with and interest in computer-based work.
It is in these cases that a space of interaction, negotiation and cooperation can be unfolded in boundary areas through computer-based work.
In many cases of science "meeting" the public by way of computer models, these serve rather to reestablish scientific authority.

Practical Relevance

The (obtained and expected) results of the research project are of relevance in the context of current transformations of science, technology and the higher education system.
The project documents and reflects these transformations insofar as they concern computer-based work and research.
In addition, the project provides a closer understanding of:
– the potential of inter- and transdisciplinary cooperation in science as well as between science and the public
– the consequences that derive from the withdrawal of the empirical realm due to the increasing significance of computer-based computation and experimentation ("dry-lab" experiments) in science and technology

Publications

M. Merz (2002), "Computer models in practice - Das Beispiel des Energiesparens am Bildschirm", in: H. Nowotny, M. Weiss & K. Häni (eds.), Jahrbuch 2001 des Collegium Helveticum der ETH Zürich (Zürich: vdf Hochschulverlag), 139-150.
M. Merz (2002), "Kontrolle - Widerstand - Ermächtigung: Wie Simulationssoftware Physiker konfiguriert", in: W. Rammert, I. Schulz-Schaeffer (eds.), Können Maschinen handeln? Soziologische Beiträge zum Verhältnis von Mensch und Technik (Frankfurt/M.: Campus), 267-290.
M. Merz (2003), "Das digitale Labor - Parallelwelten aufbauen, intervenieren", in: A. Sick et al. (eds.), Eingreifen. Viren, Modelle, Tricks (Bremen: thealit).
M. Merz (2003), "Die simulative Ordnung der Dinge", in: M. Michel & Collegium Helveticum (eds.), Fakt & Fiktion 7.0. Zwischen Wissenschaft und Welterzählung: Die narrative Ordnung der Dinge (Zürich: Chronos).
M. Merz (forthcoming), "Manufacturing Knowledge", in: S. Restivo (editor in chief), Oxford Encyclopedia of Science, Technology, and Society (Oxford: Oxford University Press).
M. Merz (in preparation), "Probing Boundaries. (How) Do Computers Affect Disciplinary Differentiation?"

Contact

Dr. Martina Merz, Observatoire EPFL Science, Politique, Société
Rue de Bassenges 4, CH-1024 Ecublens, phone +41-21-693 88 24
martina.merz@epfl.ch

Last update: June 2002